

## 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.

## Replacement Housings for "Oval Track" one-piece casting Power Steering Racks

Type GE/HE racks are available in ten steering ratios. The housing is machined with the pinion bore at a set distance from the rack centerline, corresponding to its gear ratio. A GE/HE housing can only be used with the pinion for which it is machined, except for the 2.09, 2.36 and 2.62 ratios which share the same housing dimensions. Any rack originally supplied as a type GE with a separate servo can be converted to type HE by adding a servo mounting adapter and splined coupler. NOTE: The GE/HE housing will not work as a replacement housing for type E, F, G, or H racks manufactured from 1983-2008.



shown:  
GE100-392

TYPE GE/HE HOUSING (for either integral or inline servo) has its rack bushings installed and pre-honed, and includes all the R100 kit parts at lower left.

HE100-209/236/262 .....	240.03
HE100-288 .....	240.03
HE100-314 .....	240.03
HE100-340 .....	240.03
HE100-366 .....	240.03
HE100-392 .....	240.03
HE100-419 .....	240.03
HE100-445 .....	240.03

SERVO MOUNTING ADAPTER bolts to the housing and converts any inline servo to integral solid mount.

**VHE584**..... 59.51

SPLINED COUPLER connects the servo output to the pinion spline. NOTE: use of these parts requires a flat on the pinion spline.

**VH201**..... 31.87

Mounting an integral servo requires VHE584 and VH201 parts at left. Note that in a crash the VHE584 mounting adapter can be sprung out of true from contact with the frame or engine, and should always be replaced. Installation details are shown in link #1a: *Servo installation on type HE and HL racks*, in the **Detailed Tech Info** PDFs.

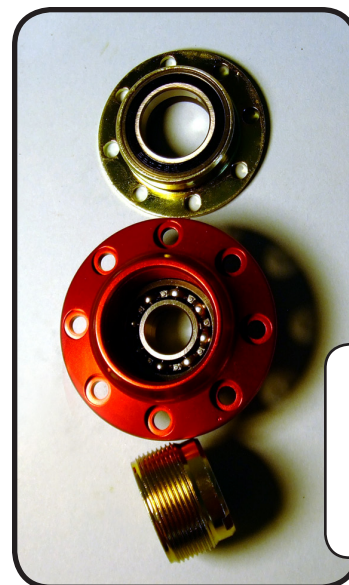
Type GL and HL "long" style racks use a three-piece housing with a casting at each end and a tube in the middle. To order a replacement for one of these, contact the factory with the rack serial number.



REBUILD KIT (refer to the Technical Reference section) **RE100**..... 54.19

**INDIVIDUAL PARTS:**

Pinion thrust bearing (pair) <b>GE340</b> .....	17.45
Snubber adjusting screw <b>GE104</b> .....	10.99
Snubber <b>GE102</b> .....	10.29
Snubber o-ring <b>GE103</b> .....	1.32
Pinion radial bearing <b>GE321</b> .....	11.01
Rack bushing (pair) <b>GE101</b> .....	11.27
Set Screw and cushion <b>GE105</b> .....	2.14
Pinion seal <b>GE323</b> .....	4.86
Rack bushing (pair) <b>GE101</b> .....	10.34



### Pinion Bearing Caps

The pinion is adjusted against the rack with these eccentric bearing carriers. One set works with all ratios. The bearings are offset in the caps .015 which allows easy and precise adjustment of gear lash by simply indexing the caps in one-hole increments.

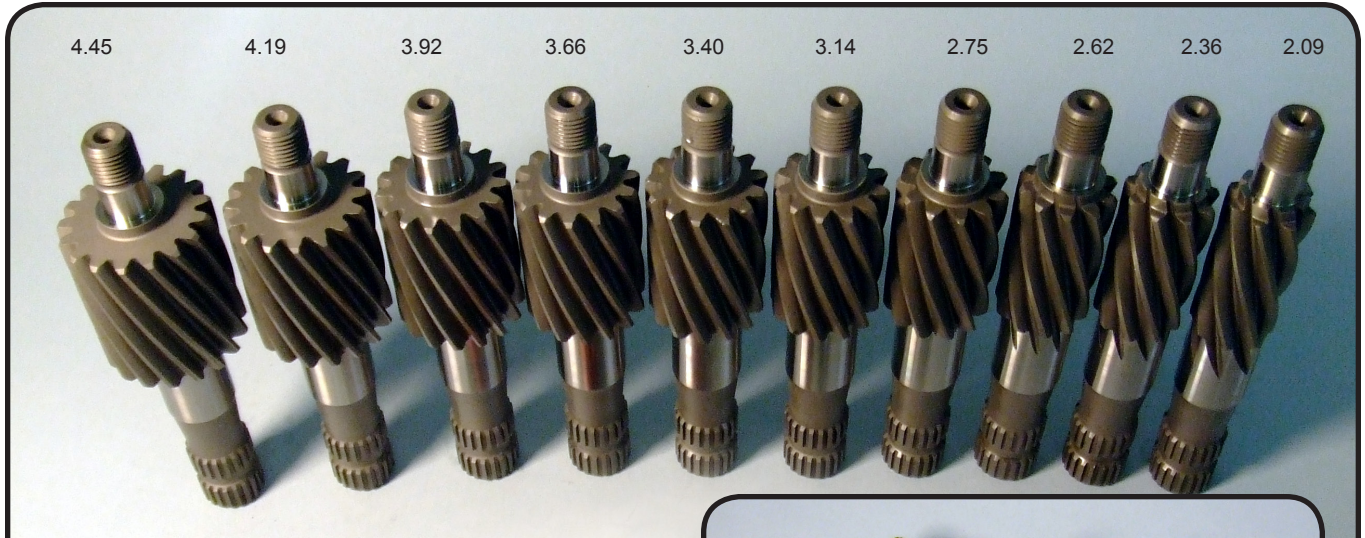
The presence of eight bolts per side effectively ties the housing together, reinforcing it against the separating force of the gears.

LARGE CAP w/ bearings	
<b>GE500</b> .....	48.65
SMALL CAP w/bearing and seal	
<b>GE400</b> .....	32.92
BEARING RETAINER PLUG	
<b>GE341</b> .....	18.61



## Pinions

The ratio is determined by the pitch circumference of the pinion; the larger the pinion, the farther it will drive the rackshaft in one turn. This distance is the "gear ratio" of a rack and pinion set. The range of pinions in GE/HE racks is 2.09 (53 mm), 2.36 (60 mm), 2.62 (66 mm), 2.75 (73 mm), 3.14 (80 mm), 3.40 (86 mm), 3.66 (93 mm), 3.92 (100 mm), 4.19 (106 mm) and 4.45 (113 mm). You can figure "turns lock-to-lock" by dividing the total rack travel, which is nominally 6 inches (152 mm), by the ratio. For example,  $6/2.36=2.5$  turns ( $152/60=2.5$  turns).

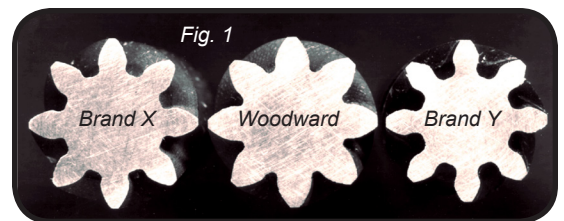


PINION (gear only)	
2.09 ratio	GE308 ..... 132.23
2.36 ratio	GE309 ..... 132.23
2.62 ratio	GE310 ..... 132.23
2.75 ratio	GE311 ..... 132.23
3.14 ratio	GE312 ..... 136.36
3.40 ratio	GE313 ..... 150.64
3.66 ratio	GE314 ..... 152.00
3.92 ratio	GE315 ..... 153.52
4.19 ratio	GE316 ..... 165.36
4.45 ratio	GE317 ..... 169.50

PINION w/ flat for VH201	
2.09 ratio	HE308 ..... 132.23
2.36 ratio	HE309 ..... 132.23
2.62 ratio	HE310 ..... 132.23
2.75 ratio	HE311 ..... 132.23
3.14 ratio	HE312 ..... 136.36
3.40 ratio	HE313 ..... 150.64
3.66 ratio	HE314 ..... 152.00
3.92 ratio	HE315 ..... 153.52
4.19 ratio	HE316 ..... 165.36
4.45 ratio	HE317 ..... 169.50

PINION ASSEMBLY	
2.09 ratio	GEA308 ..... 261.14
2.36 ratio	GEA309 ..... 261.14
2.62 ratio	GEA310 ..... 261.14
2.75 ratio	GEA311 ..... 261.14
3.14 ratio	GEA312 ..... 266.31
3.40 ratio	GEA313 ..... 269.74
3.66 ratio	GEA314 ..... 271.48
3.92 ratio	GEA315 ..... 274.92
4.19 ratio	GEA316 ..... 283.55
4.45 ratio	GEA317 ..... 286.60

PINION ASSEMBLY w/ flat	
2.09 ratio	HEA308 ..... 261.14
2.36 ratio	HEA309 ..... 261.14
2.62 ratio	HEA310 ..... 261.14
2.75 ratio	HEA311 ..... 261.14
3.14 ratio	HEA312 ..... 266.31
3.40 ratio	HEA313 ..... 269.74
3.66 ratio	HEA314 ..... 271.48
3.92 ratio	HEA315 ..... 274.92
4.19 ratio	HEA316 ..... 283.55
4.45 ratio	HEA317 ..... 286.60

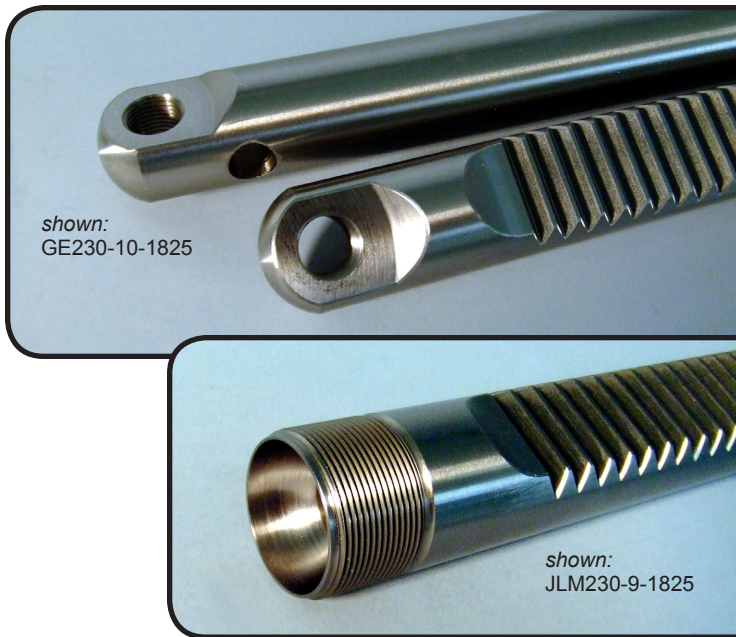


## Woodward Gear Design

The pinion is the single most highly stressed element in the steering. Because the teeth are formed around a circle, their profiles assume a curved shape whose base is always narrower than that of the basic rack tooth. In conventional gears this involute curve produces an undercut which weakens the teeth compared to those on the rack. Woodward pinions are made with a 30° pressure angle. Because this form allows the teeth to be generated without undercut, the gear has inherently stronger proportions and resistance to shear than a pinion of conventional form. In Figure 1, sections through some competitors' pinions appear on either side of a Woodward pinion of the same nominal ratio. You can easily see the strength advantage provided by the shape alone of the Woodward gear. In addition to their beefier profile, Woodward pinions have superior physical properties. Made of 4150 chrome-molybdenum alloy steel and heat treated to a minimum tensile strength level of 235,000 PSI, they are much stronger than the competition. In an revealing test of the four leading US brands, a Woodward pinion was simply hammered against each of the other pinions in Figure 2. Next, each pinion was used to hammer on the Woodward pinion. The results speak for themselves: the competition is beaten. Literally. With our equipment, you can do the same thing on the race track.







## Rackshafts used in type GE/HE

Rackshafts for SLOTTED CLEVISSES	
GEC230-8-1825 (2.09 ratio only)	185.85
GEC230-9-1825 (2.36 ratio only)	185.85
GEC230-10-1825 (2.62 and quicker)	185.85
GEC230-10-1925 (2.62 and quicker)	185.85
GEC230-10-1975 (2.62 and quicker)	185.85

Rackshafts with 5/8-18 HOLES	
GE230-8-1725 (2.09 ratio only)	175.44
GE230-9-1725 (2.36 ratio only)	175.44
GE230-10-1725 (2.62 and quicker)	175.44
GE230-8-1825 (2.09 ratio only)	175.44
GE230-9-1825 (2.36 ratio only)	175.44
GE230-10-1825 (2.62 and quicker)	175.44
GE230-8-1925 (2.09 ratio only)	175.44
GE230-9-1925 (2.36 ratio only)	175.44
GE230-10-1925 (2.62 and quicker)	175.44
GE230-10-1975 (2.62 and quicker)	175.44

GE and GEC rackshafts longer than 19.75..... 192.39

## Rackshafts used in type JL/JLR

Rackshafts for PRELOADED MONOBALL ENDS  
(for type JL/JLR manual racks only; these shafts are hard chromed for high wear resistance)

JLM230-8-1625 (2.09 ratio only)	206.76
JLM230-9-1625 (2.36 ratio only)	206.76
JLM230-10-1625 (2.62 and quicker)	206.76
JLM230-8-1725 (2.09 ratio only)	206.76
JLM230-9-1725 (2.36 ratio only)	206.76
JLM230-10-1725 (2.62 and quicker)	206.76
JLM230-8-1825 (2.09 ratio only)	206.76
JLM230-9-1825 (2.36 ratio only)	206.76
JLM230-10-1825 (2.62 and quicker)	206.76

JLM rackshafts longer than 18.25..... 226.72

The "length" of a steering rack refers to the *distance between the spherical centers of the inner tie rod ends*. This is a critical dimension which must conform to the car's suspension geometry.

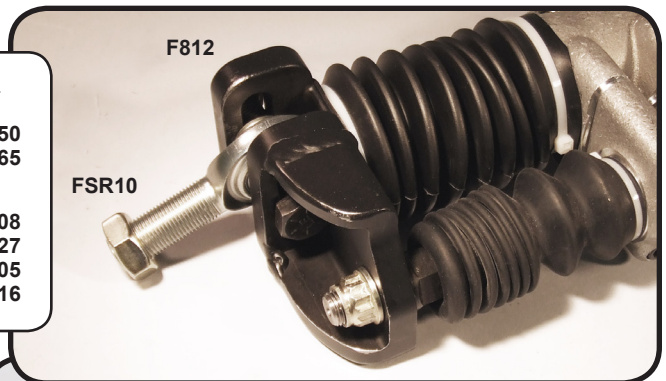
In the GE/HE and JL/JLR steering racks, any increase or decrease from the "basic" length of 18.25 inches is made at the smooth end of the shaft; rackshafts are never extended from the toothed end. *In both these rack types, the distance from the left tie rod hole to the nearest rack tooth is constant.*

These rackshafts are 1.25 inches (31.75mm) in diameter and their end parts are NOT adaptable to any other Woodward rackshafts such as the type CF/CFR (1 inch/25.4mm) or the type MR/MRC (.875 inch/22.23mm).

## Rack Ends for type GE/HE

**SLOTTED CLEVIS** installs with 1-1/2 hook spanner, includes 5/8 rod end.  
RIGHT CLEVIS ASSEMBLY (WITH ROD BRACKET)  
Specify slot UP or slot DOWN F812..... 163.50  
LEFT CLEVIS ASSEMBLY F712..... 92.65

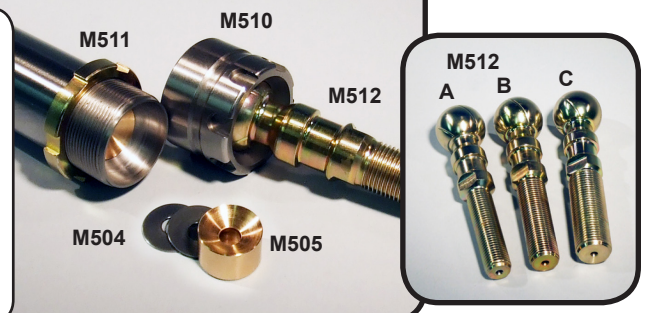
Individual parts:  
Bolt w/nut F510..... 10.08  
Rod end FSR10..... 17.27  
Rod end hats (pair) F513..... 9.05  
Jam nut M511..... 18.16



## Rack Ends for type JL/JLR

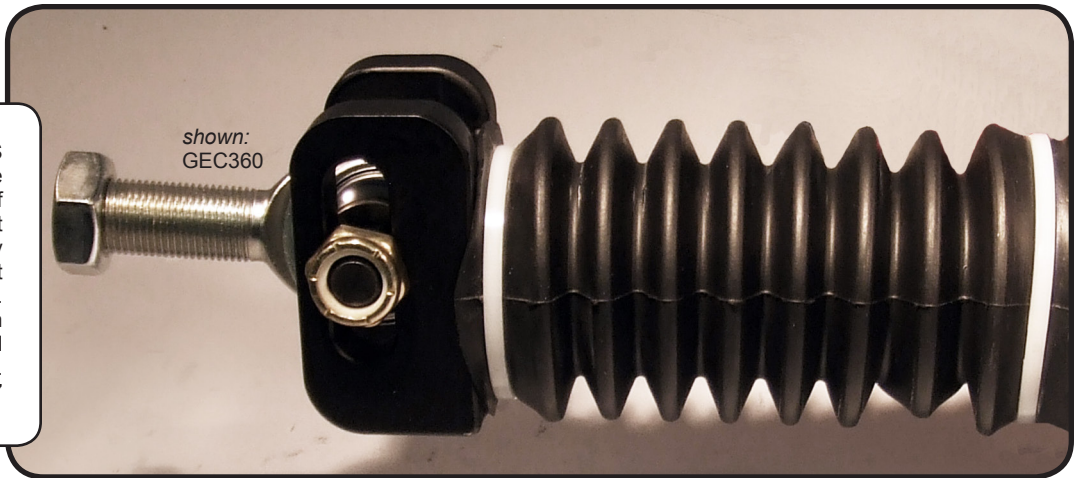
**Adjustable-preload MONOBALL KIT** for one end:  
M501A, M501B or M501C..... 160.69

Individual parts:  
Ball stud 14mm x 1.5 M512A..... 75.64  
Ball stud 5/8-18 M512B..... 75.64  
Ball stud 3/4-16 M512C..... 75.64  
Monoball adjusting nut ("Swivel nut") M510..... 69.60  
Monoball locking nut ("Jam nut") M511..... 18.16  
Preloader M505..... 27.18  
Belleville spring washer (pair) M504..... 11.97

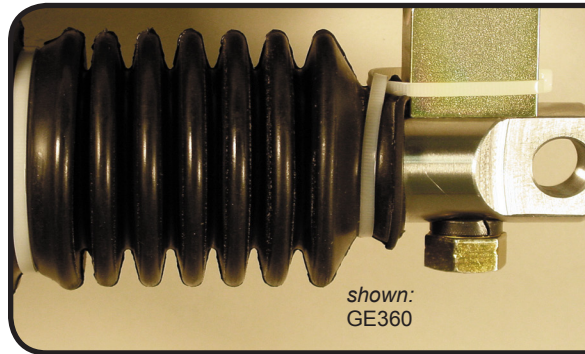
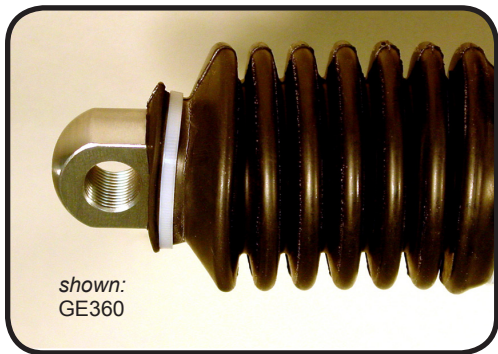


**Clevis rack boots**

BOOT for SLOTTED CLEVIS fits a groove machined in the shank of the clevis. The ID of any GE360 or GEM360 boot will fit the clevis the same way it fits the rack housing, just trim off the outer reduced end. This is an airtight installation and a 1/16 vent hole should be clipped in the bottom side.  
**GE360.....18.37**



**“Standard” rack boots**

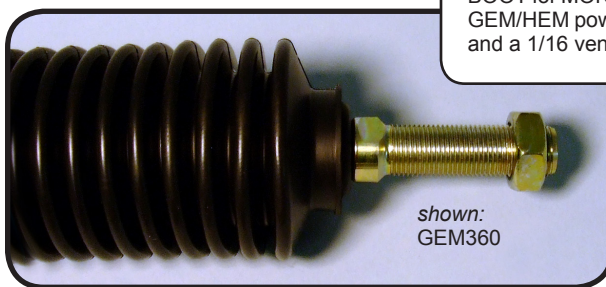


BOOT for rack with 5/8 vertical tie rod hole fits both ends of manual or power rack. When slid up on the shaft for use with the GE264 rod bracket (as at right) the fit will be airtight and a 1/16 vent hole should be clipped in the bottom side.

**GE360 ..... 18.37**

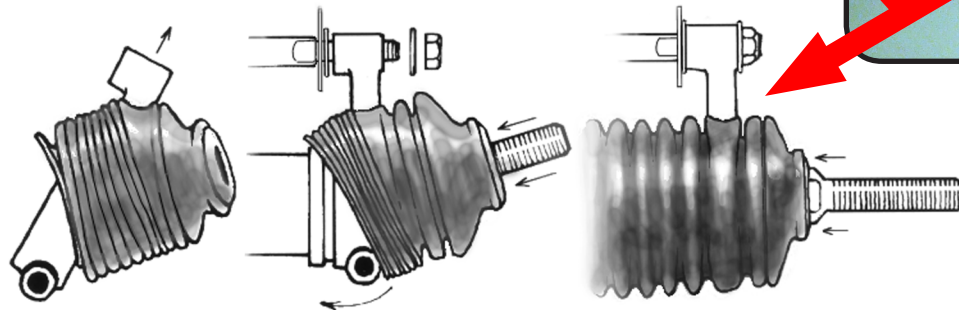
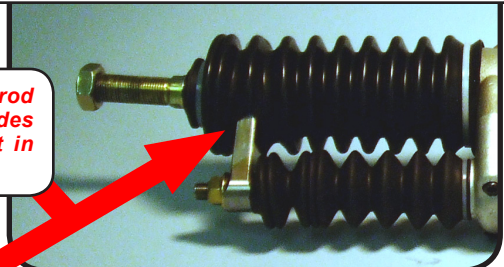
**NOTE: Monoball ends are no longer available on power steering racks because of the notorious difficulty of maintaining the right-side boot where it must be penetrated by the rod bracket. Monoball ends are standard on the type JL/JLR heavy-duty manual steering racks, which do not use a rod bracket. The boots remain available as a service part for existing GEM/HEM racks.**

**Monoball rack boots**



BOOT for MONOBALL rack used on both ends of manual JL/JLR manual racks and on the former GEM/HEM power racks. Has a reduced end which snaps over the ball stud. The fit will be airtight and a 1/16 vent hole should be clipped in the bottom side. **GEM360 ..... 18.37**

**The monoball rod bracket protrudes through a slot in the third pleat:**



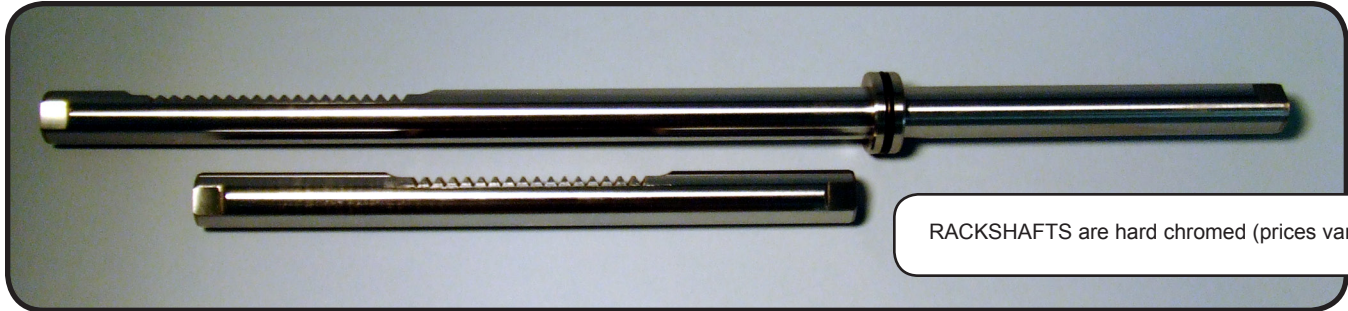
**Installation tip for right Monoball Boot:**

When installing the boot over a GEM264 or 265 rod bracket, coat the inside of the boot liberally with grease. After aligning and tightening the rod bracket, use a smooth pair of pliers to pull the boot the rest of the way on.

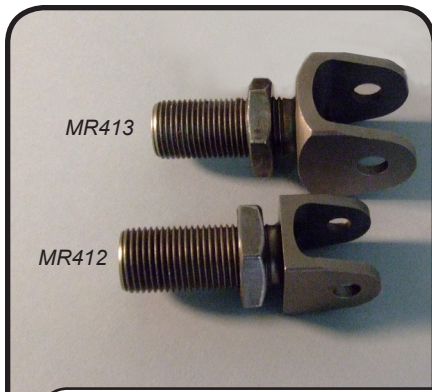


## MR series custom rack parts

MR and MRC racks are essentially custom built and do not have "standard" rack shafts, cylinders, or housing tubes. Some models are proprietary, and spare parts for these are available only through the car manufacturer or authorized agent. Racks are identifiable by the model number on the rear bearing plate, or the serial numbers of the rack and/or servo.



RACKSHAFTS are hard chromed (prices vary).



MR413

MR412

CLEVIS is threaded 5/8-18 UNF and includes the jam nut. Heat-treated 4142 alloy steel, made for two sizes of high-misalignment rod ends:

- 1/4 bolt **MR412** ..... 54.12
- 5/16 bolt **MR413** ..... 56.68

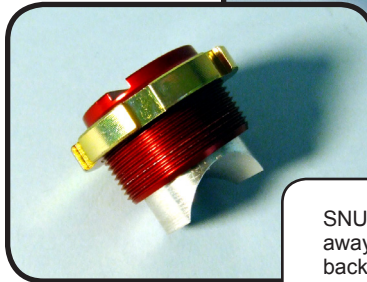
MR HOUSING is for integral servo only. Both centered and offset forms can be reversed for left or right steer and/or inverted for front or rear steer.

- 2.02 and 2.24 ratios  
**MR100A** ..... 257.51
- 2.02 and 2.24 ratios  
**MR100B** ..... 306.73



MR100

MR100B



SNUBBER keeps the rack from being deflected away from the pinion. Also known as a yoke or backstop, this part is included with the housing.



MOUNTING BRACKETS for MR and MRC racks accept 5/16 or 8 mm socket head cap screws.

- For 40 mm dia., each  
**MR35A** ..... 51.23

MRC HOUSING is extremely light and compact. Power steering versions use remote servo. The centered type A can be reversed and/or inverted for left or right steer and front of rear steer. For offset type B specify left or right.

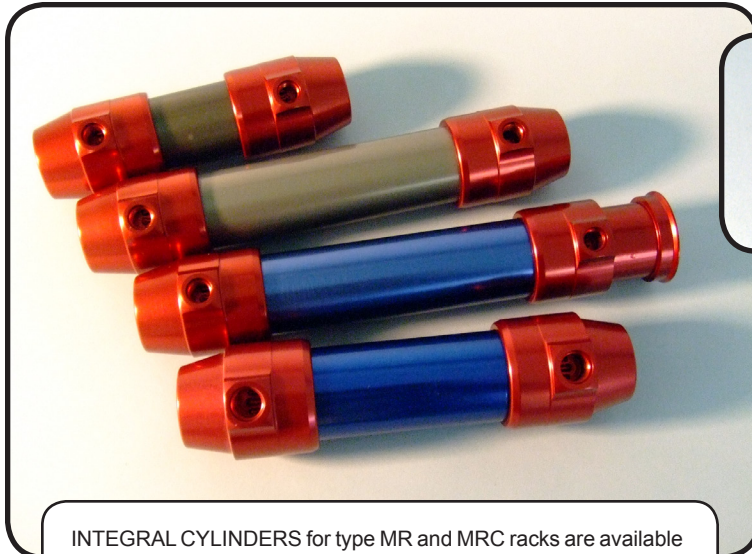
- 2.02 and 2.24 ratios  
**MRC100-224** ..... 173.31
- 2.69 ratio  
**MRC100-269** ..... 173.31
- 3.14 ratio  
**MRC100-314** ..... 173.31
- 2.02 and 2.24 ratios  
**MRC100B-224**..... 223.18
- 2.69 ratio  
**MRC100B-269**..... 223.18
- 3.14 ratio  
**MRC100B-314**..... 223.18



MC100

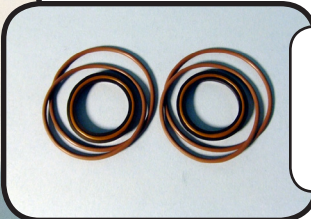
MC100B





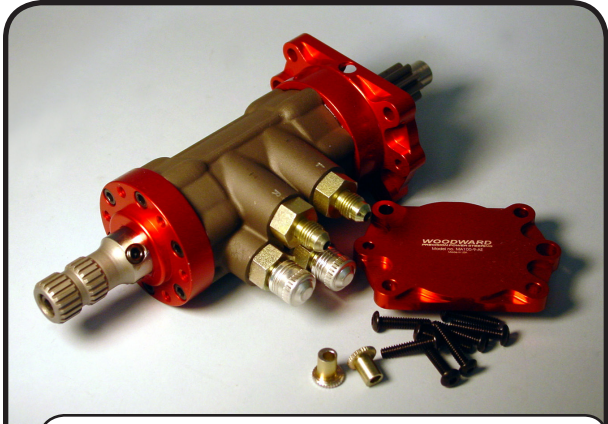
INTEGRAL CYLINDERS for type MR and MRC racks are available as complete units or as individual parts. Give model and serial number of rack when ordering.

1.38 bore: **MR150 + Model number etched on rack**  
 1.50 bore: **MR150X + Model number etched on rack**



CYLINDER SEAL KIT includes Viton® o-rings and loaded lip seals for both ends of the cylinder

for 1.38 bore **MR150R** ..... **22.08**  
 for 1.50 bore **MR150RX**..... **25.02**



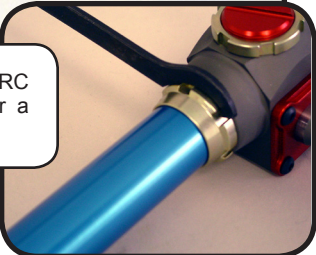
PINION AND SERVO ASSEMBLY for MR racks mounts directly to the housing. Pinion backlash is set with an eccentric bushing. Specify servo valve, ratio, and size of Torsion bar in valve.

2.02 ratio **VA850-1MR-309 + Tbar + Rack model no.**  
 2.24 ratio **VA850-1MR-309 + Tbar + Rack model no.**  
 2.02 ratio **VA850-2MR-309 + Tbar + Rack model no.**  
 2.24 ratio **VA850-2MR-309 + Tbar + Rack model no.**

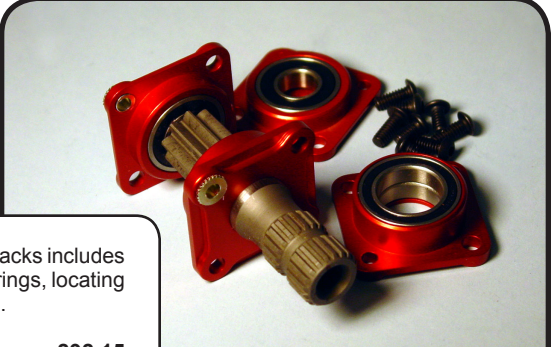
*Note: Ratio set requires both pinion and rackshaft.*



HOUSING TUBES on MR and MRC racks are length-adjustable for a perfect fit in the chassis mounts.



VALVE T-BARS for MR racks are designed for symmetrical road-race steering. They have a smaller directional adjustment band than T-bars meant for oval track racing and a greater resistance to loosening from vibration. **Specify Rack model no.**



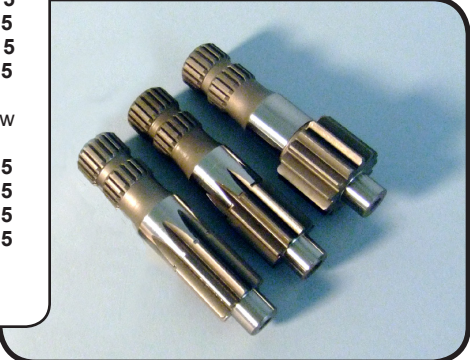
PINION ASSEMBLY for MRC racks includes the mounting flanges with bearings, locating eccentrics, and all cap screws.

2.02 ratio **MCA309** ..... **292.15**  
 2.24 ratio **MCA310** ..... **292.15**  
 2.69 ratio **MCA312** ..... **292.15**  
 3.14 ratio **MCA314** ..... **292.15**

PINION ONLY hardened alloy steel, hollow for weight reduction.

2.02 ratio **MC309** ..... **158.25**  
 2.24 ratio **MC310** ..... **158.25**  
 2.69 ratio **MC312** ..... **158.25**  
 3.14 ratio **MC314** ..... **158.25**

*Note: Pinion and rackshaft are a set.*

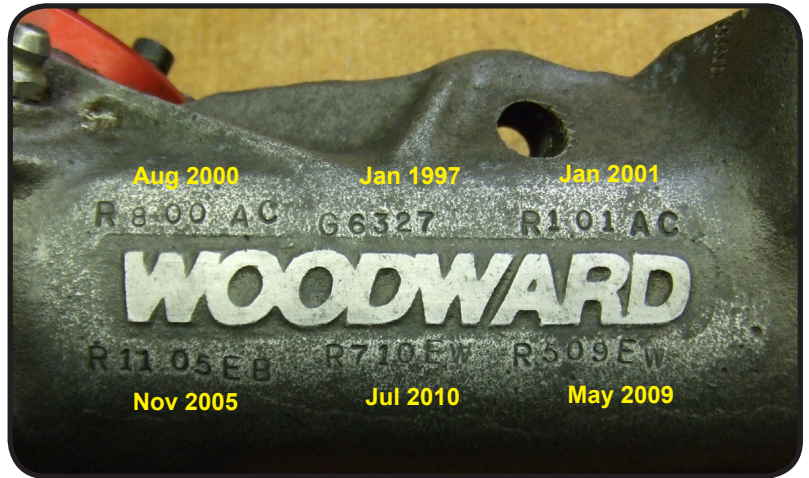






## Keep Your Gears Moving

Serial number G6327 shown below was issued in 1996/97 as a replacement housing to repair crash damage on an even older rack. The subsequent dates stamped on the housing along with the initials of the technician who serviced it, show that this unit remained in continuous service through at least 2010. WEEKLY LUBRICATION OF THE MOVING PARTS by its owner and replacement of the rack bushings after every 50 races helped it survive what probably exceeded 15 years of competition. The newer GE/HE design with its all-ball-bearing pinion is expected to average an even longer useful life than the G/H, but regular and conscientious maintenance will always be the most important single factor in getting the most actual seat time per dollar spent.



ST-3 RACK GREASE is formulated to Woodward specs and is Lithium based with 5% Moly Disulfide, in a commercially unavailable ALGI 2.5 weight. Made from a very heavy base oil, it does not need silica gel as a thickening agent, so its combined properties of tack, lubricity, and high film strength are unsurpassed. **Important: Keep in a separate, clearly labeled gun and use only in the rack. NOT FOR USE IN WHEEL BEARINGS! ST-3 .....28.03**

Since all Woodward seals are now made from material with high temperature resistance (300°F/150°C), chemically compatible with modern automotive fluids such as Dexron III, we have discontinued the sale of our private brand of oil-base power steering fluid shown at right, as it is no longer required.

Note that there is no *functional* difference among various brands of hydraulic fluid; basically, it must (1) be—like any liquid—practically incompressible, (2) flow rapidly enough to operate the steering, (3) lubricate the pump, and (4) not swell or shrink the seals. HOWEVER, there are some commercial “performance aftermarket” brands of PS fluid and ATF which violate point (4). Since Dexron III is readily available worldwide we are recommending it be used in all Woodward servos beginning with serial number 10150, or in any servo rebuilt at the factory since approximately mid-2019 (rebuilt are automatically upgraded with the new type seals).

One useful characteristic of dead-dinosaur-derived petroleum is that its chemical effects in a steering system are benign. You can always use straight petroleum oil in any Woodward steering rack, including 5W-40 motor oil.

