

# Johnson Engineering

Johnson Engineering *Helical Technology For V-Twins*



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# The Helical Plus Advantage

For all practical purposes an overdrive transmission simply isn't necessary to obtain comfort and performance from today's modern v-twin power curve.

## The Advantages of Helical

Since the first Evolution engine was introduced in 1985, the rise in v-twin power output has been dramatic. Today, modern era v-twins easily exceed 130 cubic inches, producing dyno readings that surge past the 200-horsepower mark.

But transmissions - the critical link between motor and pavement - remain much as they were when the first four-speeds were designed nearly 70 years ago. Although there's been progress in case design and component materials used, the actual design has its beginnings firmly rooted in the early 20th century. As a result, failures are increasingly common as the design shortcomings of critical components come to light when subjected to stresses they were never intended to sustain.

Johnson Engineering's helical drivetrain technology delivers superior performance to the v-twin marketplace by employing sophisticated engineering and exclusive design methods not found elsewhere. Our state-of-the-art premium gearing, components, and service items for

late model big twin five-speeds, v-twin sport bikes, and earlier four-speeds, focuses on the total relationship between gears, clutch, bearings, and seals, especially during the transient stages of acceleration.

Commercial trucks, for example, usually operate at a fairly constant 50-100% of available engine torque. Motorcycles, on the other hand, typically run under relatively light loads — except during hard acceleration, or under race conditions. That's when the shock factor can be 300-500% of steady state torque, and why we use transient load factors in our transmission design.

## Faster Shifting And Easier Cruising

Smooth shifting results in both quicker acceleration and longer transmission life. Smoother shifting and positive engagement are the results of increased clearance on the back cut main drive gear dogs. A side benefit is that porting the dogs is no longer necessary for high-speed shifts.

Want lower engine speed and better gas mileage? A simple pulley or

sprocket change lowers cruising RPM's while leaving original performance unaffected. Replacing a stock ratio 32/17 or 41/22 5th-gear set with TwistGear's 41/20 ratio helical gears results in 10% shorter 1st through 4th ratios. The result is six speed highway performance without the fatigue of constant shifting, the expense of a new transmission.

## Direct Or Overdrive

An overdriven transmission compensates for low power output by adding gears and multiplying the gear reduction. Though used primarily in trucks when torque was inadequate for industry needs, today, thanks to advances in both engine output and gear design, overdrives are an anachronism no longer needed in most instances.

With today's impressive v-twin power curves, overdrives, in addition to added expense and complexity, simply aren't necessary for either comfort or performance. Compared to direct drives, which generate far less noise and vibration, overdrives are generally less efficient, less effective,

Specifications			
	TwistGear	Stock	Stock
ratio	41/20	41/22	32/17
profile contact ratio	1.4	2.0	1.5
face contact ratio	1.1	0	0
total contact ratio (more is better)	2.5	2.0	1.5
pressure angle (more is better)	29°	20°	20°
gear width	0.92	0.82	0.82
gear rim thickness	no rim	0.16	0.16
rim stress factor (less is better)	1.0	1.84	1.80

*TwistGear design parameters against OEM gear characteristics.*

less reliable, and in fact rob horsepower.

Overdrives require two sets of gears and bearing supports which run under constant load. In direct (final) drive, the input and output shafts are coupled together, which unloads the gears and bearings within the transmission. This is a critical consideration, because today's riding often involves long distances ridden at steady speeds.

Our TwistGear, WideGear, and SportGear 5th-gear replacements work by increasing the transmission reduction ratio from 10% to 16%, resulting in more reduction ratio than most six-speed overdrive gearboxes, without the distraction of constant shifting.

### Gear Design Basics

Spur gear design methods used today were originally developed in the early 1900's as a necessary refinement as part of the transition to the Industrial Age. Tooth proportions were standardized to produce designs that worked well enough for the early machine technology of the day. Today,

those outdated methods for cutting specific gear families still depend on manual calculations taken from handbooks written at the turn of the 20th century.

The popularity and use of spur cut v-twin transmission gears is based on nothing more than economics. They're cheaper to produce, but the performance tradeoff is significant and includes issues of rider comfort based on noise and vibration.

A gear's shape determines its characteristics. High contact ratio gears generally have taller teeth and are quieter, while short teeth tend to be stronger and noisier. Other clues include thin tips on one or both gears, the slope of the flank, and height.

Most motorcycle gears still incorporate these antique designs, recognizable by relatively thick tooth tips (i.e. stubby or chunky teeth) with a tooth flank slope that's usually around 20 degrees. The main advantage of this obsolete technology is the interchangeability of parts. However, these gears, and their associated cutting tools, cannot be

optimized for either strength or noise.

### Optimized Computer Design

Johnson Engineering's computer designed cutting tools produce gears that operate much more quietly, and with far greater strength and reliability, by constantly iterating through thousands of complex "what-if" situations to deliver the optimum design and deliver the maximum combination of characteristics.

Because helical gear teeth are twisted rather than straight, they allow more simultaneous tooth contact which increases the contact ratio and reduces the noise level. In fact, federal noise requirements are a big reason the automotive industry has turned entirely to helical technology. Not only do helical gears mesh much more smoothly than spur gears, they also possess superior tooth strength.

Our helical gear delivers a face contact ratio of 1.1, and at least one tooth is in contact at all times. The involute gear profile provides a contact ratio of 1.4, resulting in at

# Gear design methods used today were first developed in the early 1900's, using standard tooth proportions to produce designs that worked well enough for the imprecise technology and requirements of the day.

least one tooth in contact at all times. Together, there are at least two full teeth in constant contact.

Gear performance is also influenced by its operating pressure angle. The higher the angle, the less stress, and the stronger the gear. Higher pressure angles also reduce the contact ratio, which tends to produce more noise. TwistGear's computer enabled technology optimizes these two factors - contact ratio and pressure angle - to produce higher strength and a quieter, more efficient transmission.

## Thinking Wide? Think WideGear!

The demand for increasingly wider rear tires has manufacturers turning out more and more monster cross sections, but until WideGear was introduced, conversions were anything but simple. The usual routine of obtaining additional clearance is to move the transmission to the left and space out the primary at the engine with a jackshaft; offset the rear tire; a combination of both; offset the entire engine and drivetrain, the least elegant but most expedient solution; or space out the primary only, using

jackshafts (and their loose clearances) on both the main shaft and the engine sprocket shaft to achieve the necessary clearance.

These approaches are short term fixes that usually result in a bike that is unbalanced and generates various degrees of handling difficulty, vibration, and rider discomfort. In some situations, the bizarre handling that results can strike onlookers as humorous and the rider as terrifying, embarrassing, or both.

WideGear solves tire clearance problems by extending the primary and its associated components. This leaves handling generally unaffected, and the engine and transmission remain aligned as they were designed, with the drivetrain mass centered in the frame, primarily on a centerline with the tires.

Extending the primary drive can generate increased engine sprocket shaft vibration, though it's virtually imperceptible in low revving stock engines. The WideGear sprocket nut is designed with a bearing race in the outboard end, which when used with an outer primary capable of accepting

the bearing, eliminates flex at the engine sprocket shaft.

WideGear is extended using a one-piece mainshaft - not a jack shaft adaptation that's prone to whip, flex, and teeth stripping. Engine torque is transmitted through one continuous forged shaft for strength and reliability. And instead of weak two-piece transmission spacers offered by other manufacturers - which can quickly fail, taking with them the entire housing - WideGear's cast aluminum spacer is a one-piece, heat treated design that easily handles the additional stress generated by a wide tire conversion.

Available in both the original 30mm extension and a new 25mm version (ideal for Dynas), WideGear is a robust engineered answer to a complex problem that won't leave you stranded on the side of the road.

## The Four-Point Bearing Solution

While spur gears exert only radial force on the support bearings, helical gears generate both radial and axial force. If a deep groove ball bearing is next to a gear, the proportion of

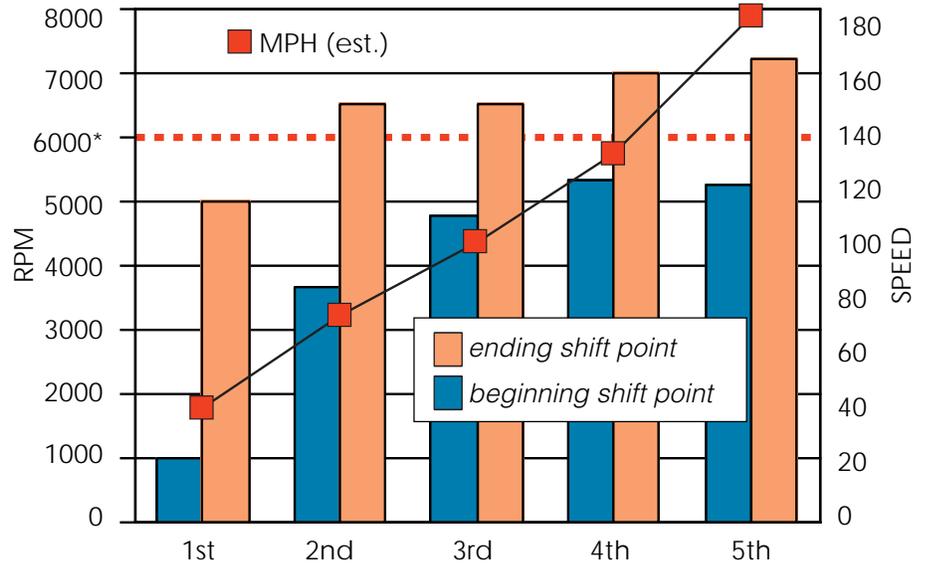
radial force to axial force is normally large enough to keep the balls contacting the groove. This is usually the case for the output gear, but not always the situation for the counter-shaft trapdoor bearing.

Under the loading condition encountered when the driving gears are on the opposite side of the trapdoor, the radial to axial force proportion is small and the balls can contact the shoulder edge, damaging both the balls and the race with predictable results. Our four-point bearings feature much larger shoulders, preventing any combination of radial or axial ball edge loading.

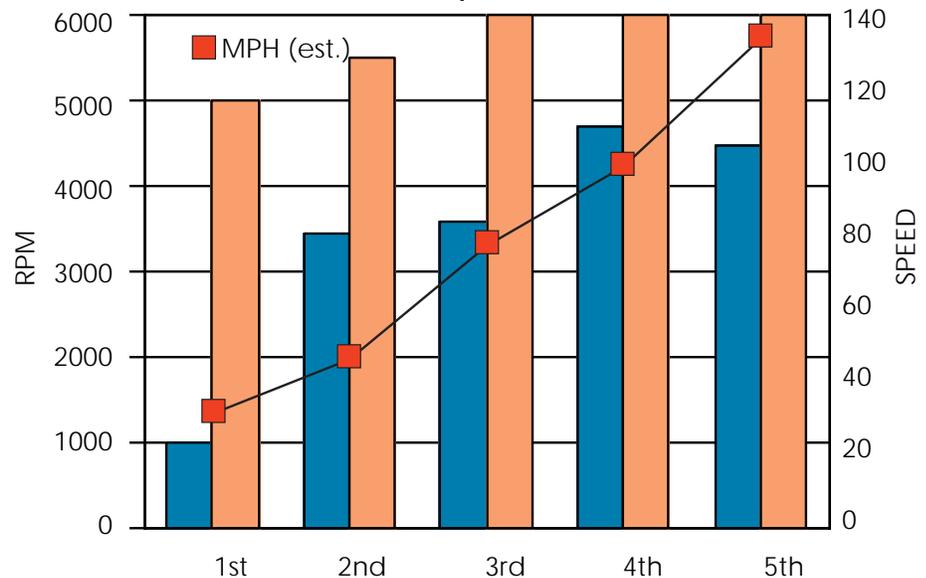
Under heavy load, bearing races can move on the shaft no matter how much press fit is allowed for the bearing. The same is true for shell bearing movement in the bore. Performance and reliability are both enhanced by our use of retainer rings, washers, and caged roller bearings in conjunction with our four-point bearings.

With a radial strength double that of deep groove designs and a corresponding increase in axial capacity,

**SportGear Performance Curve**  
Buell S1W, 101HP With 29/55 Sprockets



**TwistGear Performance Curve**  
BT With 32/70 Sprockets (Stock)



*Characteristics shown in top graph display the top end possible for a SportGear equipped Buell with a 29/55 pulley setup. Note shift points against max horsepower.*

*TwistGear and WideGear share the same characteristics as shown in bottom chart. Performance data based on installation using 32/70 stock pulley combination for quicker first through fourth in town stop and go, and a large reduction in cruising rpm in fifth.*

*Both graphs demonstrate the huge performance gain obtained by a relatively simple transmission modification.*

# SportGear's the quickest way to unleash the full potential of your Buell or Sportster, without sacrificing around town performance.

our four-point ball bearings dramatically reduce bearing failure in both helical and conventional trapdoors.

## Buells And Sportsters

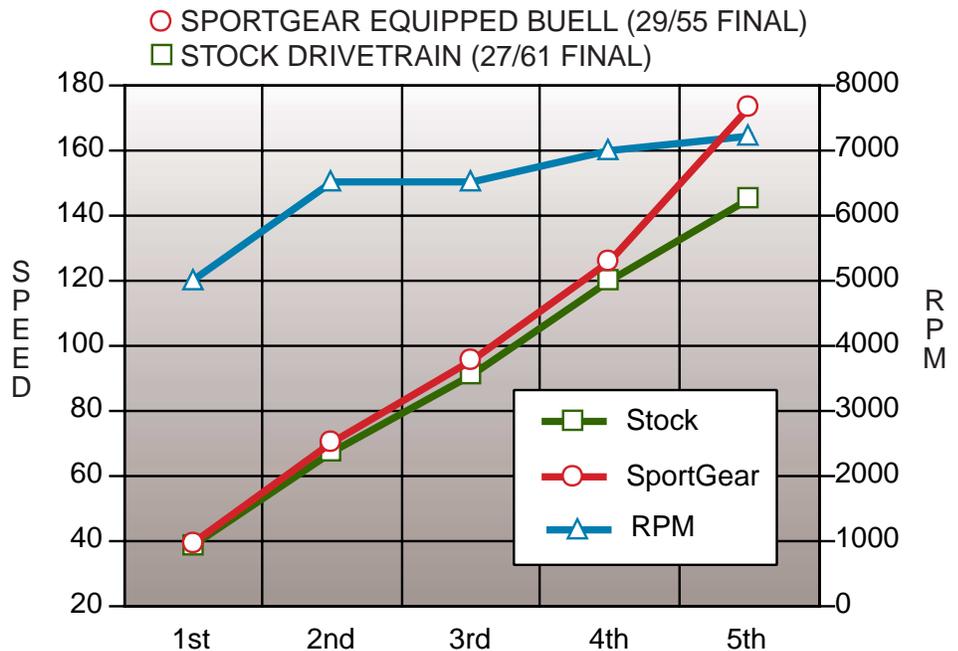
Want to steamroll the competition? Then take a look at the performance gains you'll enjoy after installing SportGear. It's the quickest way to unleash the full potential of your Buell or Sportster, without sacrificing around town fun.

Incorporating all the technology of TwistGear in a sport performance package, SportGear features our exclusive four-point caged ball bearings and triple lip oil seal improvements for long life and reliable operation. In addition, we've added extra beef to the countershaft retaining screw while the main gear oil seal is now firmly secured by a snap ring retainer. No more oiling, and no more countershaft working it's way loose due to retaining screw failure!

Installing the recommended 29/55 pulley combination allows your Buell to finally pull a decent top end without running out of revs and without giving up around town acceleration. Is it the best of both worlds? Just check the graph.

Our new SportGear chart clearly demonstrates the dramatic difference Johnson Engineering's helical fifth-gear assembly can make in top end performance – without sacrificing

will be for 883 riders, for whom lack of horsepower means poor acceleration. SportGear drastically improves first through fourth acceleration, the



around town acceleration. Notice that first through fourth are nearly identical overlays in terms of shift points at the respective mph/rpm mark. The big difference is in top end capabilities, in this case a nearly 30 mph increase over a stock configuration Buell.

Perhaps the biggest improvement

perfect solution for around town and in traffic, where most riding is done.

## Fixing The Main Gear Bearing

High and moderate horsepower applications can easily generate lateral movement of the inner drawn cup bearing. This movement can

eventually result in the bearing working its way out of the main drive gear, with generally unpleasant consequences.

We've fixed this problem by first replacing the inexpensive main drive drawn cup bearing with a high performance caged roller that's capable of much higher load and torque than OE or other aftermarket bearings.

Then we add snap rings over washers on both ends of the bearing, eliminating lateral movement in either direction while allowing the bearing to float within the bore. In addition, our bearing features 3.5 mm diameter heavy duty rollers, three times the capacity of standard 2.5 mm diameter needles.

### **One Piece Countershaft**

Typical 5th-gear countershafts and gears are two-piece designs, resulting in a thin cross-section between the splines and teeth roots and a high stress concentration factor of 1.7. And that's like asking for trouble. Our one-piece gear and countershaft has an ideal stress concentration factor of 1.0, resulting in a significantly

stronger piece with superior fatigue resistance.

All our 5th-gear replacements are fully assembled for easy installation in 1991-up Evolution and Twin Cam 88 5-speeds, usually without removing the transmission or modifying the case.

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# TwistGear



## Outperforms Overdrives!

TwistGear is the revolutionary transmission modification that's sweeping the country, delivering quicker performance, smoother shifting, quieter running, and greater reliability for five-speed big twins and sport bikes.

This 5th-gear replacement, available in kit form or as a completely assembled trapdoor swap, is designed for serious interstate cruisers and boulevard blasters alike, with tuneable characteristics that can lower cruising rpms without sacrificing around town riding.

In many instances popping in a TwistGear kit is a lot less expensive than adding horsepower, and with better results. Our standard kit fits all 1991-up HD-type 5-speed transmissions and come complete with our industrial strength four-point caged bearing set and exclusive triple-lip oil seal and spacer that can greatly extend service intervals.

# WideGear



## Wow! Up To 230mm Wide

WideGear takes the worry out of wide tire conversions, allowing tire sizes up to 240mm – without offsetting the wheel, engine, or transmission, or losing correct geometry and handling.

WideGear features proven TwistGear technology in an engineered package perfect for new construction or existing conversion. Available in either kit or completely assembled trapdoors, WideGear comes with all the parts necessary for a successful and reliable conversion, including extended main shaft and clutch push rod, engine sprocket and starter extensions, and cast transmission spacer and billet engine spacer, as well as WideGear main gear and counter-shaft.

Also included in all our kits are our exclusive triple lip oil seal and chamfered spacer for the easy, reliable way to a leak resistant transmission. Softail kits are stocked. Dyna and FL applications available at a slight additional cost. Choose from 30mm or new 25mm extension.

# SportGear



## Buells and Sportsters

SportGear, our newest helical addition, delivers over 13% more overall gear reduction than stock using the 55/29 sprocket setup. You'll get a taller overall gear ratio while retaining near stock acceleration through the gears. It's the same effect as an overdrive, yet with all the benefits of a direct drive and at a fraction of the cost.

The recommended 55/29 sprockets reduce engine speed about 470 rpm at 60 mph in 5th gear while keeping the gear reduction in 1st-4th gears close to original, providing four narrow ratio speeds for street performance and a slightly larger step to a highway cruising gear. Top end is where all the excitement is, and SportGear speed's increased about 30 mph before the engine rev limiter kicks in at around 7200 rpm.

SportGear has been lengthened to accommodate a retainer ring, keeping the oil seal from falling out of the bore (a common problem with OEM and other aftermarket parts) while also preventing the shell bearing from moving out of the bore.

# Trapdoors



## Convenient Trapdoor Assembly

Both WideGear and the original TwistGear can be installed right out of the box with our fully assembled, factory adjusted trapdoors, available in your choice of polished, chrome, or natural finish.

Our assemblies are clearanced for perfect performance and come complete with our unique four-point caged ball bearings on both the counter and output shafts for unrivaled strength and reliability.

Built tough for years of smooth, effortless shifting, they're easily installed, don't require removal of the engine or transmission, and should save the average builder at least two hours of labor.

Trapdoor assemblies include our exclusive triple lip transmission oil seal and chamfered transmission spacer – guaranteed labor savers that drastically reduce the need for constant seal replacement. Options include choice of trapdoor, finish, and first gear ratios.

# Bearings



## Exclusive Four-Point Bearing

A major source of catastrophic trapdoor failure can be traced to the effects of vibration and the subsequent disintegration of conventional bearing cages, which are usually constructed with simple welds or rivets.

Our four-point caged ball bearings use glass fiber reinforced polyimide 66 cages, which are capable of sustaining oil temperatures up to 250° F and are virtually impervious to vibration.

By effectively distributing the shoulder load these unique four-point bearings, rated at over 6,500 pounds, significantly improve the radial load rating by more than 70% over OE deep groove bearings. And because they're also rated for axial load bearing — something OE bearings can't provide under any circumstances — failure due to lateral migration is totally eliminated.

Our four-point bearings are ideal for all stock, modified, and high-performance transmissions, and are easily used with either stock spur or TwistGear components.

# Seal & Spacer Kit



## Main Drive Oil Seals

In today's harsh operating environments seal failure is a frequent and expensive event because of embedded grime in the outer seal. This grooves the spacer while the extreme friction soon causes temperature failure of the lip, creating a perfect channel for oil to leak past.

Conventional oil seals have only two rubber lips. Our polyacrylate high temp seal, rated to 340F, utilizes a triple lip design for 100% more sealing surface. The result? Extended service intervals and no more dribbling.

## Sprocket Spacers

Our spacers are engineered from a specially coated, extremely hard alloy for top resistance. The micro-smooth surface rotates easily in the seal for low operating temperature and wear, while providing superior corrosion resistance that's not available in conventional hard chrome, nickel plate, or stainless steel spacers. Our five-speed spacers are critically designed with a lead-in chamfer for fast, efficient installation.



*v-twin drivetrain performance*

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