

In the Clutch

By Jeff Smith

Photos by Jeff Smith and courtesy of manufacturers

This is the new age of manual transmissions. The new darling of the street set is the T-56 six-speed, and there is a passel of new five-speeds to choose from, most of which sport some kind of overdrive top gear. Automatics have their

Everything Basic You Need to Know About Clutches

place, but 21st-century performance machines are increasingly sporting manual transmissions. That means clutches are back in the spotlight.

Just like a high-performance cam or carburetor, it's important to choose the proper clutch and pressure plate that's matched to your application. The good news is there are literally dozens of different clutch assemblies available to choose from. That's also the bad news because that offers plenty of opportunity to choose the wrong one.

Let's take a look at some clutch basics first, and then we can jump into selecting the best clutch and pressure plate assembly for your car. For this story, we'll concentrate on the clutch disc and pressure plate. Flywheels are part of the system, and weight does play a big role. Suffice to say that those trick lightweight aluminum flywheels may seem like a great idea by reducing the mass the engine has to accelerate. But for a typical street car, that reduced mass also makes light acceleration from a dead stop very difficult. We'll save the rest of that story for a later issue.

Basics

A clutch only has two basic functions—to momentarily disengage the engine from the transmission and to

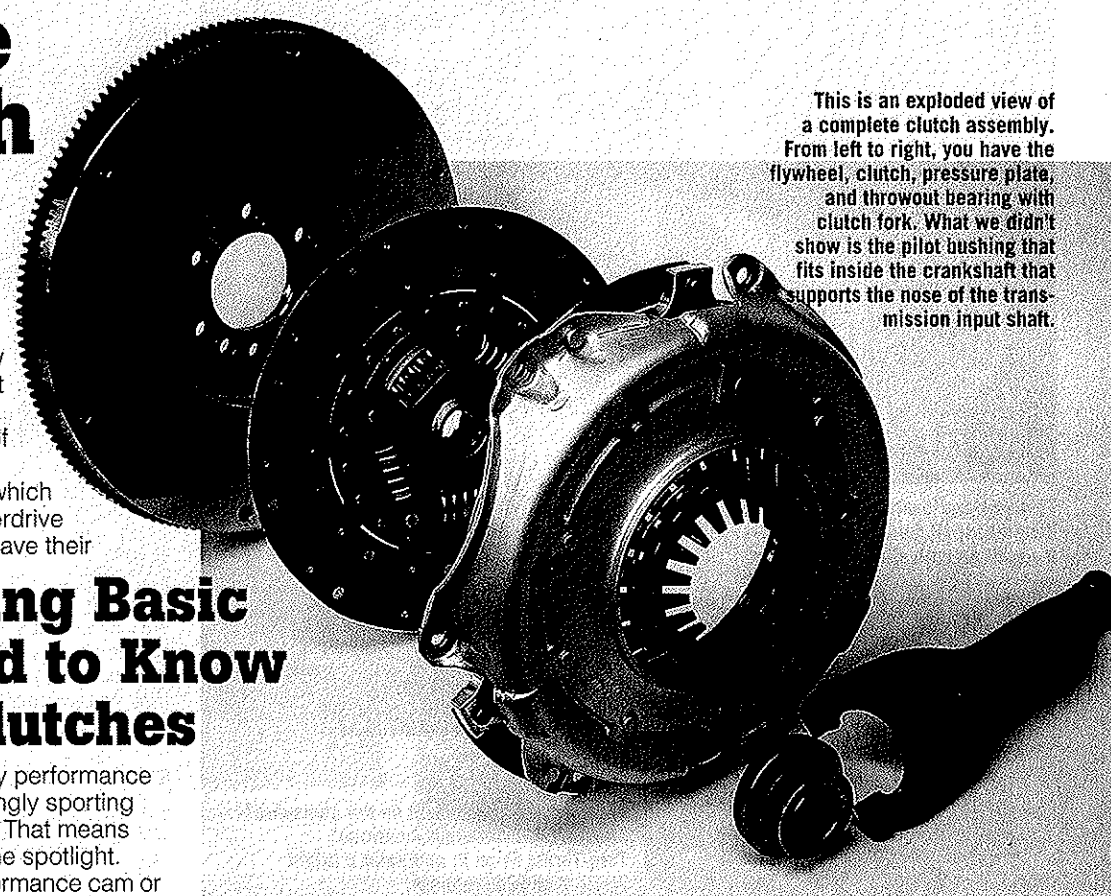
be able to transfer maximum engine torque without slipping. The clutch must also be capable of performing this job for thousands of miles of easy street operation where a small amount of slippage is necessary to make the engagement of the clutch as hassle-free as possible.

To achieve this compromise between performance and street civility, all clutches operate within three basic parameters: The clutch designer must juggle clamp load, coefficient of friction, and surface area to meet his goals. For example, you can have a clutch with a relatively high coefficient of friction (like a sintered iron race clutch), but it will be a nasty, grabby, terrible clutch for street use. You could increase the clamp load, also called static pressure. Static pressure is the amount of base pressure exerted by the pressure plate ring on the clutch disc when the clutch is engaged. The problem with high static load pressure plates is that this also increases the pedal effort, making it a chore to push in the clutch pedal. This

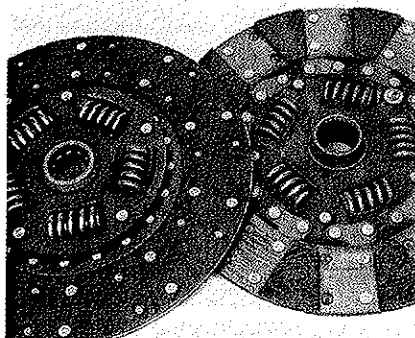
takes a toll on linkage parts.

Alternatively, you could use a larger-diameter clutch. This increases the surface area, which will increase holding capacity, especially if the clamp load is the same. For example, a GM 11-inch clutch disc has a roughly 16 percent larger surface area than the smaller GM 10.5-inch assembly. This increased size does work well, but the tradeoff is the larger clutch requires a larger-diameter flywheel that is heavier and is also roughly 1-inch-larger diameter, requiring more power to accelerate. As an example, Centerforce tells us one of its top-of-the-line 11-inch street clutches can connect up to 620 lb-ft of torque, while a 10.5-inch disc is rated around 530 lb-ft of torque capacity.

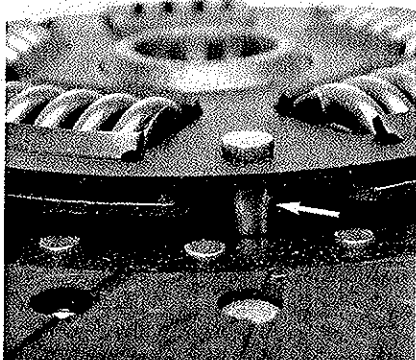
So the key is to carefully balance these three variables to create a clutch and pressure plate combination that can hold all the power your engine makes while not requiring superhuman strength to push the clutch pedal in at a stoplight. You also want a clutch with the right friction surface



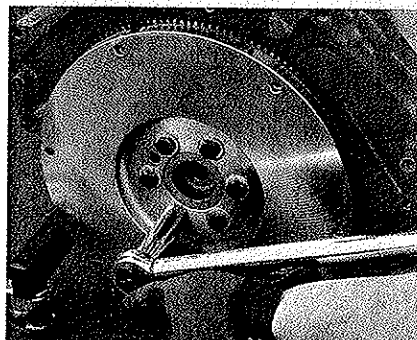
This is an exploded view of a complete clutch assembly. From left to right, you have the flywheel, clutch, pressure plate, and throwout bearing with clutch fork. What we didn't show is the pilot bushing that fits inside the crankshaft that supports the nose of the transmission input shaft.



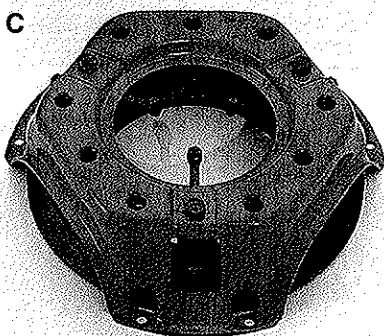
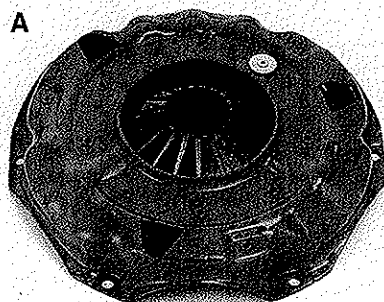
Disc material selection changes the coefficient of friction—or how well the facing grabs the flywheel and pressure plate. The organic compounds (*left*) generally are less aggressive and offer easier engagement. The metallic compounds (*right*) can withstand more heat and offer greater holding power but are difficult for daily street driving. Many companies like Centerforce and Hays offer discs that compromise by using both materials, one on each side.



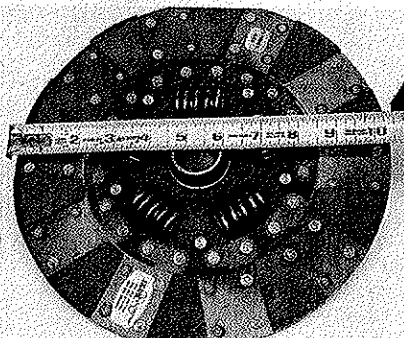
This is a side view of the spring hub that helps cushion the engagement. The limit pins (*arrow*) prevent the hub from rotating too far. If you see flat spots on the limit pins, you've got problems and should replace at least the disc.



Always have the flywheel machined when installing a new clutch disc. This ensures the disc will perform as it should. Also torque the crank bolts and use thread locking compound rather than star washers. ARP makes great bolts for virtually all applications.



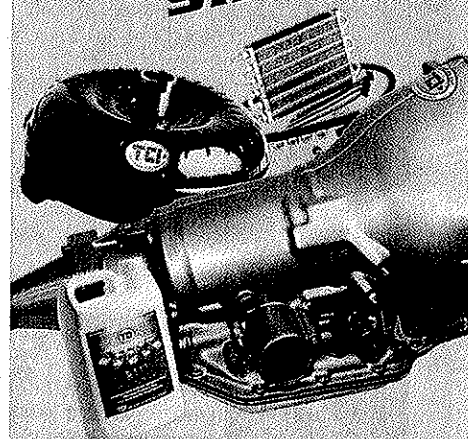
There are three basic pressure plate designs: the diaphragm (*A*), which is the most popular and easiest on the leg; the Borg & Beck (*B*); and the Long style (*C*), which can offer adjustable centrifugal assist.



Comparing a 10.5-inch to an 11-inch clutch, the larger clutch disc offers roughly 16 percent more surface area. This allows the same clutch facing to hold additional torque without resorting to higher static pressure or a more aggressive metallic material.

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IN THE CLUTCH

that offers a pleasant engagement action each time you use it, and one that will deliver durable performance over a reasonable lifespan. Let's start by looking at the clutch disc.

Discs

All street clutches are designed to provide easy engagement for normal street driving. From a dead stop with the engine running, the disc is required to slip slightly as the transmission and everything downstream accelerates up to engine speed. There are lots of things happening when this occurs. A typical street clutch disc is made up of a hub, a drive plate (where the facings are attached), two friction material facings, several springs, and four drive limit pins. The springs are located in the hub, which rides on the input shaft. Inside the hub face are six to eight small coil springs. These springs are designed to cushion the engagement by absorbing a portion of the impact load as the disc is squeezed between the flywheel and the pressure plate. If these springs are too weak, they can bottom out, which allows the hub to hammer the limit pins. If this occurs, it can cause clutch chatter. The evidence of this is found when you inspect the pins and find flat spots. The fix is generally a disc with stiffer springs.

An additional cushion, if you will, is something called the Marcel spring, which is a very thin wafer-like spring that is placed between the clutch facings and the disc. It also acts to cushion the engagement as the disc is loaded by the pressure plate. This may not sound like much, but if you've ever driven a car with a race clutch without the Marcel spring, you've noticed they grab very quickly and can chatter like crazy. Clutch chatter problems with street clutches are usually related to the disc (rather than the pressure plate) and can sometimes be traced to a flat Marcel spring that allows the disc to skip across the flywheel creating the chatter.

Clutch face material is perhaps the most important factor in choosing a clutch disc. Aftermarket companies like Centerforce, Hays, McLeod, and Ram all offer several choices of clutch discs based on the clutch facing coefficient of friction. Over a decade ago, Centerforce made the Dual Friction concept popular, with a metal

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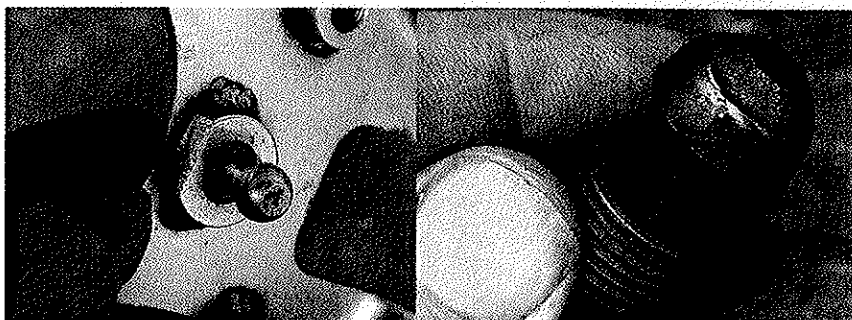
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When installing a new clutch and pressure plate, always install a new ball stud and release arm as well as a new throwout bearing. A badly worn ball stud (*inset photo right*) can lead to binding problems that can cause untold grief.

matrix material placed in segmented pucks on the flywheel side of the disc. This idea has spread to many after-market clutch companies because it combines the more aggressive metallic facing that has a higher coefficient of friction with a more conservative organic facing on the pressure plate side of the disc. The combination of the two facings can hold increased power levels without slippage.

The advantage to the metallic facing is directly related to its temperature capabilities. In most cases, as a friction material temperature rises in an organic compound, the coefficient of friction decreases. This is also true of metallic linings, but they do offer higher temperature capacity. It is possible to mount segmented metallic facings on both sides of a street

clutch, but this also creates a much more aggressive connection between the flywheel and the transmission.

Heat is by far the biggest enemy of any clutch material. Heat is generated anytime you have two surfaces sliding past one another, so there is always heat in a clutch system. The key is to not exceed the clutch disc's temperature ceiling. As a clutch slips, much of the heat is transferred to the flywheel, which acts as a giant heat sink. But if you abuse the clutch by creating more heat than the flywheel can absorb, the temperature quickly spikes in the clutch disc lining. This excessive heat then melts the resins that bond the clutch lining material. These resins rise to the surface of the disc and create a glaze that drastically reduces the coefficient of friction. This

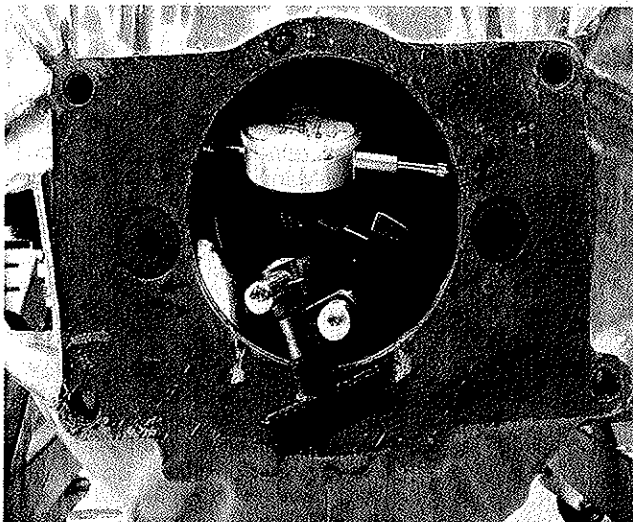


The Marcel spring is that thin, wafer-looking spring placed between the two clutch facings that helps cushion the engagement of a typical street clutch. Race clutches eliminate this spring, which makes the disc engagement much harsher—that's fine for racing but not good for the street.

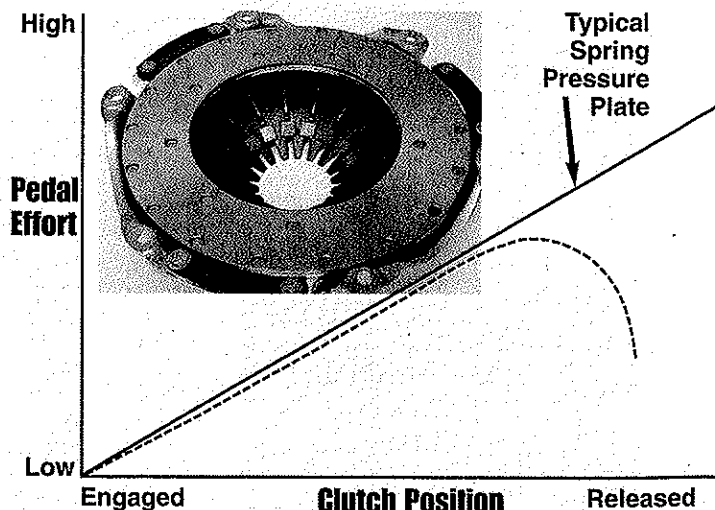
creates even more slippage, and pretty soon you have a dead clutch disc that will barely move the car. That's when it's time for a new clutch disc and pressure plate.

Pressure Plates

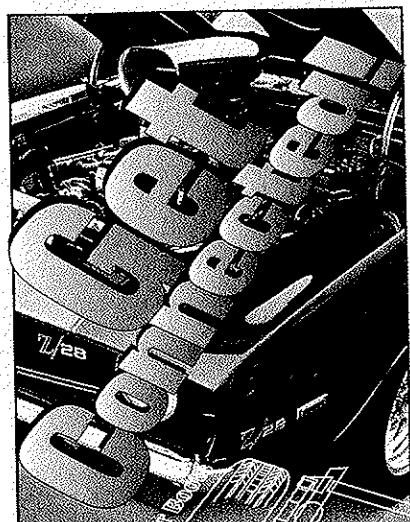
The pressure plate's job is to apply the clamp load to squeeze the clutch plate firmly between the pressure plate and the flywheel. In the performance world, there are basically three types of pressure plates: the Long style, the Borg & Beck,



Whether you are using a stock bellhousing or a steel scattershield, you should make the time to dial in the bellhousing using offset dowels. Ideally, the centerline of the large hole should be within 0.005 inch of the crank centerline. As little as 0.015 inch of offset can put the input shaft in a bind and create high-rpm shifting problems, generally when shifting from Third to Fourth gear.

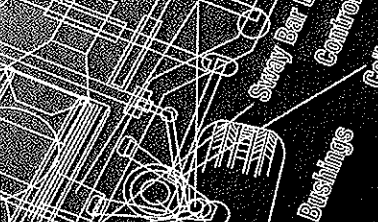


This graph shows how a typical coil spring pressure plate like a Long or Borg & Beck increases pedal effort as the clutch is released. The beauty of a diaphragm is that at a certain point, the Bellville spring over-centers and pedal effort drops dramatically. This makes it easier to hold the clutch pedal in when driving on the street. This is why diaphragms are so popular.



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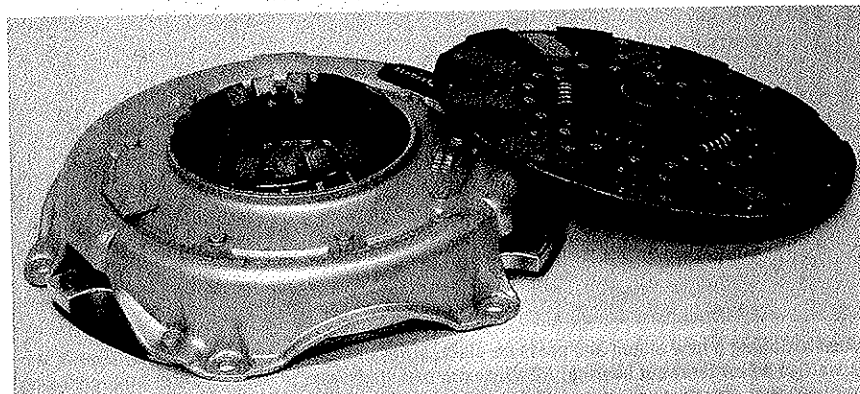
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Centerforce also offers a pressure plate called the Light Metal assembly that uses a lighter aluminum pressure plate ring with a riveted steel face. This reduces the plate's weight while also using ball bearings for the Bellville spring to ride on, significantly reducing the overall effort required to compress the spring. This allows Centerforce to add static pressure without a pedal effort penalty.

and the diaphragm. Of these three, the diaphragm is the best plate for street use, but all three offer certain advantages.

The Long pressure plate is easily identified by the three thin fingers that engage the release bearing. Under the pressure plate cover is a series of nine coil springs. In order to release the clutch, you must compress these springs. The lever arrangement allows the clutch tuner to add small weights to increase centrifugal loading on the pressure plate as engine speed increases. The Long style is mainly used for drag race applications where the static load (established by the stand height) can be adjusted separately from centrifugal load.

The Borg & Beck style is similar to the Long style and is basically a street version of the Long style pressure plate. It can be identified by the somewhat wider three fingers that release plate pressure by compressing the coil springs found under the pressure plate "hat." Certain applications of the Borg & Beck also offer centrifugal assist for high-rpm, high-horsepower applications. The Borg & Beck uses rollers inside the cover that are forced to the outside under centrifugal force to increase the plate load with rpm.

The diaphragm pressure plate uses a single, large Bellville-style spring to load the pressure plate. There are several advantages to this style of spring. First, it loads the pressure plate evenly since the pressure is equally applied to the entire plate assembly. Second, and more importantly, as the Bellville spring is com-

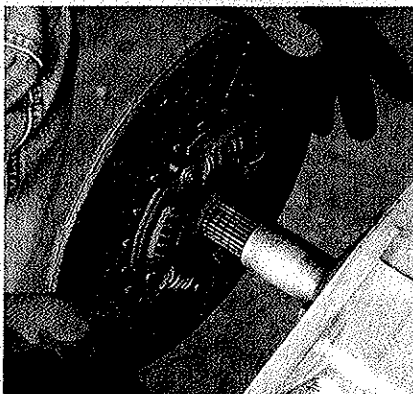
pressed (clutch released), it reaches a point where the pedal effort decreases when the spring over-centers. This makes holding the clutch pedal in at a stoplight much easier than a coil spring type pressure plate.

Recently, companies like Centerforce have attached weights to the fingers of the Bellville spring to add centrifugal load to the spring like the Long and Borg & Beck pressure plates. This does work, although the load increase is not tremendous, it does tend to help the clutch hold the power.

Details

There's also much more to this area than just pressure plates and clutch discs. Proper clutch linkage adjustment and using the right parts is also a major concern. When replacing a clutch and pressure plate, always include a new bellhousing ball stud, release arm, and throwout bearing. Many enthusiasts overlook the ball stud and release arm, and major wear here can bind the linkage and cause all kinds of grief that can be difficult to spot. For example, a worn ball stud can cause binding that can ruin parts and your general disposition.

Fasteners are also critical. Most companies supply new pressure plate bolts with a new clutch and pressure plate, but if not, be sure to include new bolts and always use a torque wrench to ensure proper fastener torque. And we shouldn't have to tell you to never allow the clutch disc or machined surfaces of the pressure plate or the flywheel to get oily or greasy. And always machine



In almost all cases, the clutch disc is installed with the spring hub facing the transmission.

the flywheel surface when using a new clutch. This will ensure a proper break-in and optimal performance from your new parts.

Conclusion

There's at least another story just in installation tips and tricks, but if you pay attention to details, use a quality clutch alignment tool, and don't force the trans if it doesn't want to seat in the bellhousing, you should be in for a pleasant afternoon laying under your car. Also keep in mind that you will need to be easy on the clutch for the first 100 miles or so to break in the organic material. If you pull all that off, your new clutch should reward you with thousands of miles of outstanding performance. **CC**

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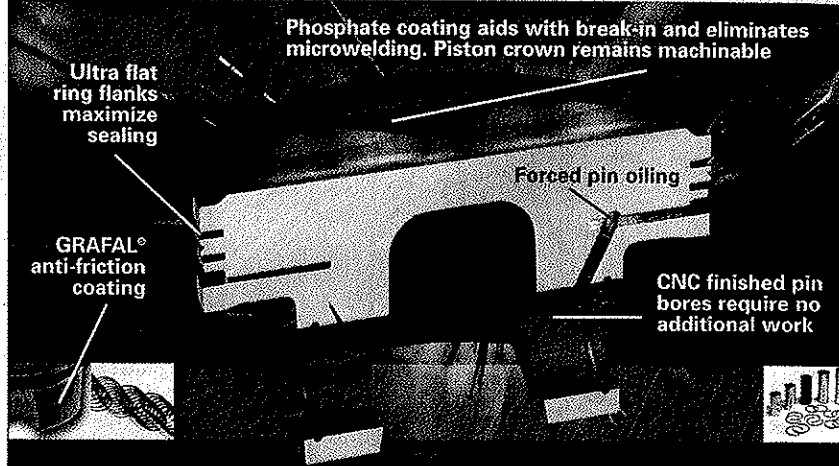
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