Keeping Your

BY CHUCK EDDY

THIS SECTION WILL consider one of the lesser-known and seldom discussed facets of harnessing horsepower. In our experience, few mechanics or speed artists have a basic understanding of the part that engine-transmission-driveline *alignments* play in preserving performance. It is well to be able to coax extra power out of an engine, but conserving power along its path to the rear wheels also produces additional performance.

We are sure all of our readers are conscious that only a percentage of an engine's rated horsepower ever reaches the rear wheels or the road.

Most chassis dynamometers indicate only 50% to 80% of the engine manufacturers' rated output reaches the rear wheels. This is merely to illustrate how power losses do occur in the average power train. Losses are taken for granted because few of us realize how potent a vehicle would be that delivered an honest 150 hp to the rear wheels for every ton of car weight. (This is slightly better than a Mercedes 300 SL!) For direct comparison, a 235 hp Chrysler does not usually deliver 150 hp to the wheels—and weighs over two tons.

Lest we confuse you further at this point, let's tie-in these various important performance factors and see how our chosen subject affects them.

An engine-clutch-transmission-driveline-rear axle train handles torque at various rpm. If we increase the weight of a vehicle, the torque necessary to move it a given speed or rate of acceleration is proportionally increased.

At the front end of the train, increasing the engine's output potential will also allow greater torque loads to be imposed on the long-suffering drive train.

Ordinarily, this transmission of twisting effort (torque) occurs without much fuss or agony. However, should components of the train be out of proper alignment, the agony becomes great and life of the drive train units is much shorter.

We will consider these relationships between successive units of the train and see how abnormal power losses may be avoided.

ENGINE-TRANSMISSION RELATIONSHIP

Two factors involved in possible trouble at this point are angular misalignment and an off-center condition. Basically, perfect alignment of engine and transmission simply means that the crankshaft and all main shafts in the transmission revolve on exactly the same axis. Most of them will not align perfectly due to manufacturing tolerance errors—and there's the rub!

Driving connection between the transmission and the engine occurs in the clutch disc splines. However, the transmission input shaft is not centered by the clutch disc, but rather by a pilot on its fore-end which is centered in a bearing located in either the flywheel center or end bore of the crankshaft. To do the checking job 100%, even the possibility of this pilot bearing being off-center must be considered.

Suspicion that the main bearings themselves are off-center can be dismissed with a recent model engine. However, engines having the main bearings poured and then line-bored may have the main bearings located off-center. This condition existed in many '35 Ford V8's and contributed much to their vibration and wear characteristics. One solution to this problem on the early engine types would be the use of the clutch housing bore (while bolted to the block) as a reference center for the main bearing line-bore operation.

Although these relationships are easily understood by an able machinist, most mechanics are not aware of their importance. Common symptoms of either angular misalignment or an off-center condition are:

1. Oppressive, grinding vibrations (sometimes so powerful that the steering wheel numbs the driver's hands). 2. Clutch disc binding even with pressure plate released (noticeable when shifting from neutral to low). 3. Rapid wear of transmission front main bearing. 4. Transmission comes out of high gear or slips out of second, when coasting against compression.

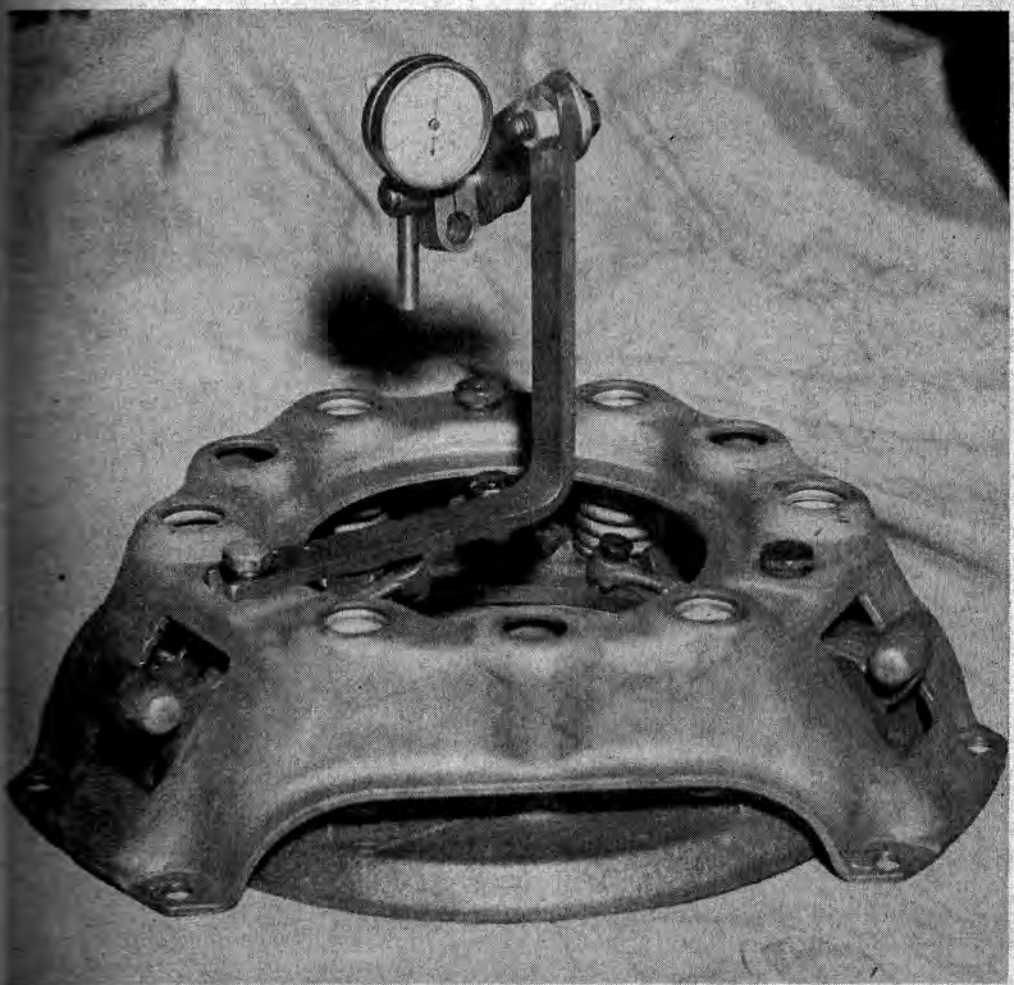
Serious degrees of misalignment will dam-

Horses in Line

TREND BOOK PHOTOS BY JOE MOORE

age automatic transmission pumps of the concentric gear type mounted on the front of the transmission. We have experienced cases of .040 inch off-center in Fordomatic-Mercomatic types. Warning is given by the intensity of front pump noise, which persists even after a new front pump is installed. However, mere front pump noise in the early series Fordomatics should not be diagnosed as misalignment without further checking.

In the heavy truck type transmissions, these conditions may affect the operation of the top two gears in the box, along with malfunctions of the synchronizers. Under load, the shift lever may come out of gear with a loud pop, or may be difficult to shift into



Dial gauge is mounted to the pressure plate with plate removed from engine. Gauge stand is clamped beneath one of the rocker pivot cap screws. Use of magnetic base is simpler.

one of the top gears. As the rear main shaft of most transmissions is piloted in the bore at the rear of the front main shaft, damage to the pilot bearing at this point is usually indicative that an out-of-line situation, forward, has produced binding at this point.

Resorting to basic diagnosis, the question should be asked "Why does a particular bearing wear out in one transmission and not in others at comparable mileage?"

Obviously, transmission bearings, by design, are adequate for normal loads. Therefore, it is foolish to continue to replace gears or bearings under high wear rate conditions without looking elsewhere for the source and remedy of trouble.

Any of the situations mentioned may occur when we start cross-breeding our horsepower. The use of a new mill may involve the installation of one of the excellent transmission adaptors sold by speed equipment houses. Although the mating surfaces of the adaptor may incorporate dowels or other alignment devices, it is well to be skeptical of the accuracy of the completed installation. After all, if an error is machined onto the rear of a new (or used) block you are installing, it would be foolish to place any blame upon either the clutch housing or the transmission!

One quick and dirty method of checking the complete installation of a late model engine may be used. This simple check can be done as the last operation before buttoning-up the driveline. It takes but a moment and may reveal hidden grief. Use the front universal-joint yoke, separated from the drive line, to turn the transmission output shaft. Place the transmission in high gear and hold the clutch released. The output shaft should revolve quite freely without bind in the transmission or drag at the clutch disc. Naturally, if the transmission front main, rear mainshaft pilot, and rear main bearings are all worn, they would probably not bind up, even if misalignment existed.

So take heed to the steps that follow unless you are of the chrome and lead school, in which case, we're boring you.

Since most standard and overdrive transmissions are centered in the clutch housing by their front bearing retainer, there is little possibility of an off-center condition occurring at this point. It is the bore in the clutch housing which may be off-center or angular relative to the crank. Therefore, step number one is to check this alignment. Remove the transmission and withdraw the clutch release fork and release bearing. The pressure plate and disc may also be removed (you may want to inspect them, anyhow). A dial gage mount is fastened to the flywheel or the pressure plate. This may be accomplished simply by making a right angle bracket, slotted on one end to fit under one of the rocker pivot cap screws of the pressure plate. Or with the plate removed, the dial gage stand may be clamped under two of the flywheel cap screws, using large washers under the heads of the cap screws to span the base of the stand. More simple than either of the above methods of mounting the dial is the use of a magnetic dial gage base. This will stick firmly to any iron surface and support the indicator as rigidly as though it were bolted.

You will notice in the photos that we have shown these operations on an engine stand. We feel this method far surpasses checking performed with the engine and clutch housing in the car. One reason is the error that may be encountered as a result of possible sag by the dial indicator support as the crank is revolved. This error is nullified when the engine is mounted vertically in a stand with an unchanging weight factor on the dial indicator as it revolves with the crank.

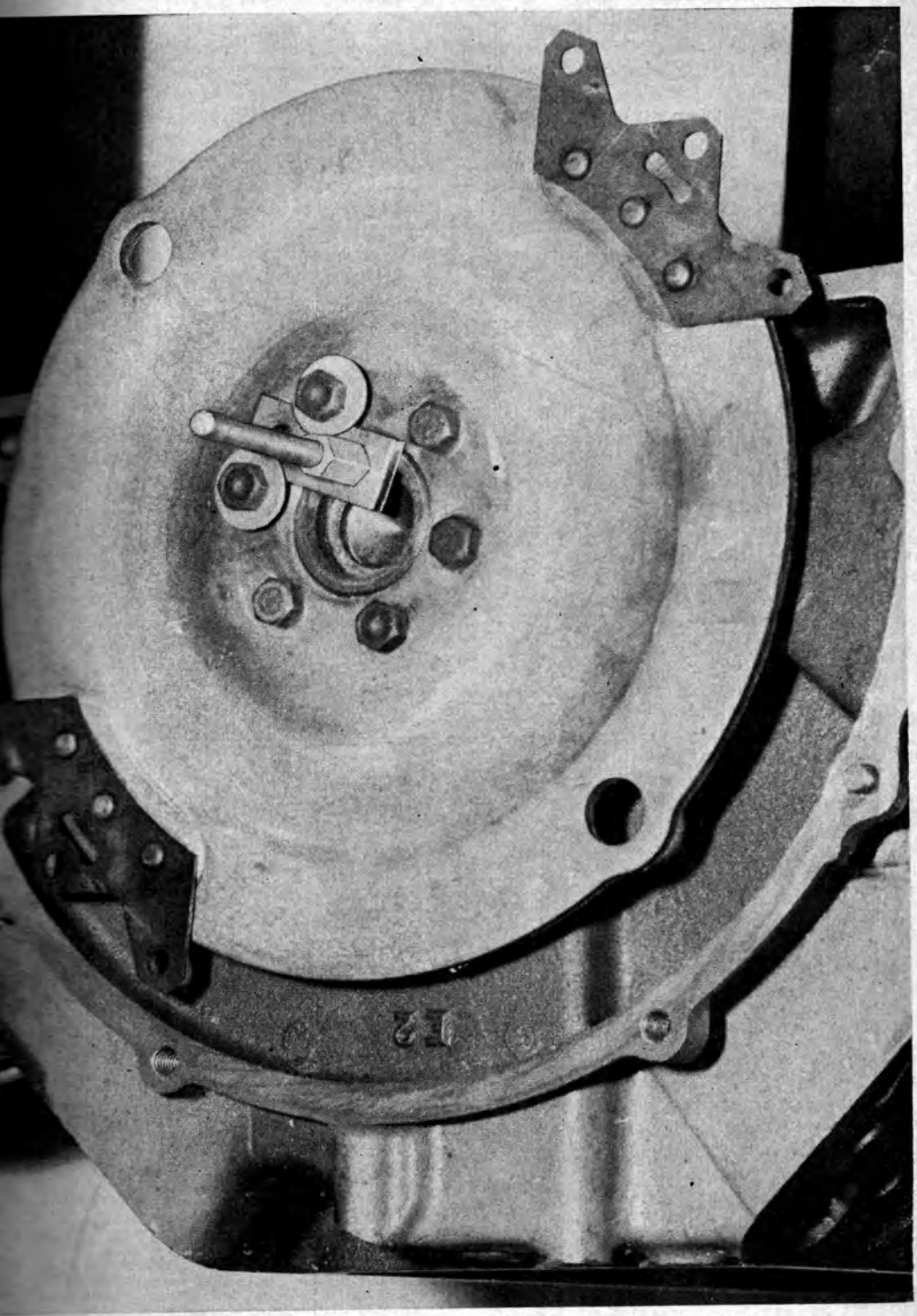
About here, the question usually arises as to how the dial indicator is centered relative to the crank. Centering is not necessary because we are actually extending the crankshaft centerline back through the clutch housing and revolving it, to pick up the variations on our indicator.

Regardless of whether the checking is done with the engine in the car or out, it is obvious that spark plugs should be removed to allow the crank to be rotated more easily.

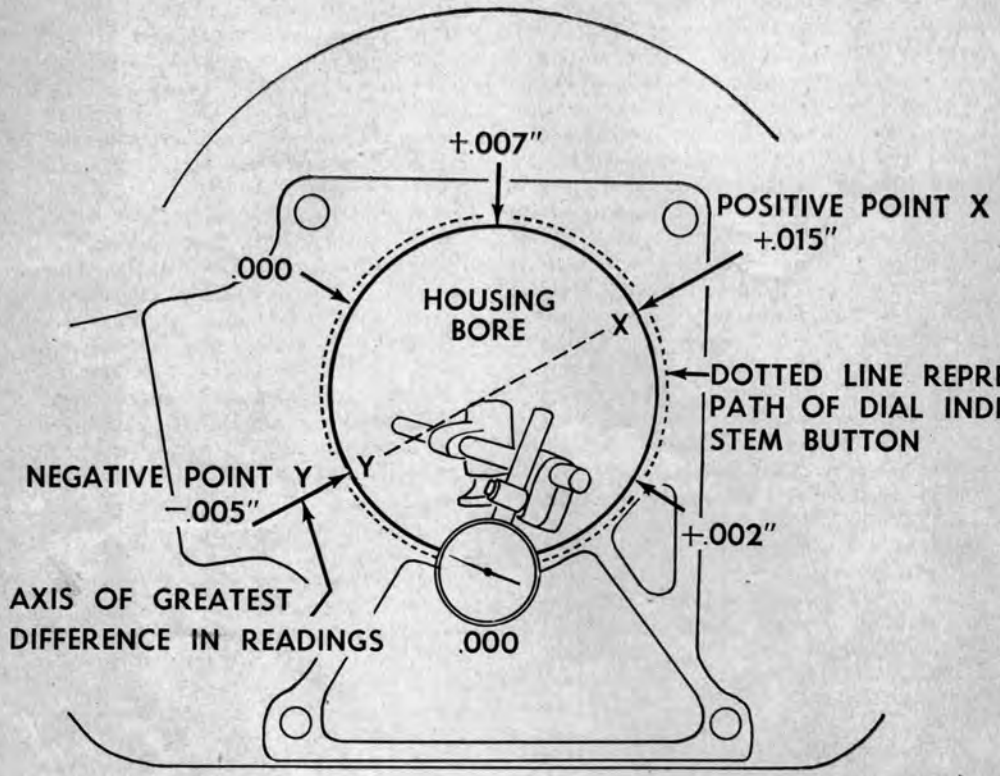
DIALING FOR TROUBLE

The next relationship to be checked and corrected is the angular character of the rear clutch housing face. With chalk or layout blue, mark locations around the housing face at intervals of 60 degrees.

Adjust the indicator stem button so that it rests on the flat machined surface lying about ¼ inch outside the circumference of the housing bore. The readings may start at any of the six locations, provided the indicator is set at zero. As all specifications for runout are based on total indicator readings, the variations from the zero point on the positive side of the indicator must be added to the amount which may occur on the negative side. For instance, typical angular readings might run like the drawing which appears on page 50.



Non-magnetic dial gauge base may be clamped to flywheel by loosening two bolts and using large washers to span the base of the stand. Here's Fordomatic setup. TREND BOOKS PHOTO

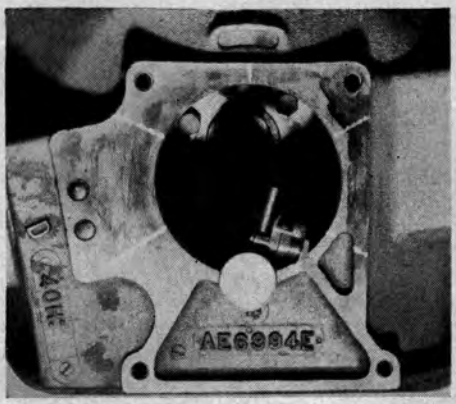


As explained in text, dial gauge readings of rear clutch housing are taken at points shown.

TREND BOOKS PHOTOS

Total indicated runout (TIR) is the highest positive reading added to the highest negative reading, or a total of .020 inch.

Normal production tolerance is about .008 inch for this angular alignment, so our example would require shimming to correct the angularity. To determine the location of the necessary shims, we need only look at the axis of the greatest difference in readings. As positive dial indications mean the gage stem is moving into the indicator, this can be interpreted that the upper right side of the housing (point X) is out, while the lower left (point Y) is in. Correction should be made by shimming the housing as near as possible to point Y to move that section out



Angular character of the rear clutch housing face is checked with the dial gauge spotted as shown here. Stem is moved around mating surface and readings taken at six points.

and correct the angularity. The shims should always be placed between the rear face of the engine and the clutch housing. The reasons for this shim location are important. First, no correction should be made which cannot be rechecked (shimming between the clutch housing and the transmission cannot be measured). Second, shims should be placed at locations bearing the least loads. Again, the engine-clutch housing mating surface qualifies because of a much large-bolt circle radius.

However, on some engines the rear block surface does not extend below the crankshaft centerline. With this type of block construction, a lower housing is utilized which may be aligned with the block by two vertically-located dowels. If for any reason either the block or lower housing have been replaced with an unmated part, the fore and aft relationship must be checked for a flush condition. If not perfectly flush, the dowel holes in the lower housing should be elongated slightly with a rat-tail file. Elongation must be only fore and aft and not sideways and only enough to allow the dead flush relationship at the parting line.

A major error at this point could result in damage to an aluminum transmission adaptor.

MAKING THE SHIMS

Either brass or steel shim stock may be used in the shim installation. Shims should be made in the form of a square horseshoe. These may be cut with an ordinary pair of scissors or small tin-snips.

Shims for this purpose may also be purchased through your local Ford dealer. The part numbers are 8T-7638 A, B and C. These are respectively (A) 2, (B) 3, and (C) 10 thousandths thick with the thickness stamped on a tab which protrudes outside the housing when properly installed.

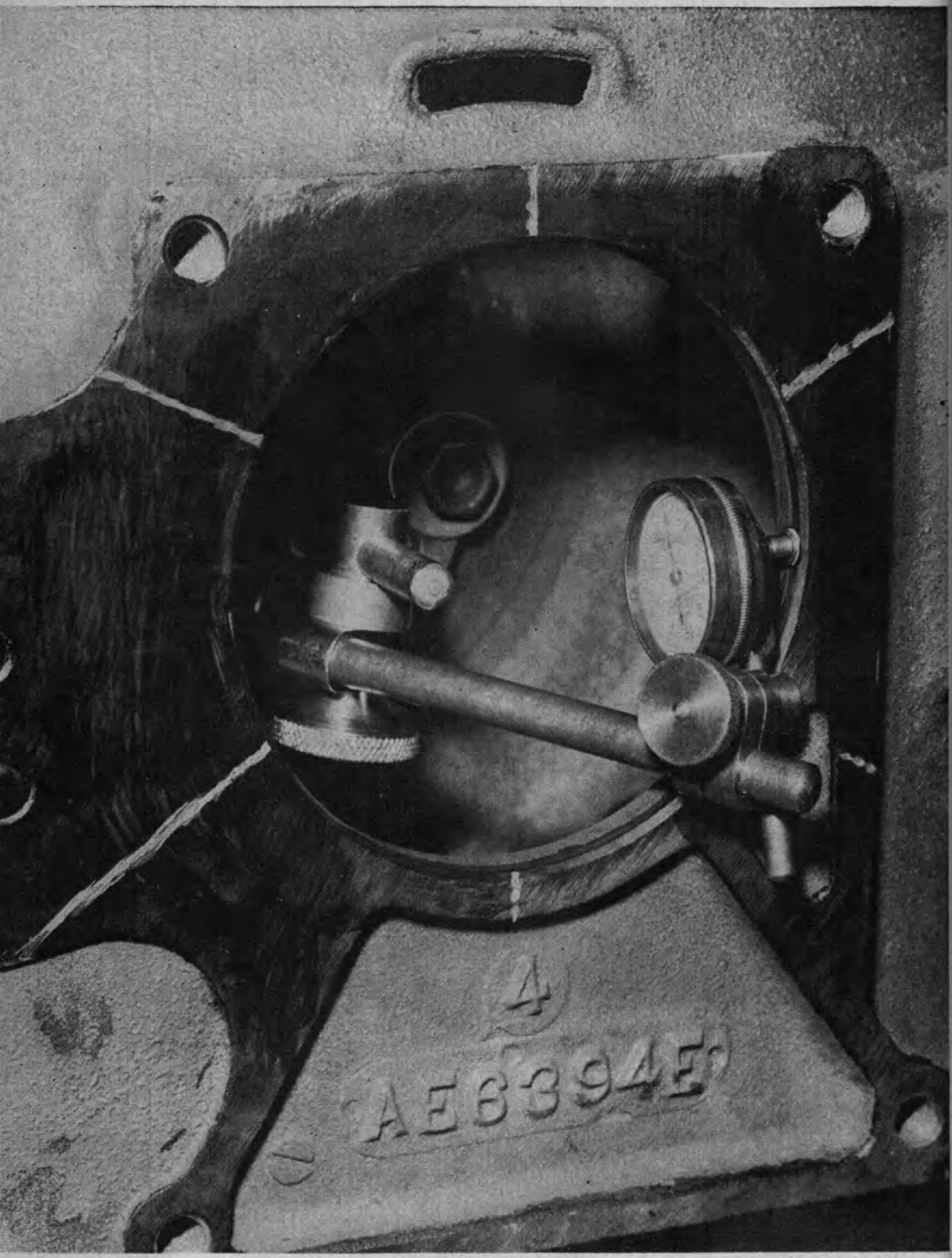
When the required shim pack is determined at the location of maximum out-of-plane, the adjacent bolt locations should be supplied with thinner stacks. These should gradually taper down to no shims at the point which previously read the highest positive runout. Thus the clutch housing will be firmly supported at all capscrew locations. To aid in keeping the shim stacks together apply Permatex #3 to both sides of the shims.

BORE ALIGNMENT CHECK

If you are lucky, the previous correction may have also corrected the accompanying bore misalignment. This often happens and if so, the next check will reveal that your work is complete.

Rearrange the dial indicator to position its stem just inside the housing bore. Revolve the crank slowly, holding the indicator readings at the previously used 60 degree locations. A total indicator runout of over

Alignment shims may be purchased from Ford dealers. Thicknesses run from .002 to .010.



Clutch housing bore misalignment is checked by running the stem button around inside surface of bore, is made with shim stacks in place and housing bolted tight. TREND BOOKS PHOTO

.008 inch on this check indicates that the two dowels that are supposed to center the housing must be removed. It should be pointed out that this check must be made with all shim stacks (as were determined necessary in the face alignment check) securely in place.

If out of limits on bore, remove the housing, keeping track of the various shim stack locations. The dowels may be removed by firmly gripping them with vise grips, sideways, and rotating them while prying with a screw driver between the block face and the vise-grip jaws.

On some engines, the top dowel hole penetrates into the water jacket. If you do this operation in the chassis without draining the cooling system, be prepared for a deluge!

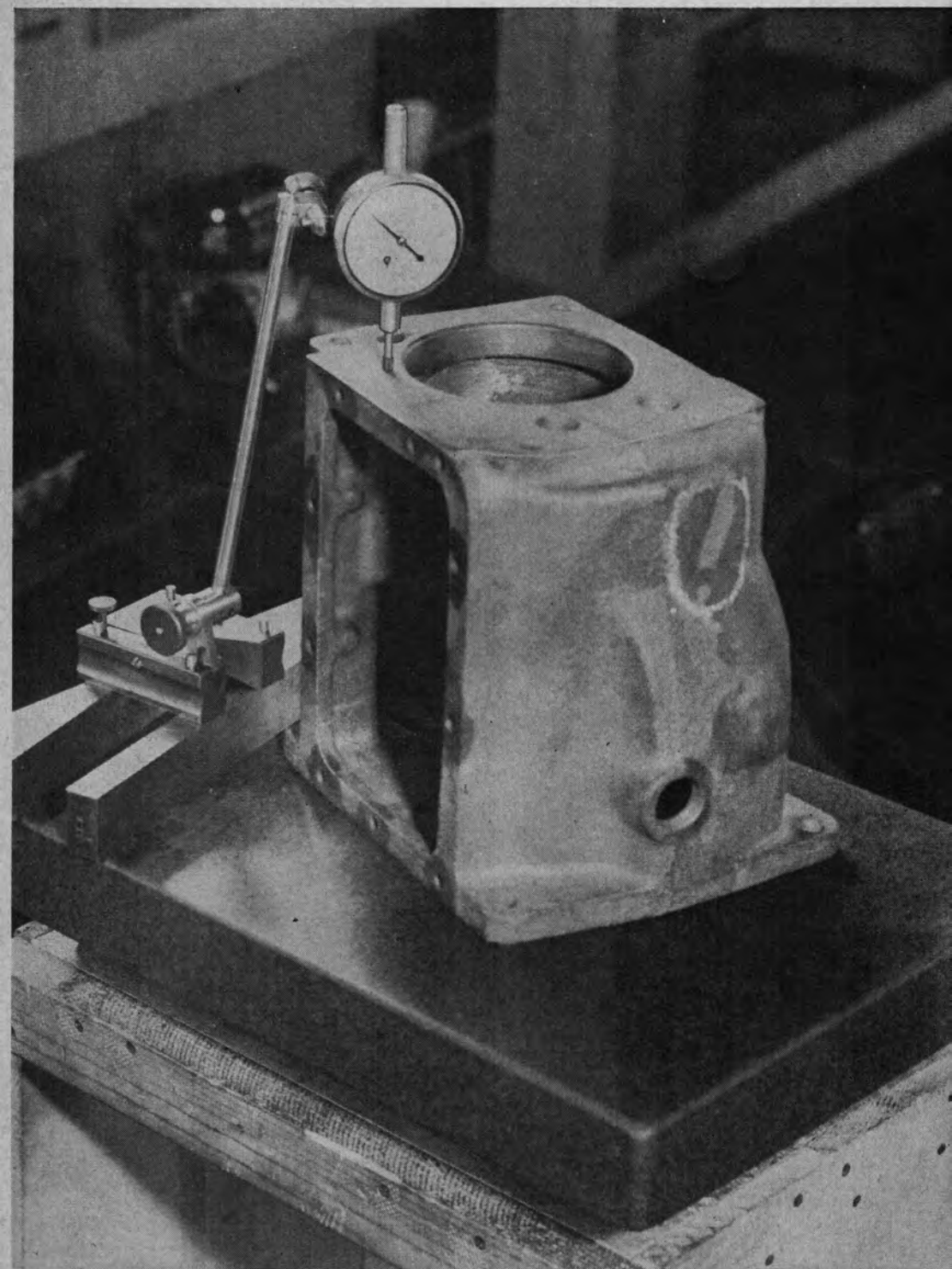
After dowel removal replace the housing, any necessary shim stacks and tighten the attaching capscrews. Back off each capscrew one quarter turn from the tight position. This will allow the housing to be tapped on-center with a soft hammer.

In no case in our experience has a housing ever measured so far off-center that the normal bolt hole clearances prevented recentering. After subsequent rechecks with the indicator show the housing within .003 inch of center, retorque the attaching capscrews to hold it there. Now it will be necessary to use two oversize dowels and a reamer to enlarge the holes. Many manufacturers furnish special tools for this purpose. If these are not available, simply obtain a dowel 1/16 inch larger than the original. With a drill 1/64 inch smaller than the dowel, carefully enlarge the two locating holes through the housing and into the block. Use a reamer of the dowel size and finish the holes to fit. To retain the dowel in the block, roughen one half its length with vise jaws or a center punch. The resulting enlargement will retain the dowel (after it is driven into the block) with the housing removed. Buttoning-up the housing now should finally indicate that your painstaking efforts are rewarded. Recheck of face and bore alignments should now indicate both have less than .005 inch T.I.R.

FURTHER CHECKS

The next point of attack is the transmission case. Any competent, well-equipped machine shop can measure parallelism of the front and rear faces of the transmission case. This is done by sliding the case about on a surface plate with a dial indicator resting on the upper face of the case. Parallelism within .004 inch is desirable. Angularity of the case ends is rare but worth checking for. At the same time, the bores in the case may be

Oversize dowels may be installed, using special reamer set shown here. TREND BOOKS PHOTO



Parallelism of transmission case is checked by sliding empty case around on a surface plate. Angularity, if present, is shown by dial gauge attached to plate as shown. TREND BOOKS PHOTO

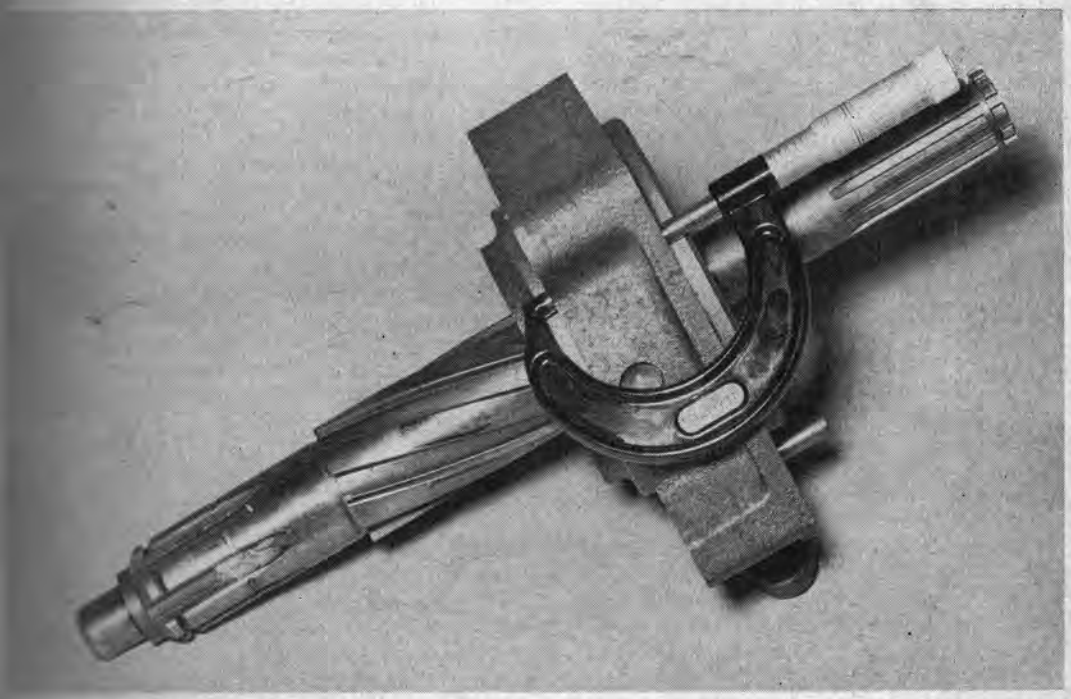
easily checked with a machinist's square, but only if the front and rear bearings are the same size. If they are, insert the blade of the square into the case, to span both bores. The other leg of the square should rest true against the case end with the blade resting at the bottom of each bore. Check both ends.

On overdrive transmissions of the Borg-Warner type, sometimes the adaptor plate faces are not parallel. The adaptor plate is the housing between the case and the overdrive or extension housing. Parallelism of its faces can easily be proved by measuring the thickness across them at various points with a 1-2 inch micrometer. Again, less than .004 inch is desirable.

We neglected to mention when we started this discussion, that it is good practice to carefully remove all burrs from mating faces with a good flat mill file. This initial dressing will sometimes reveal localized low spots *between* bolt ends. When later checking with the indicator gives slightly erratic readings in these dips, you may discount them unless an attaching hole occurs in the *middle* of the dip. This would tend to distort the mating parts, when tightened.

Another simple dial indicator check that is a must on conventional or overdrive transmissions is the flywheel and starter ring gear runouts. These defects will be reflected by clutch application peculiarities and starting gear noises. With the indicator stem against an area of the flywheel where the disc contacts, the T.I.R. should not exceed .010 inch. If it does, the difficulty could be the flywheel mounting flange on the crankshaft. Runout of this flange face should not exceed .002 inch. Ring gear runout is not so critical, but may be troublesome if over .030 inch.

We realize the foregoing article may have been a bit strenuous with the hammer and tongs boys. This was intentional, as we feel that only those with enough patience to follow us this far would apply these valuable practices to the fascinating pastime of swapping horsepower. Anyone with enough savvy to stuff a Cad into a '49 Ford and make it look like it grew there will be able to make most of these suggestions pay off. The late Clay Smith was supposed to have said that he was willing to give away 95% of his speed secrets and beat 'em with the other 5%. This sort of savvy, patiently applied, is our conception of what Clay meant by that winning 5 percent. ■



Overdrive adaptor plate parallelism is checked by measuring thickness. TREND BOOKS PHOTO