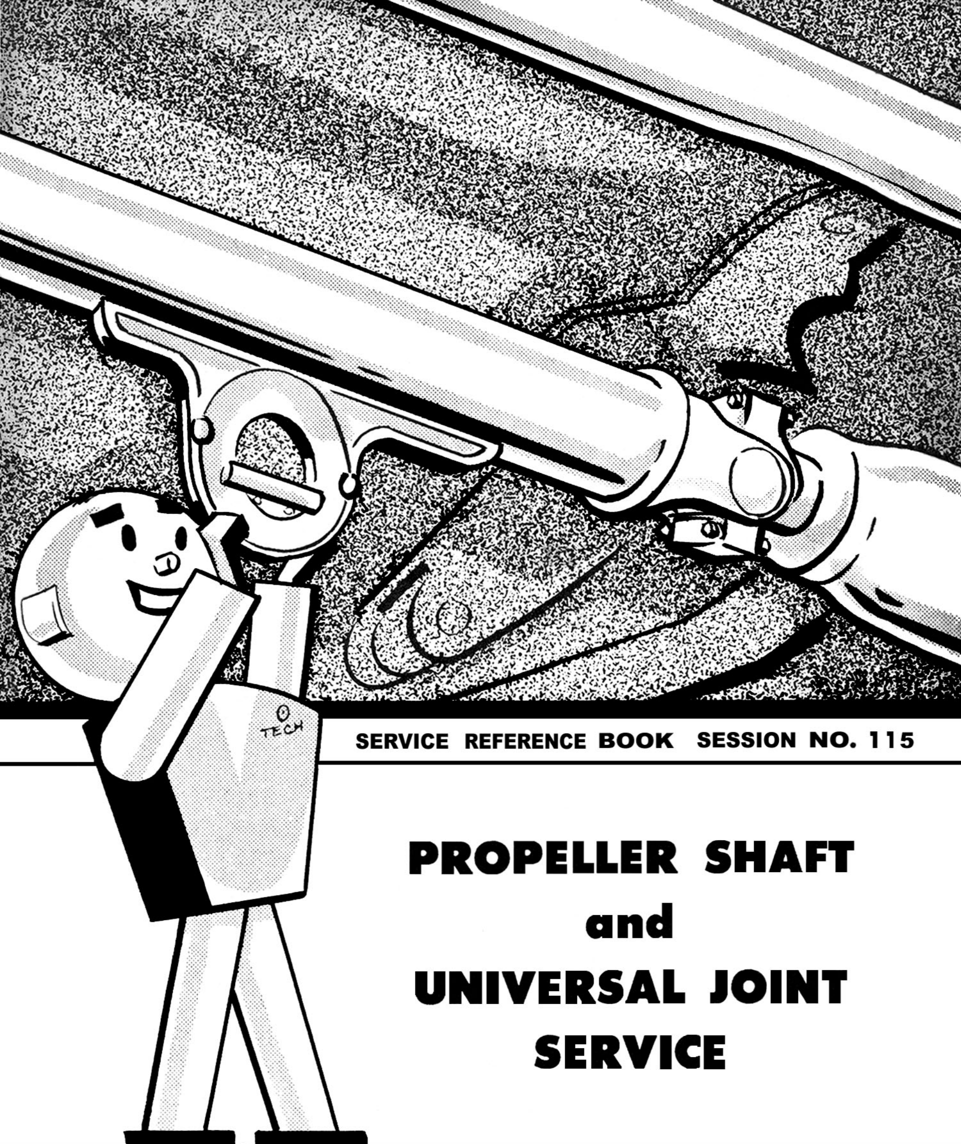


SERVICE REFERENCE BOOK SESSION NO. 115

PROPELLER SHAFT and UNIVERSAL JOINT SERVICE

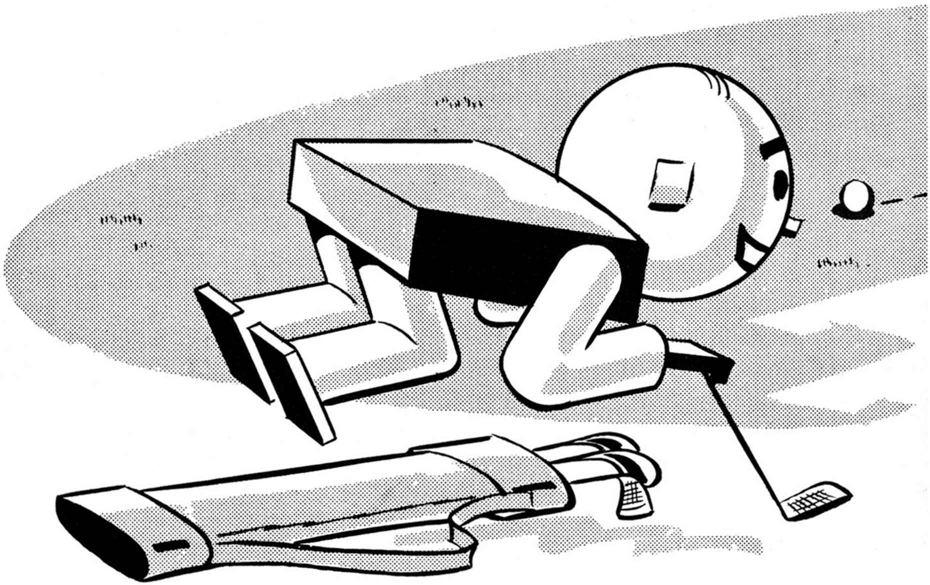
Prepared by

CHRYSLER CORPORATION

Plymouth • Dodge • De Soto
Chrysler • Imperial

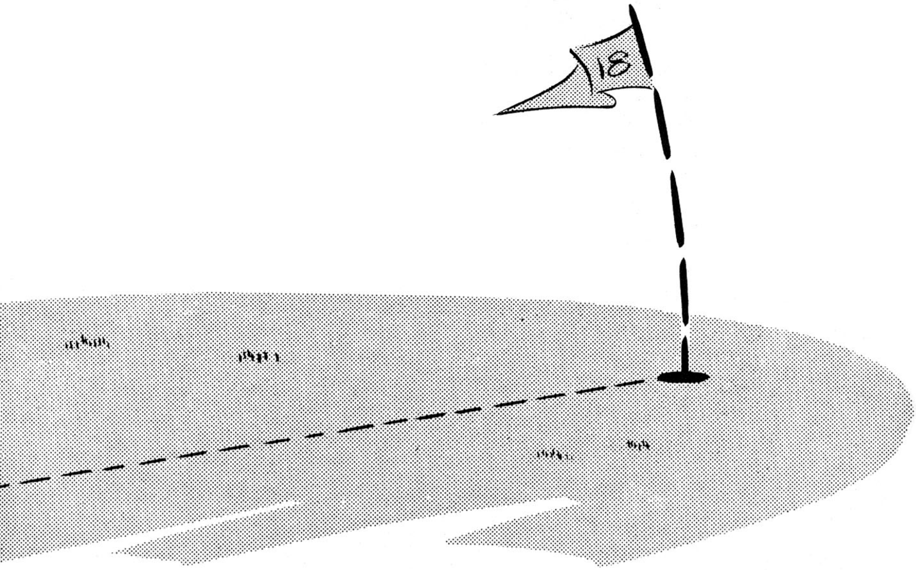
TECH SEZ:

"FOR GOOD PROP SHAFT SERVICE, Y'GOTTA KNOW THE ANGLES!"



Workin' on propeller shafts and universal joints is as easy as rollin' off a log, once you know all the angles. And those angles are important, because whether or not a universal joint lasts a normal life is dependent on the working angle at which it is forced to operate. But working angles aren't all. There are other factors in the picture.

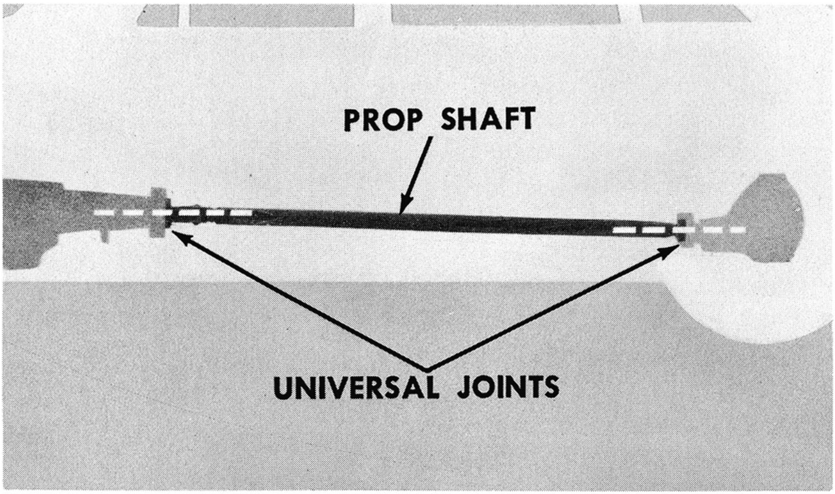
So, this reference book provides a complete rundown on these important drive-line parts, how they do their job, and how to adjust working angles when they're not within specified limits.

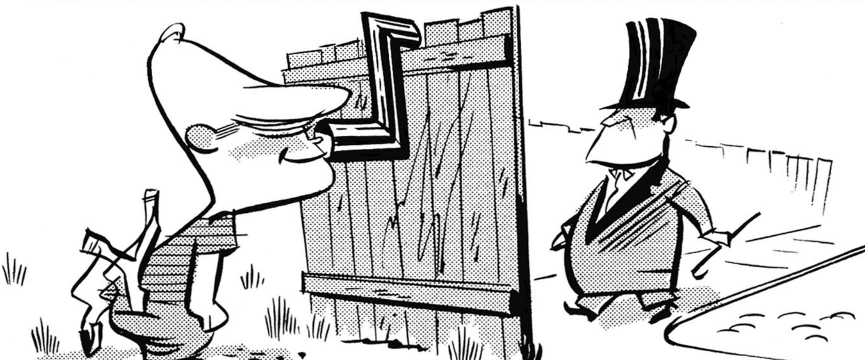


You'll find this useful information on the following pages:

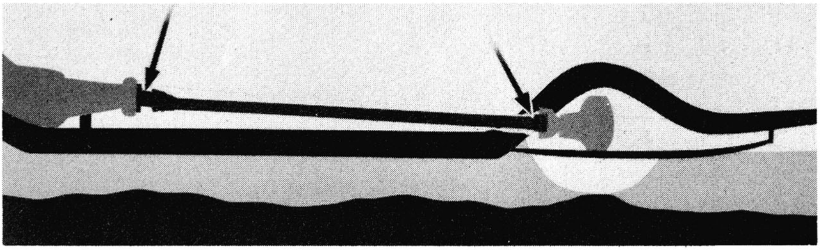
FUNCTION OF PROPELLER SHAFT AND UNIVERSAL JOINTS

Most of you know that the prop shaft and universal joints do more than tie the transmission and rear axle together so engine driving power gets to the rear wheels. It's true, of course, that the prop shaft is the main link. But the universal joints are the parts that make it possible to connect two shafts in different planes. In other words, power is transmitted through an *angle*.

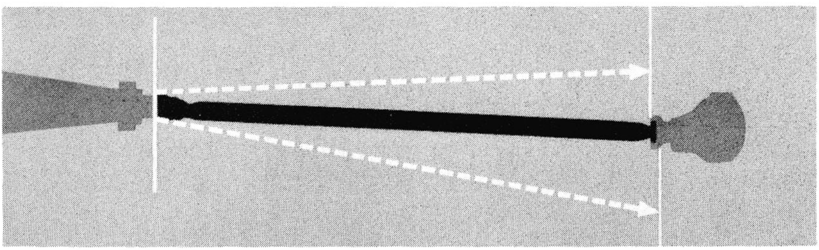




One important point to keep in mind is that the transmission is attached to the frame crossmember. As a result, the transmission output shaft won't change in relation to the frame. On the other hand, the pinion shaft *does* change in relation to the frame and, consequently, to the output shaft. This happens each time the rear axle moves up or down because of travel over uneven road surfaces.



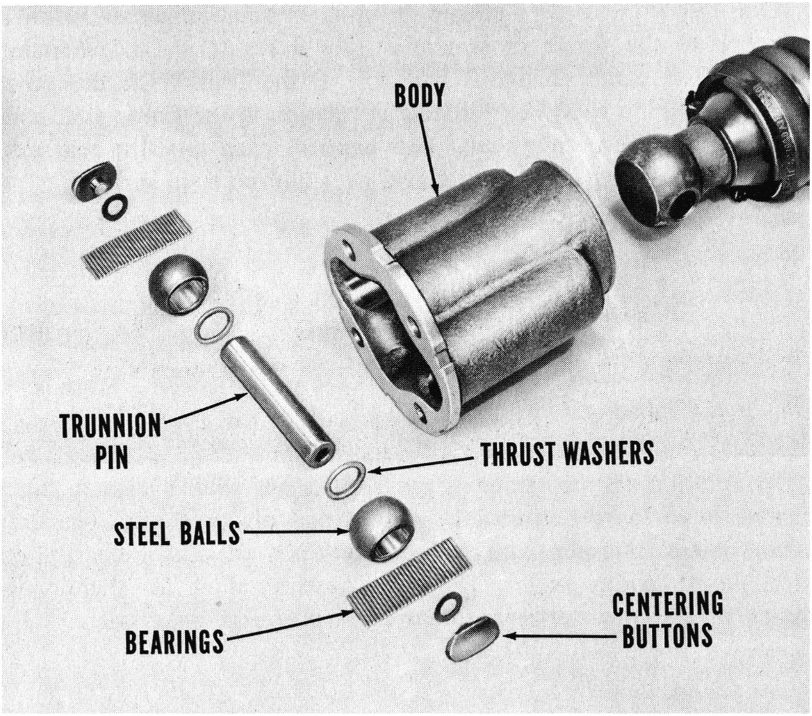
In addition to the changing angle-of-drive, there's also a slight change in *distance* between the output and pinion shafts. The universal joints, therefore, must do more than provide a connection throughout various angles. They also have to allow for slight variations in distance between the transmission and rear axle.

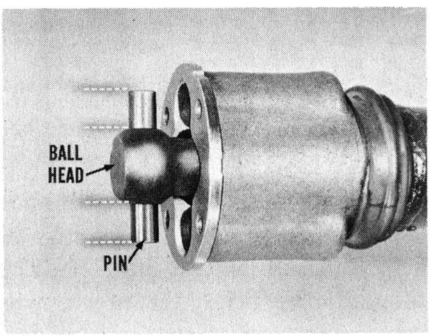


TYPES OF UNIVERSAL JOINTS AND PROPELLER SHAFTS

Two types of universal joints are in general use. One is the ball-and-trunnion type, and the other is the cross type.

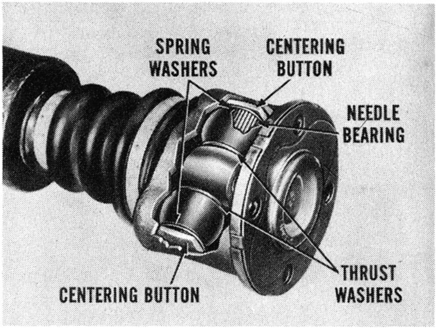
The ball-and-trunnion design is an enclosed joint. It has a body, a trunnion pin, two steel balls with needle bearings, thrust washers, and centering buttons.



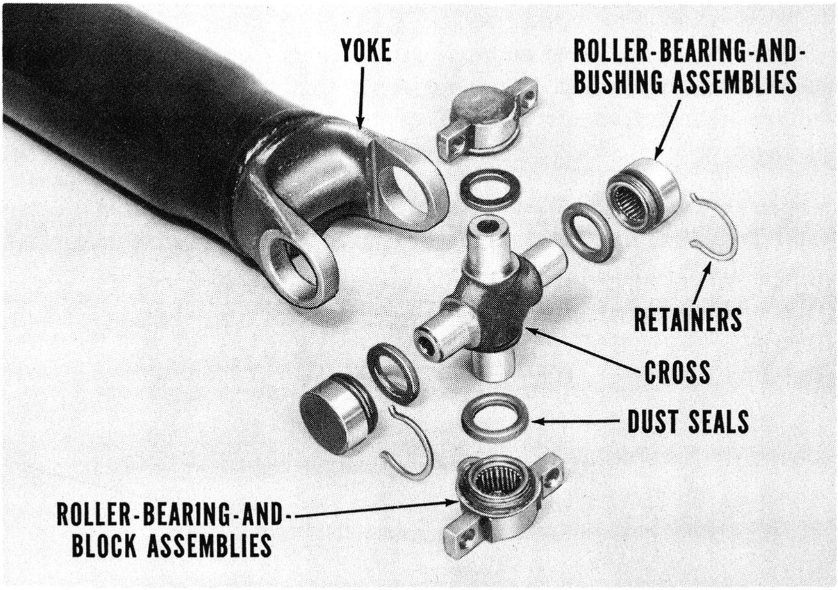


The ball head for the trunnion pin is a built-in part of the prop shaft. The pin is a press fit in the ball head and is accurately centered so that each end extends the same distance. If the pin is off center by as little as .003″ it can cause the shaft to run out of balance, setting up a vibration.

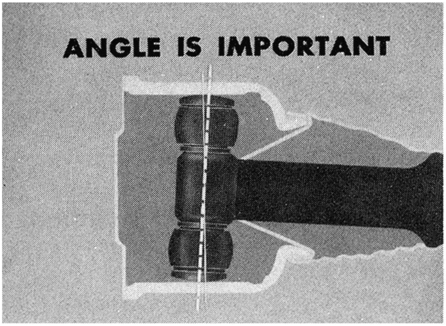
The steel balls, mounted on the pin ends, run on needle bearings. Thrust washers between the bearings and prop shaft ball head soak up any side thrust. Centering buttons and spring washers help center the pin in the body. The steel balls work in smooth raceways in the body. This lets the balls slide back and forth to accommodate any changes in prop shaft length.



The cross-type joint has a yoke, a cross, two roller-bearing-and-bushing assemblies, two roller-bearing-and-block assemblies, dust seals and retainers.



A sliding spline connection between the prop shaft and the joint compensates for variations in distance between the output shaft and the pinion shaft. On all cars but the Imperials, you'll find a one-piece shaft that uses a ball-and-trunnion joint at the front, and a cross-type joint at the rear.

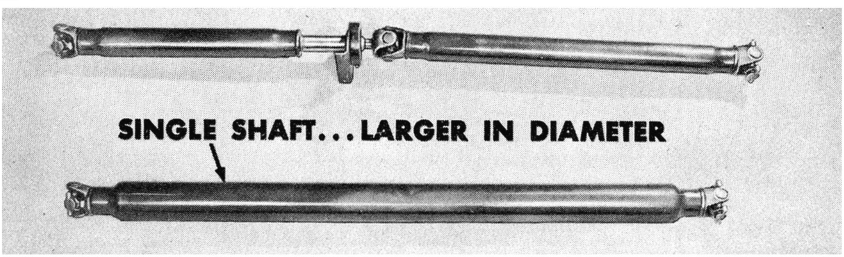


Importance of Working Angle. Since the universal joints must transmit torque through an angle, the degree of angle is mighty important to the maximum life of the parts.

As a matter of fact, *no* angle, or an angle that's *too slight,* won't permit proper lubrication of the joint. This, of course, would lead to early wear of the joint parts.

Conversely, *too great an angle* at the joints would cause vibration. As a result, you have to use an angle that will give long life and trouble-free performance. On all cars with either the single or two-piece propeller shaft, the working angle is 1° to 3°, with 2° preferred.

Single vs. Two-Piece Shaft. On an Imperial, you'll notice a two-piece shaft and three universal joints are used. In this case, a two-piece shaft is used because of the Imperial's long wheelbase. If you wanted to use a single prop shaft on a long-wheelbase vehicle, you'd have to make the shaft larger in diameter. That's necessary to give the shaft enough strength to prevent whipping at high speeds.



But when you go to too large a diameter, you're very apt to introduce more vibrations. There's more mass to rotate, for one thing. Also, it's very difficult to *balance* a longer, thicker shaft.

In general, then, a two-piece shaft will help to eliminate vibrations, provided that the working angles are correct. The center joint angle can be adjusted by adding or removing shims at the center bearing support. This makes it easy to get the right working angle at the *center* joint.

Adjusting the working angle at the rear joint is accomplished by installing tapered shims between the rear springs and saddles on the rear axle.

Road-Testing Tips. When you get a report of a vibration condition, your first step should be to road-test the car. Road-testing will not only tell you when a prop shaft is the cause, but it will also tell you whether the shaft is out of balance, or just has the wrong working angle.

If there's a roughness that begins to show up at about 3 m.p.h.—as soon as the car gets under way—and continues into the higher speed ranges, it usually means lack of lubrication in the universal joints. It might also mean excessive wear in the joint, or a case where the joint has become brinnelled. To determine the cause, disassemble, clean and inspect both joints. Evidence of wear means the parts will have to be replaced.

NOTE: Use only factory-approved parts for replacement. They have been designed for maximum stress and service life in this vital area.

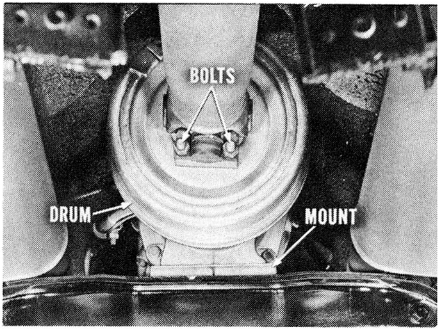
If the parts are found to be satisfactory, lubricate and reassemble them.

When testing an Imperial (two-piece shaft), experience indicates that a vibration between 15 and 20 m.p.h. is apt to be caused by prop shaft *misalignment* (incorrect working angle), rather than shaft unbalance. But if the vibration comes in at speeds above 28 m.p.h., chances are it's caused by an *unbalanced* condition.

When you road-test a car with a one-piece shaft, a prop shaft vibration will show up at a higher speed than on cars with a two-piece shaft. For example, if the vibration shows up between 30 and 35 m.p.h., chances are it's because the rear joint *working angle* isn't right. If there's a vibration between 65 and 70 m.p.h., and the wheels have been balanced, it's probably due to an *unbalanced* shaft.

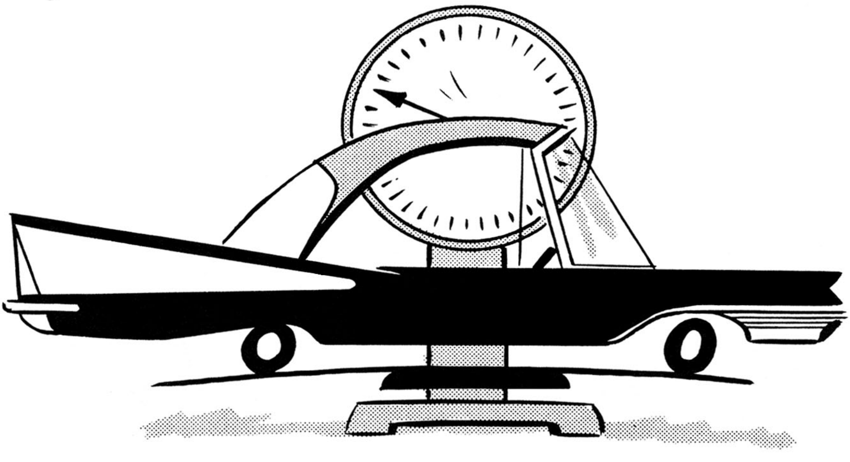
DIAGNOSIS AND CORRECTION

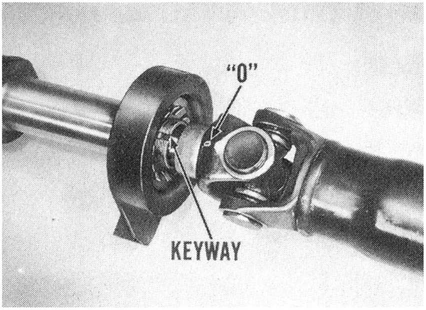
Before you go out on a road test it's wise to look for other causes of vibration that might be confused with a prop shaft vibration. For one thing, be sure the wheels are balanced. Next, see if the universal joint flange bolts are loose. They should be tightened to a torque of 35 foot-pounds. In addition, see that the parking brake drum is not out of balance. Also, make sure the rear engine mount is securely tightened.



Check for the presence of undercoating overspray on the propeller shaft or parking brake drum. Overspray alone is enough to cause an out-of-balance condition. Once you've checked these points, you're ready to check the working angle.

Be sure there's no extra weight in the car or luggage compartment. The gas tank should be at least three-quarters full. In addition, the weight of the car must rest on all four wheels.

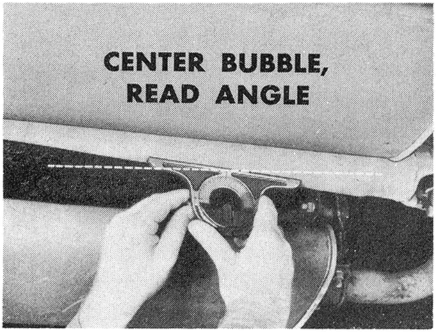




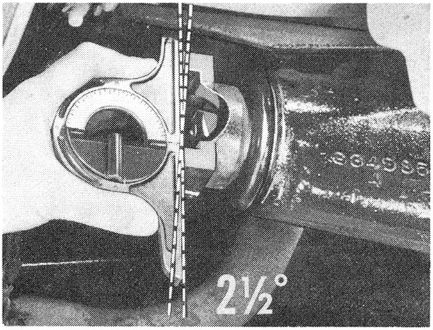
Checking Two-Piece Shaft. You're now ready to check phasing of the center universal joint. See that the letter "O" on the front face of the yoke lines up perfectly with the keyway in the rear end of the front shaft. To get a clear look at the keyway, back off the oil seal cap about ½″.

If you find the joint *out* of phase, you'll have to disconnect the rear shaft and index the splines properly. However, remember that each time you unbutton the prop shaft, you should first mark or scribe the shaft and joint in some way so you'll be able to reconnect them in the same position. This will help you maintain proper alignment and balance. If you don't mark the shaft and joint prior to disassembly, you may reconnect them differently and introduce new conditions not present originally.

If the joint is found to be *in phase,* then you're ready to measure the angle of the rear propeller shaft. Use a spirit level protractor to get this measurement. Put it on the underside of the shaft, and parallel with the shaft. Adjust the bubble so it's centered in the glass. Then, read how many degrees the shaft slants down toward the rear from a horizontal position. As an example, let's say you get a reading of 2°.

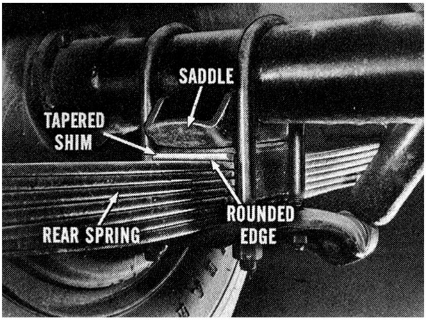


Next, disconnect the universal joint at the pinion shaft. Put the spirit level against the front face of the companion flange. Hold the level so that its long dimension is vertical, and center the bubble. At this point, let's assume the pinion shaft slopes down about 2½°.

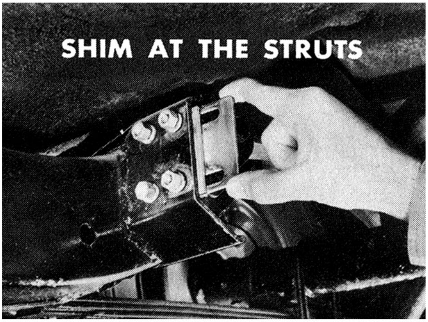


Now, add your two readings (2° + 2½°) and you'll get the working angle of the rear joint, 4½°, in our example. Don't forget that specifications call for an angle not over 3°. So, in this instance, you'll have to correct the angle by reducing it until it falls within the 1° and 3° limits.

This is done by installing a tapered shim of the proper thickness between the rear spring and its saddle on the axle housing to bring the working angle within specifications.



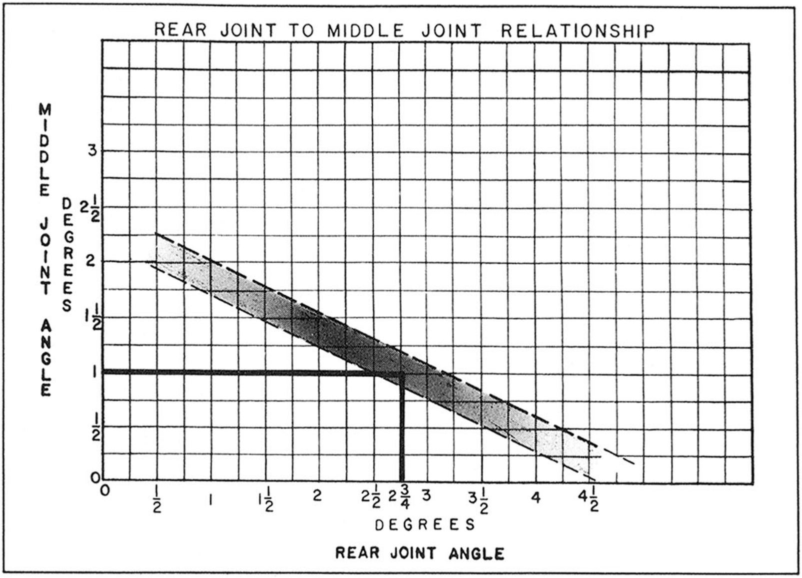
Always keep the flat side of the shim with the rounded edge toward the spring, and see that the thick end points forward. After installing the shim, recheck the rear flange angle. This is mighty important because you'll want to know that the angle is within limits.



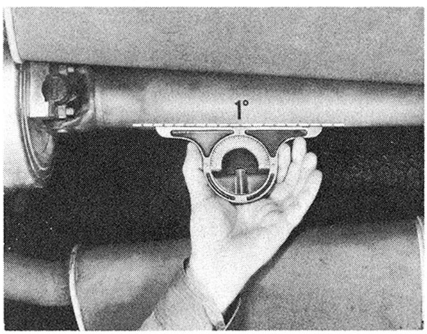
When you install a shim at the spring saddle, you'll probably have to do some shimming at the struts. Just loosen the attaching bolts and add shims until the struts are free and unloaded. This releases the load on the rear axle housing and permits it to assume the proper angle.

Now, let's assume you've rechecked the rear shaft angle after all the shimming, and you get a working angle of 2¾°. That's within limits and provides a good indication of what the center joint angle should be. You'll see, there's a definite tie-in between the working angles of the rear joint and the center joint. Both angles must work together as a smooth, quiet, and efficient drive-line team.

The chart, (p. 15), shows you what that relationship should be. If you run your finger up from 2¾° to the shaded portion, and then out to the left, you'll notice that the center joint angle should be 1°. So, use the protractor to check the front shaft angle.

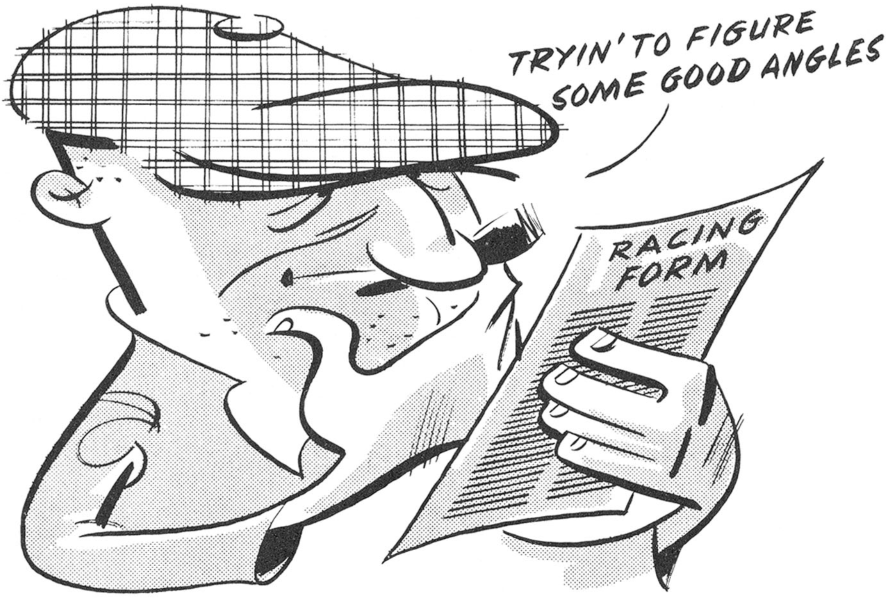


Let's assume that your protractor on the front shaft does give you a reading of 1°. Let's further assume that you find the front shaft sloped down toward the rear, the same as the rear shaft. If that's what you find—front and rear shafts sloping in the *same* direction – *subtract* your readings to determine the center joint working angle.

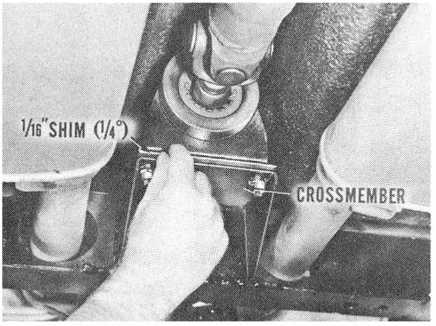


Following out our example, we have a 1° angle of the front shaft; *subtracted* from the 2° angle of the rear shaft, this gives an answer of 1° for the working angle of the center joint. This is within limits, so no further work is required.

NOTE: If the front and rear shafts slope in *opposite* directions, *add* the two readings to determine the center joint working angle.

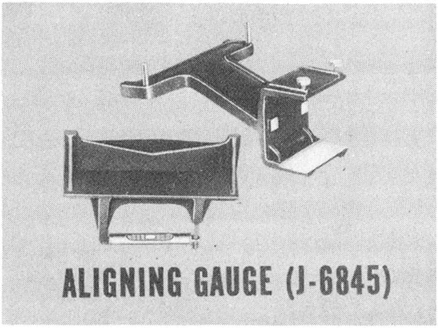


If you find that the center working angle differs from what the chart indicates it should be, you'd have to change it. But this is very easily done. You simply add or remove 1/16″ shims between the center support insulator and crossmember. One 1/16″ shim will change the center angle about ¼°. If the angle is too low, you'd add shims to increase it. If the angle is too great, you remove shims to cut it down.



Keep in mind that if you find yourself adding or removing a fair-sized stack of shims, you'd better recheck the rear joint angle. A lot of shims at the center joint will change the rear angle, but see that it doesn't change so much that it gets away from the 1° to 3° specification.

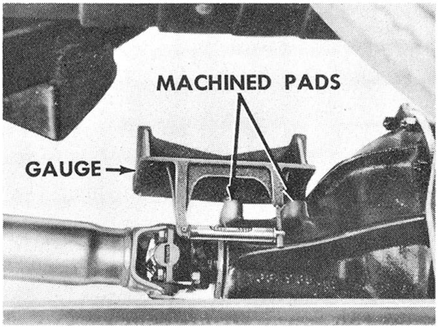
New Aligning Gauge (J-6845). There's a new gauge that can be used to check the prop shaft angles on the Imperial. It's an Aligning Gauge (J-6845) that lets you make direct readings. This saves time when checking prop shaft angles because you don't have to add or subtract angles.



ALIGNING GAUGE (J-6845)

You'll notice that this new tool consists of an index gauge and an adapter. The gauge has an adjustable spirit level and provides direct readings of the angles at the pinion shaft and rear propeller shaft. You use the adapter to apply the gauge to the front propeller shaft where space is limited by the X-frame member on hardtop models.

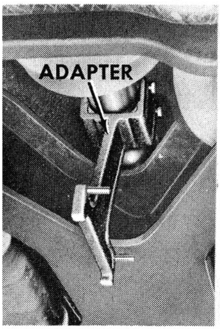
First remove the screws holding the rebound bumper plate on the differential carrier. Remove the plate. From the left side of the car, put the gauge on the machined pads of the carrier. Center the bubble.

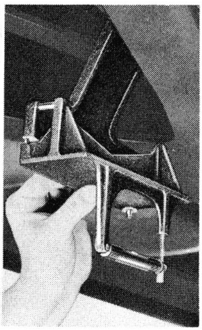


Place the gauge squarely on the underside of the rear shaft, spirit level on the left. If the bubble's leading edge is centered, or within three graduation marks fore-or-aft, the rear joint angle is satisfactory.

But, if the leading edge of the bubble is ahead of the third graduation, you'll have to put a 2° tapered shim between the spring and its saddle to correct the angle. As before, shim the struts, too, so they're free and unloaded and will let the pinion shaft assume the proper working angularity.

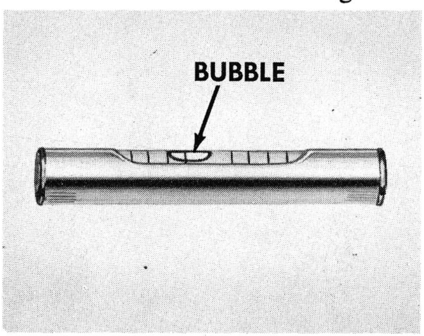
To check the center joint working angle, hold the gauge squarely on the underside of the rear prop shaft, and center the bubble. Next, attach the adapter to the front of the front shaft keeping the two





adapter pins pointing left. Tighten the thumb screws to secure the adapter to the shaft. Then, index the gauge on the adapter so the level is at the left. Make sure the locating pins index squarely on machined pads on both the adapter and gauge.

Notice the bubble's leading or trailing edge. For each mark the



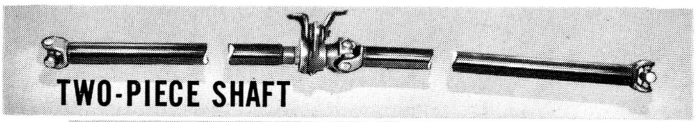
leading edge is *ahead* of center, *add* one $\frac{1}{16}''$ shim beneath the center bearing support. For each mark the trailing edge is *to the rear* of center, *remove* one $\frac{1}{16}''$ shim. After you adjust the bracket, recheck the center joint working angle.

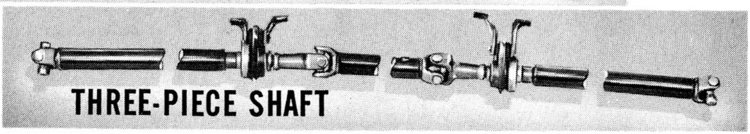
Once you've corrected the working angle on a prop shaft, remember to do one more thing. Road-test the car to find out if the work has eliminated the vibration.

Checking Single Shaft. Use the protractor to check the rear joint angle just the same as you would on the Imperial. Check the angle of the shaft first, and then check the angle at the pinion shaft. Find the working angle. If a correction is necessary, add shims at the rear spring saddles. After shimming, recheck the rear joint working angle, and then road-test the car to be sure the vibration has been eliminated.

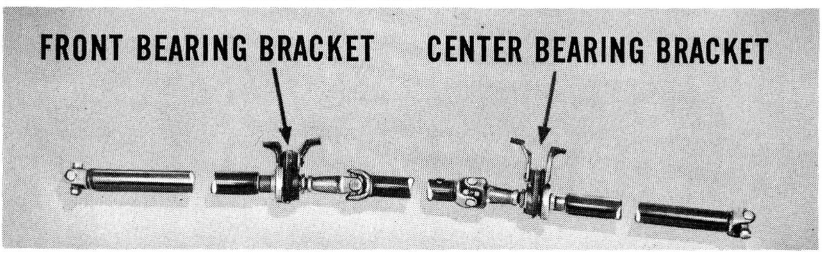
DODGE TRUCK PROP SHAFT SERVICE

Much of the information on servicing passenger car prop shaft angles also applies to Dodge trucks. In general, trucks have a longer wheelbase. As a result, they use two-piece shafts, and in some cases a three-piece shaft. A series of shorter shafts, with ample support between them, helps keep the truck free from drive-line vibration.

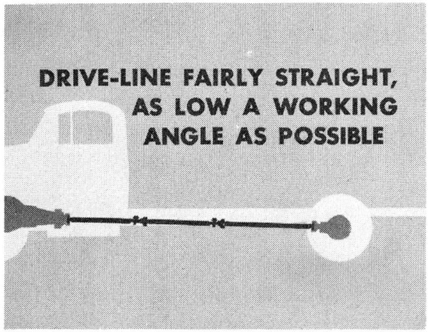




As on the Imperial, a center bearing bracket supports the rear of the front shaft. On three-piece shafts, you'll find a bearing bracket at the rear of the front and center shafts.

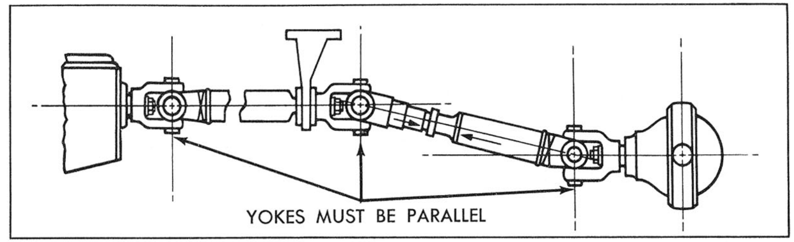


The angle specifications for trucks are different than for passenger cars. You see, trucks perform better when the drive-line from the transmission to the rear axle is fairly straight, and has as low a working angle as possible. You'll often find the pinion shaft of a truck tilted up slightly at the front instead of down. This reduces the working angle of the rear joint. Checking working angles follows the same procedure as used in passenger car service. Parallel alignment of the universal joint yokes is vitally important in truck service.

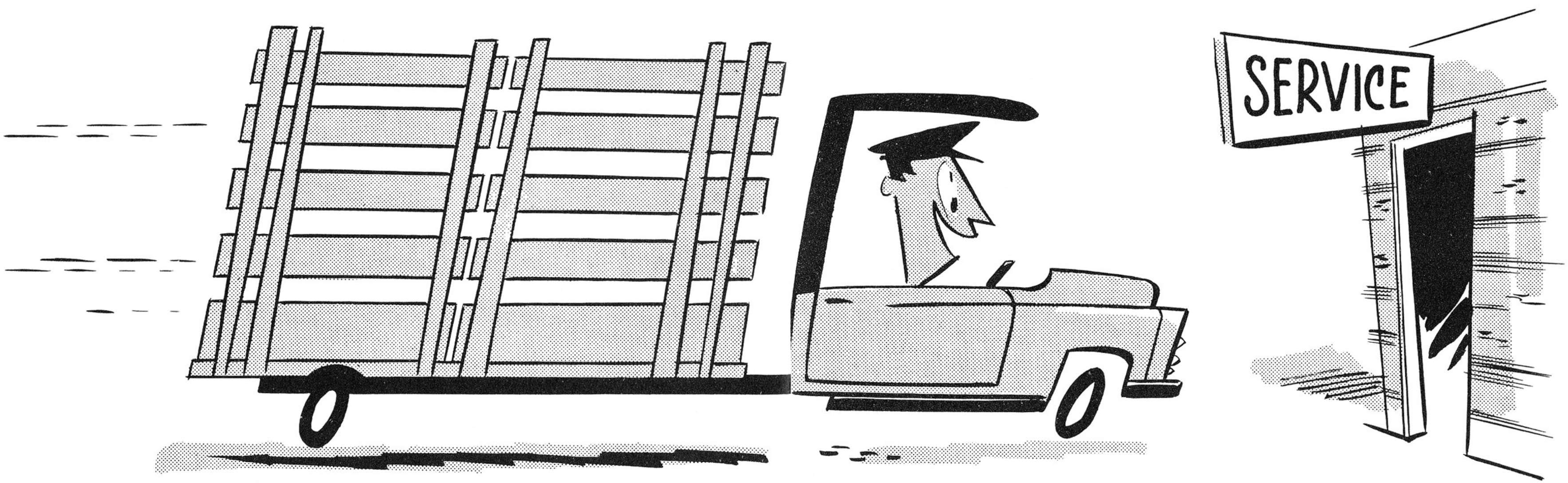


Check Yoke Parallel Alignment. Trucks use cross-type joints with slip-spline yokes. It's important to see that the stamped arrows on the yoke and prop shaft line up. Being off as little as one spline is enough to cause vibration.

Vertical parallel alignment of the universal joint yokes is vital to quiet operation. If the yokes are out of parallel, the resulting vibration can damage the joint and rear axle parts.



Now, to line up the yokes properly, you must use bearing brackets of the correct length, and the proper rear axle spring seats. Brackets on different models vary in length from about $2\frac{3}{8}''$ to $4\frac{15}{16}''$. Using the wrong length bracket can cause too great a working angle and its resulting vibration. A chart that lists the brackets and spring seats to use for the corresponding model is given on the next page.



CENTER BEARING BRACKET AND REAR AXLE SPRING SEAT CHART (K series Dodge Trucks)

MODEL	SYMBOL	WB.	BEARING BRACKET CENTER	BEARING BRACKET REAR	REAR AXLE SPRING SEATS PART NO.	REAR AXLE SPRING SEATS TYPE
P-300, D-300	VT-518-538	126	1501588-9			
P-400, D-400	VT-522-542	129	1501128-9			
D-400	T-VT-542	153-171	1501588-9			
D-500, D-600	VT-544-6	129	1501128-9			
D-500, D-600	T-VT-544-6	193-217	1501588-9	1501128-9		
D-500, D-600	T-VT-544-6	141-153-171	1501588-9			
C-500, C-600	VT-556-8	132-162	1501588-9			
D-700	VT-548	129	None		2-1266080	Tapered 3°—45″
D-700	VT-548	153	1664727		2-1191099	Straight 1¼″ Thick
D-700	VT-548	141	1664728		2-1266080	Tapered 3°—45″
D-700	VT-548	171	1664728		2-1191099	Straight 1¼″ Thick
S-700	VTS-548	236-254	1664728	1664729	2-1668750	Tapered 3°—45″
D-800	VT-550	132-144	1664728		2-1265558	Tapered 3°—45″
D-800	VT-550	156-174-192	1664727		2-1265558	Tapered 3°—45″
D-900	VT-552	132-144-156-174-192	1664727		2-1265558	Tapered 3°—45″
C-700	VT-560	108-120	None		2-1266080	Tapered 3°—45″
C-700	VT-560	132-162	1664727		2-1191099	Straight 1¼″ Thick
T-700	VT-562	171-189	1664727		None	
T-800, T-900	VT-566-8	174-192	1664727		None	

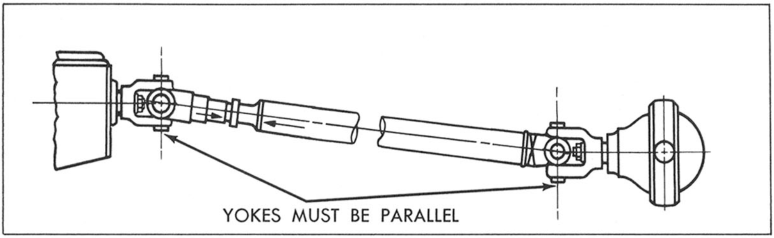
NOTES: On VT-548-50-52-62-60-68 equipped with auxiliary transmission and two-piece prop shaft, use brackets as listed above.

OVER-ALL BRACKET HEIGHTS

1501588—Front—3.09	1501128—Front—4.68	1664727—2.38
1501589—Rear —3.31	1501129—Rear —4.93	1664728—3.88
		1664729—4.87

(Because of a 4° angle on bottom surface of brackets P/N 1664727-28, the upright section with the hole for identification purposes must face front of vehicle.)

On a one-piece prop shaft, keep the vertical alignment of the yokes within 1°. This makes the rear axle pinion centerline run parallel to the centerlines of the engine crankshaft and transmission main shaft.



On two-piece shafts, the front prop shaft centerline should run parallel to the centerlines of the crankshaft and transmission mainshaft. The rear axle pinion shaft centerline should run parallel to that of the front shaft. On some models, the rear of the front prop shaft tilts downward slightly to reduce the rear joint angle. You retain parallelism in this instance by tilting the rear axle housing.

On three-piece shaft models, the second shaft should run in line with the first shaft. A slight slope at the rear of the second shaft in relation to the first shaft is okay.

Incorrect working angles, due to using bearing brackets of the wrong length or an improper rear axle pinion shaft angle adjustment, will set up a drive-line vibration. Excessive clearance in rear axle gears, transmission shaft, and prop shaft center bearings also add up to cause a vibration.

If your road test pinpoints the vibration source to the prop shaft, use a protractor to make the following checks:

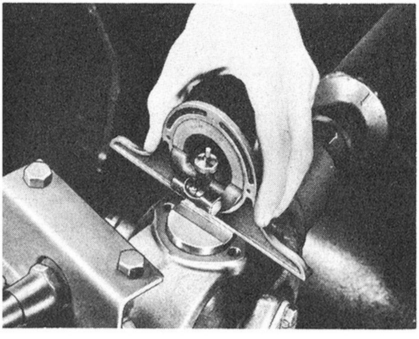
(1) Check parallelism of yokes on all shafts.

(2) Check rear axle position.

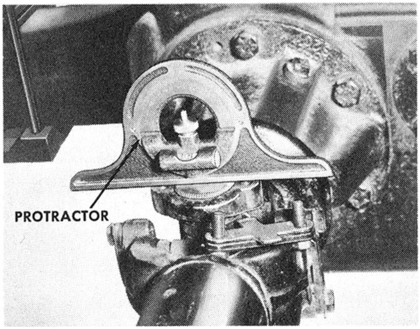
In addition, check bearing bracket heights against those specified on the chart. Also, check the spring seat installations.

NOTE: Few cases of prop shaft vibration occur on one-piece shaft trucks. So most checking pointers will refer to two-and-three-piece shaft models.

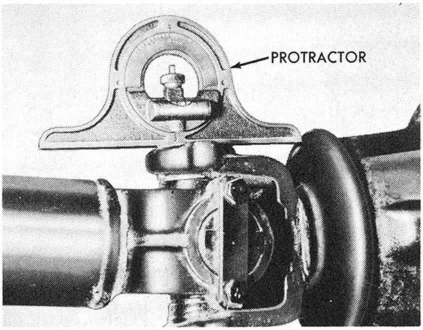
Check Parallel Alignment, Two-Piece Shaft. Be sure the vehicle is placed on a level floor. Next, if the truck has a 6-cylinder engine, place the protractor on a machined boss of the cylinder head. If studs are used, you might have to remove two stud nuts. If the truck has an 8-cylinder engine, put the protractor on the transmission prop shaft yoke. Find the angle of the transmission prop shaft yoke by centering the bubble in the sight glass. Read and record the degree of engine declination, which is the vertical angle of the yoke. Then, remove the joint yoke bearing lock plate from the axle pinion shaft yoke, and turn the yoke to put the bores in a vertical position.



Make sure the yoke is vertical. Adjust the protractor scale to zero, and put the protractor on the upper bearing cage at a 90° angle to the frame centerline. Rotate the yoke until the bubble is centered.



Next, swing the protractor 90° so it will be parallel to the frame centerline. Again, adjust the level to center the bubble. Read the scale opposite the zero indication mark. This angle should be the same as the engine angle, within 1°.



To check the center joint yoke alignment, remove the bearing lock plate from the center yoke. Turn the yoke so the bores are vertical. Adjust the protractor scale to zero and put the protractor on the yoke at a 90° angle to the frame centerline. Rotate the yoke to center the bubble.

Then, swing the protractor 90° until it's parallel to the frame centerline. Again, center the bubble. Read the scale opposite the zero indication mark. You should get the same reading as you get at the rear joint angle, within 1°.

On three-piece shaft models, you determine the angle of the yoke on the second shaft at the rear bracket in this same way.

Correcting Rear Yoke Vertical Alignment. Possible causes of rear joint yoke misalignment are: loose U-bolts at the springs; broken springs; worn out spring shackles, bracket pins and bushings. Correct any of these before going any farther.

Make sure the correct bearing support and spring seat are used. Use the chart on page 22 as a guide. On three-piece shaft models, check the height of the rear bearing bracket against the height specified on the chart.

On models using the two-piece shaft, if the front shaft yoke is misaligned, check the center bracket to see if it is the correct height. If it is, install shims between it and the crossmember to correct the angle.

Check Rear Axle Alignment. Rear axle misalignment will also cause prop shaft vibration. As you can see, shifting of the axle on the springs can affect the horizontal parallelism of the joints.

Shifting like this can happen if the spring bolts are loose, or if the spring center bolts break. Check this alignment by measuring from a point on both sides of the rear axle housing at a spring seat to the rear spring front hanger eye-bolt grease fittings. The rear axle should be at right angles to the frame centerline within 1/8".

SUMMARY

Prop shaft and universal joint diagnosis made without proper testing can lead to unnecessary parts replacement and the condition will still be uncorrected. This means unnecessary cost to the owner as well as the service department, especially in terms of good will.

Therefore, the technician who knows how to road-test such a condition, and the proper way to eliminate the vibration, is in the driver's seat. He saves time and money. He does the job easier and faster. What's more, he earns the lasting respect of his service customer.

RECORD YOUR ANSWERS TO THESE QUESTIONS ON QUESTIONNAIRE NO. 115

Statement		No.	
If a trunnion pin is off center by as little as .003″, it can cause the prop shaft to run out of balance.	RIGHT	1	WRONG
On cross-type joints, the sliding spline connection compensates for variations in distance between output and pinion shafts.	RIGHT	2	WRONG
No working angle, or one that's too slight, will prevent proper lubrication and lead to early wear of universal joint parts.	RIGHT	3	WRONG
Too great a working angle will cause prop shaft vibration.	RIGHT	4	WRONG
On all single and two-piece propeller shaft cars, 1957 models, the proper working angle is 1° to 3°, with 2° preferred.	RIGHT	5	WRONG
Check universal joint working angle with no extra weight in the car or luggage compartment, gas tank at least ¾ full, and car weight on all wheels.	RIGHT	6	WRONG
On Imperials, the letter "O" of the yoke should line up with the keyway at the rear of the front shaft.	RIGHT	7	WRONG
Install tapered shims between the rear spring and its saddle to bring the rear joint working angle within limits.	RIGHT	8	WRONG
To correct the center joint working angle, add or remove 1/16″ shims between the center support insulator and crossmember.	RIGHT	9	WRONG
Trucks perform better when the drive-line from the transmission to rear axle is fairly straight, with as low a working angle as possible.	RIGHT	10	WRONG

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