TRAINING HANDBOOK

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FORD DIVISION

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Before we go into the equipment that makes up the Bronco 4-wheel drive system, let's get basic for just a minute and see exactly what a 4-wheel drive is and how it differs from a conventional drive.

2-WHEEL DRIVE

Of course, most passenger cars are driven by two wheels in normal operation. In the conventional automobile drive (Fig. 1), engine power is transmitted through the transmission to the rear axle drive shaft. The drive shaft turns the rear axle drive pinion and the drive pinion turns the ring gear. The ring gear then drives the differential case, differential pinions and side gears, and the axle shafts and wheels. The differential makes up for any differences in wheel travel, such as in a turn. The front wheels contribute nothing to the drive, though you'll agree they're rather useful for helping support the load and for steering.

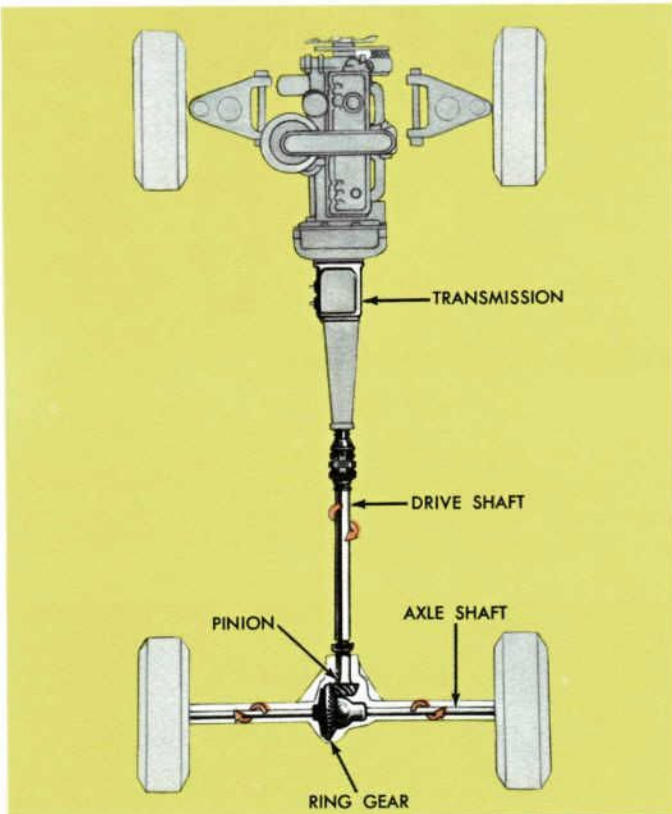


Fig. 1–2-Wheel Drive

For most driving, 2-wheel drive is quite satisfactory. Cruising down all our good roads and highways, we get all the traction we need from the rear wheels. But, out in a rough or muddy field, or in loose sand, two wheels driving may not be enough to get you through.

You need four—that is, you need some driving help from the front wheels to double your traction like a four-footed mule.

4-WHEEL DRIVE

To get the front wheels into the act, we add a few more components to the conventional system. Naturally, we need a front driving axle (Fig. 2) with universal joints at the steering spindles so that the wheels can turn to steer the vehicle at the same time they're being driven. And there must be another drive shaft to get engine power to the front driving axle.

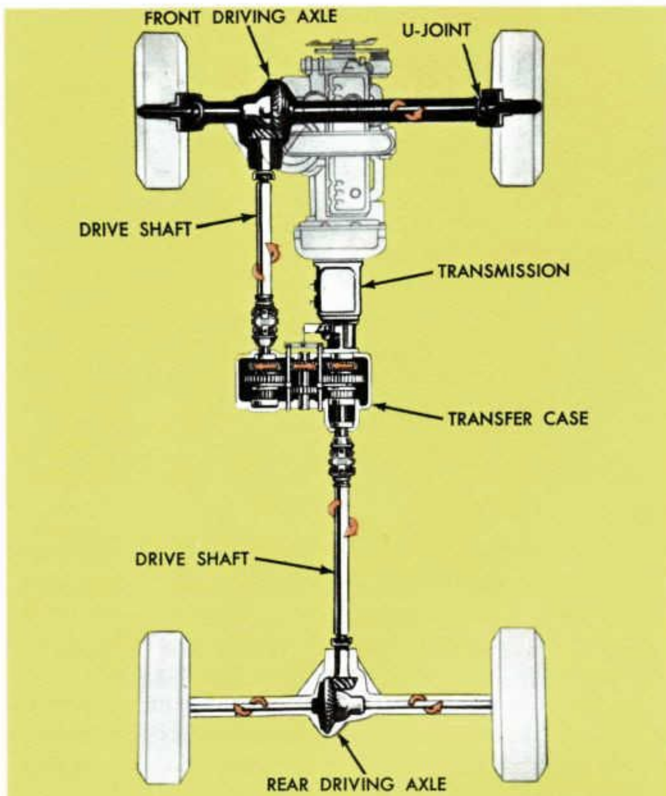


Fig. 2–4-Wheel Drive

Then, coupled to the output of the transmission we have the **transfer case.** The transfer case transmits engine power to the rear wheels alone for 2-wheel drive, or to the front **and** rear wheels for 4-wheel drive.

3-SPEED TRANSMISSION

The Bronco transfer case is adapted directly to the rear of the transmission, and the transmission output shaft is splined to the transfer case input shaft. The Bronco uses a conventional Ford 3-speed synchro-silent transmission, with a steering column shift lever, to match the engine output torque to the needs of the driving axles. But the transmission can get an assist from the **2-speed** transfer case when extra torque is needed.

2-SPEED TRANSFER CASE

There are four positions (Fig. 3) for the transfer case shift lever, which is located on the floor. Reading from front to rear, they are:

4L—4-wheel drive low
N—Neutral
2H—2-wheel drive high (rear wheels only)
4H—4-wheel drive high

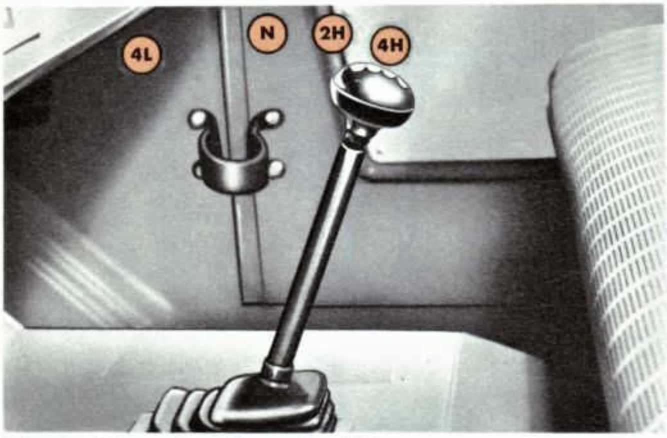


Fig. 3—Transfer Case Positions

In the high ranges (2H and 4H), the transfer case transmits transmission output shaft torque to the driving axle(s) without any reduction (multiplication). In other words, the drive shaft torque is the same as transmission output shaft torque.

In the **low** range (4L), the transfer case operates at a 2.46 to 1 reduction. The drive shafts make one revolution for each 2.46 revolutions of the transmission output shaft, and torque is **multiplied** 2.46 times. (Frictional losses, of course, are ignored here.)

Reduction in the transfer case is available only in 4-wheel drive. You won't need the extra reduction for on-highway use, where you'll be in 2-wheel drive only.

The operating principles of the transfer case and drive lines are covered in detail in the next section.

DOUBLE CARDAN U-JOINT

The Bronco drive shafts incorporate double Cardan or constant-velocity universal joints (Fig. 4) at the transfer case end. The joints operate at rather large angles and the double Cardan joints prevent vibration and wear problems from developing. Single Cardan joints are used at the axle ends where the angles are small.

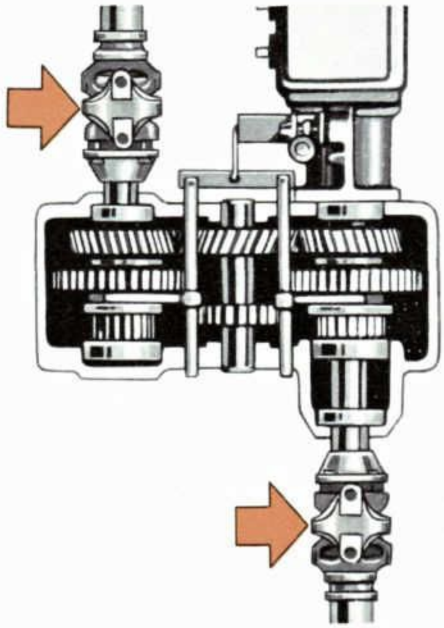


Fig. 4—Double Cardan U-Joint

FRONT DRIVING AXLE

A Dana Corporation front driving axle (Fig. 5) is used on the Bronco. It is a conventional hypoid gear design. Universal joints are built into the axle shafts to permit driving and steering at the same time. The wheels turn on steering knuckles (Fig. 6), which are supported by tapered roller bearings on the front axle tubes.

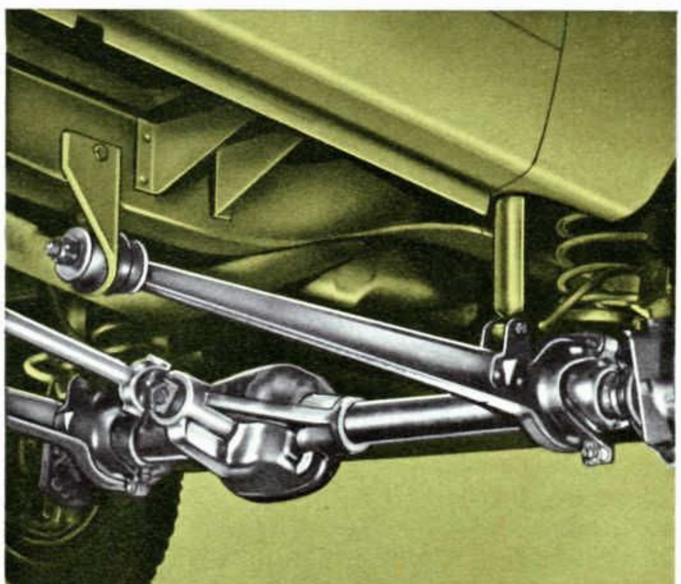


Fig 5—Front Driving Axle

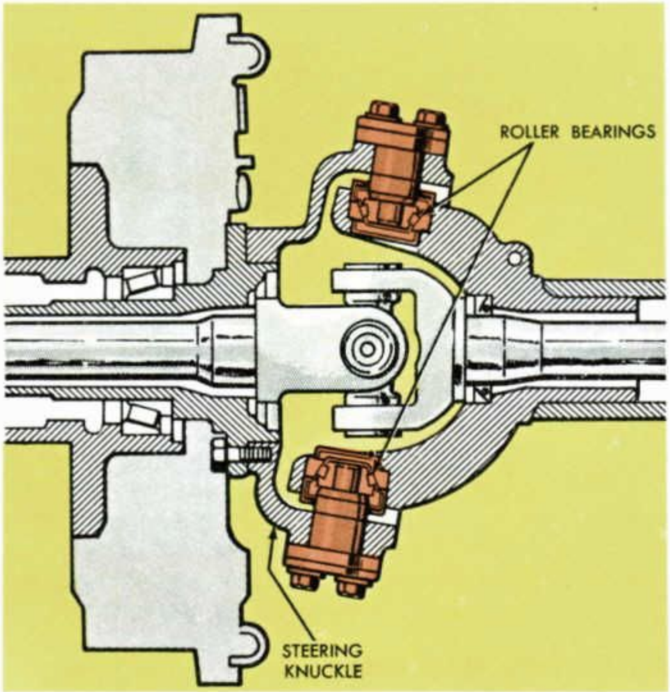


Fig. 6—Steering Knuckle

STEERING

The wheels are turned on the "kingpin" bearings by a transverse tie rod connected to the worm-and-roller steering gear by a single drag link (Fig. 7).

FRONT SUSPENSION AND DRIVE

Coil spring suspension is used at the front axle (Fig. 8). The axle is located by frame-mounted

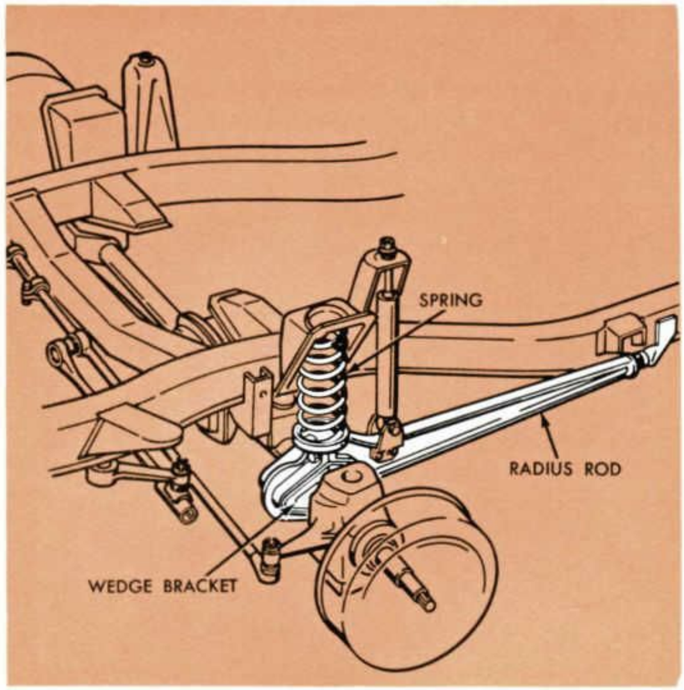


Fig. 8—Front Suspension

"radius" rods, which clamp the axle around welded-on wedge brackets.

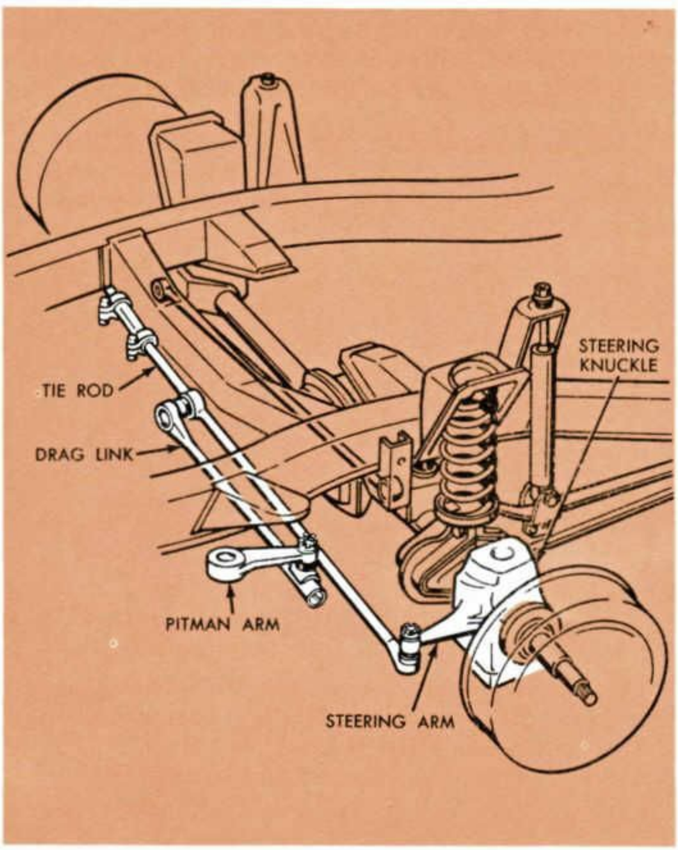


Fig. 7—Steering Linkage

REAR SUSPENSION AND DRIVE

At the rear, we have a conventional Ford hypoid-gear axle, and a conventional Hotchkiss-drive suspension. Rear axle reaction torque is contained by leaf springs.

AXLE RATIOS

Since the two drive shafts in this system are connected through the transfer case, the front and rear axle ratios must be closely matched. The ratios available in Bronco cars are:

	Standard	Optional
Front Axle	4.10 to 1	4.56 to 1
Rear Axle	4.11 to 1	4.57 to 1

The ideal situation when you're trying to diagnose the reason for a problem is to be able to visualize in your mind exactly what's going on in the mechanism while you operate it.

In the case of the transfer case, this isn't too hard to do, because it's not a very complicated mechanism. So let's take a few minutes to see what's in it and what it does.

TRANSFER CASE

MAIN DRIVE GEAR

As we've said before, the transfer case input shaft is splined to the transmission output shaft. Splined to the transfer case input shaft (Fig. 9) is the transfer case **main drive gear.** Anytime there is an input to the transfer case, the main drive gear turns.

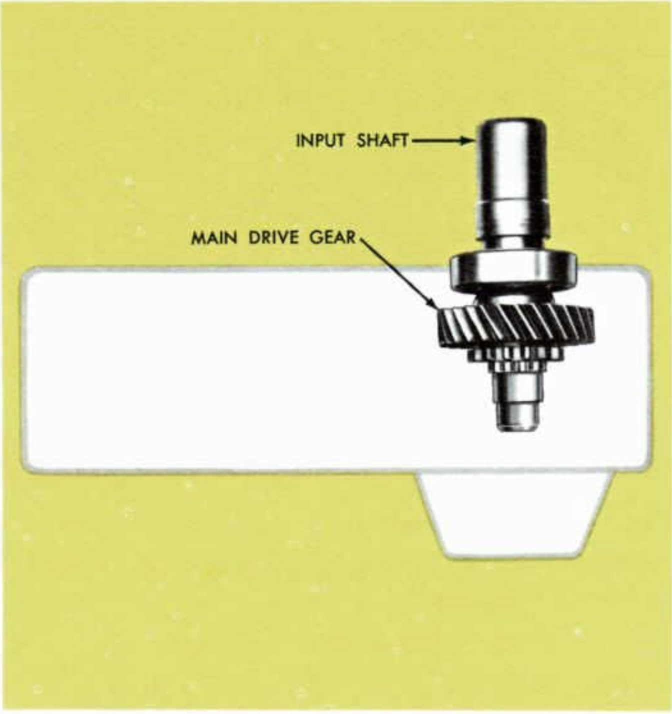


Fig. 9—Main Drive Gear

IDLER SHAFT GEARS

In the center of the transfer case (Fig. 10), we have the idler shaft two-gear cluster. Two gears—**the idler shaft drive gear** and the **idler shaft low-speed gear**—are machined from the same piece of stock. The idler shaft drive gear is always in mesh with the input shaft main drive gear. So the idler shaft gears **also** turn anytime there is an input from the transmission.

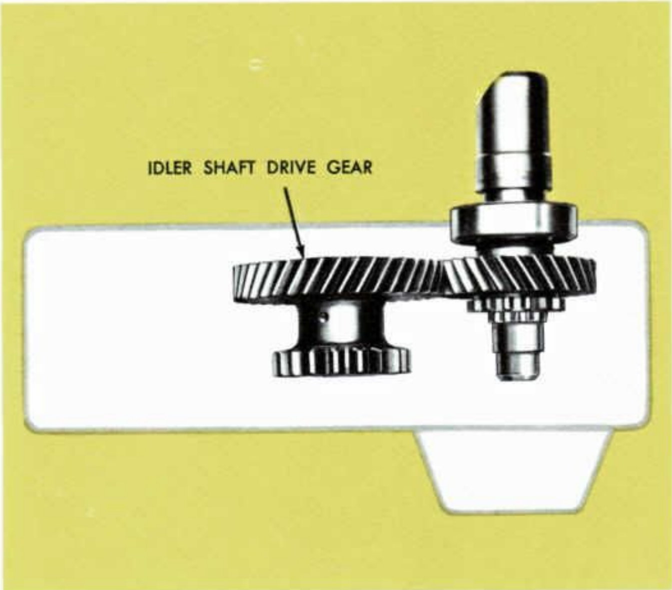


Fig. 10—Idler Shaft Gears

HIGH-SPEED GEAR

The front output **high-speed gear** (Fig. 11) is in constant mesh with the idler shaft drive gear. In neutral, it runs free on the front output shaft.

The high-speed gear has the same number of teeth as the main drive gear, so it will always turn with the main drive gear—at the same speed and in the same direction.

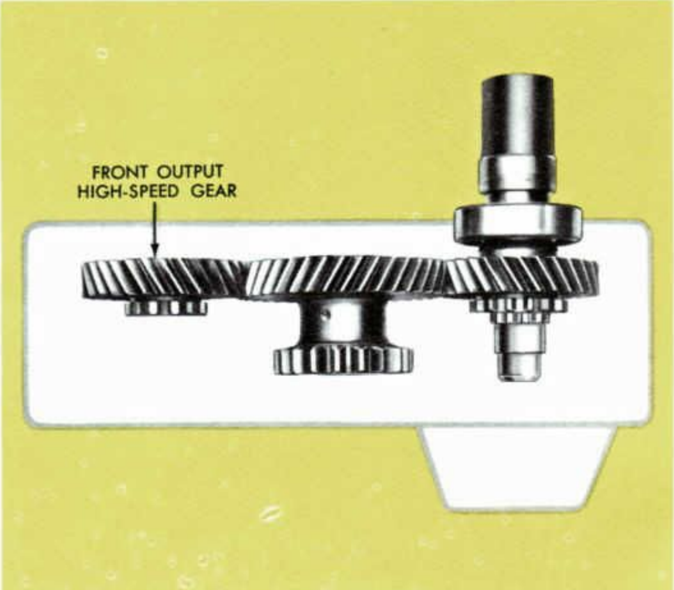


Fig. 11—High-Speed Gear

INPUT SYSTEM

Now, we have assembled the complete system of gears involved in **input** to the transfer case–the main drive gear, the two idler shaft gears and the front output high-speed gear. All four input gears are in constant mesh in the transfer case at all times, and all four turn whenever the input shaft turns.

To get the drive out of the transfer case to the wheels, we must have an output shaft (or shafts) and some way to couple it (them) to the input drive.

REAR OUTPUT SHAFT AND SLIDING GEAR AND CLUTCH

The **rear output shaft** (Fig. 12) is mounted in the transfer case on the same center line as the input shaft. Splined to the output shaft is a sliding gear and clutch. The sliding gear and clutch is shown in the neutral position. It can move forward to engage the clutch teeth on the main drive gear, thus locking the output shaft to the input shaft for direct drive. The sliding gear and clutch also can move rearward to mesh with the idler shaft low-speed gear, permitting the idler shaft to drive the rear output shaft for reduction.

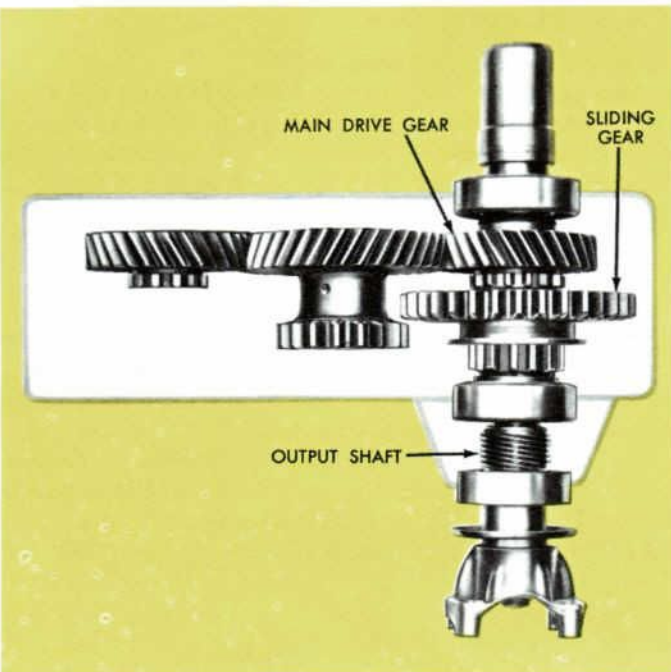


Fig. 12–Rear Output Shaft and Sliding Gear and Clutch

FRONT OUTPUT SHAFT AND SLIDING GEAR

For front wheel drive, we have the **front output shaft** (Fig. 13) which supports the front output high-speed gear. This shaft also has a sliding gear and clutch splined to it.

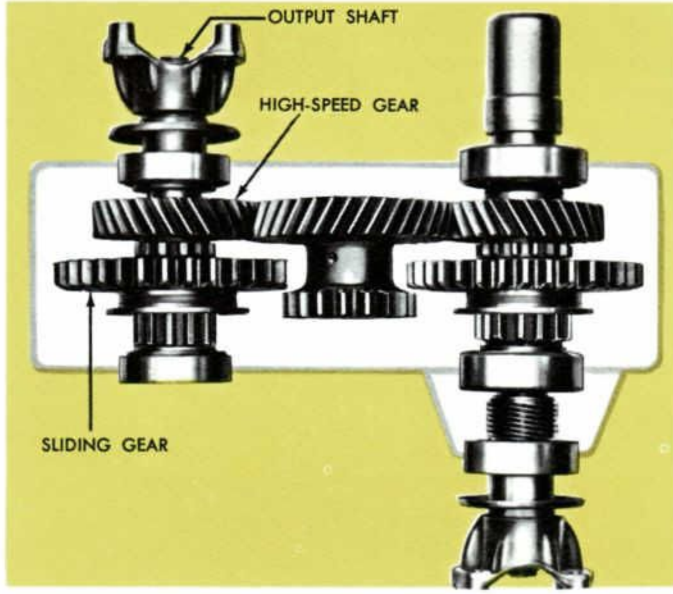


Fig. 13–Front Output Shaft and Sliding Gear

The **front output shaft sliding gear and clutch** (shown in neutral) can move forward to lock the output shaft to the high-speed gear for direct drive; or it can move rearward to mesh with the idler shaft low-speed gear and drive the front output shaft in reduction.

SHIFTING GEARS

So shifting gears in the transfer case is as simple as moving a sliding gear or two. The sliding gears are moved by forks connected to two shift rails (Fig 14). The shift rails are connected to the floor shift lever through an adjustable clevis linkage. Spring-loaded "detent" balls and interlock pins fall into notches in the shift rails to give the driver the feel of completed shifts.

And now, we can see just what goes on inside the transfer case in each of the four positions.

4L POWER FLOW

When the driver moves the shift lever to 4L (all the way forward), the shift rails move both sliding gears rearward (Fig. 15) to mesh with the idler shaft low-speed gear. Since the sliding gears are splined to the output shafts, the idler low-speed gear can drive both output shafts.

Power flow, then, is from the input shaft and main drive gear (Fig. 16) to the idler gears. At the idler low-speed gear, the power splits and continues through the sliding gears and output shafts to the

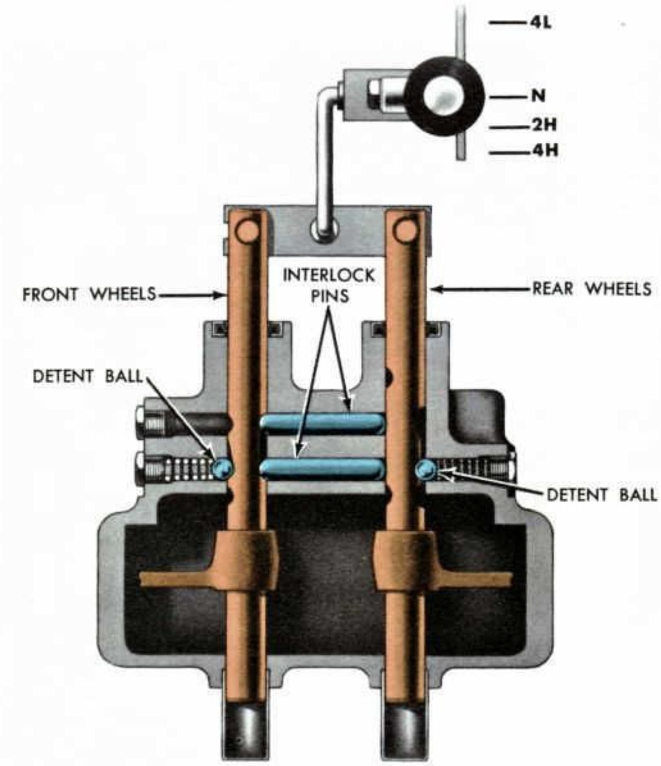


Fig. 14–Transfer Case Shift Linkage

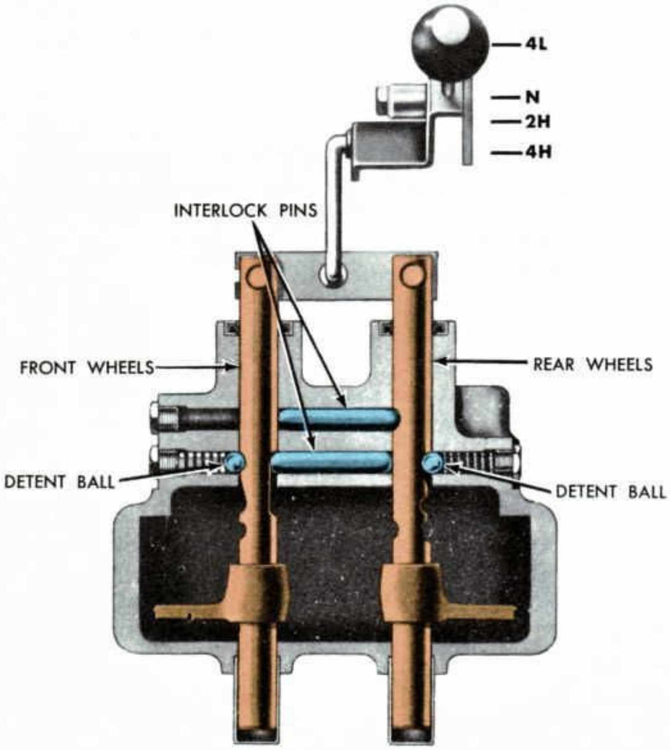


Fig. 15– 4L Shift

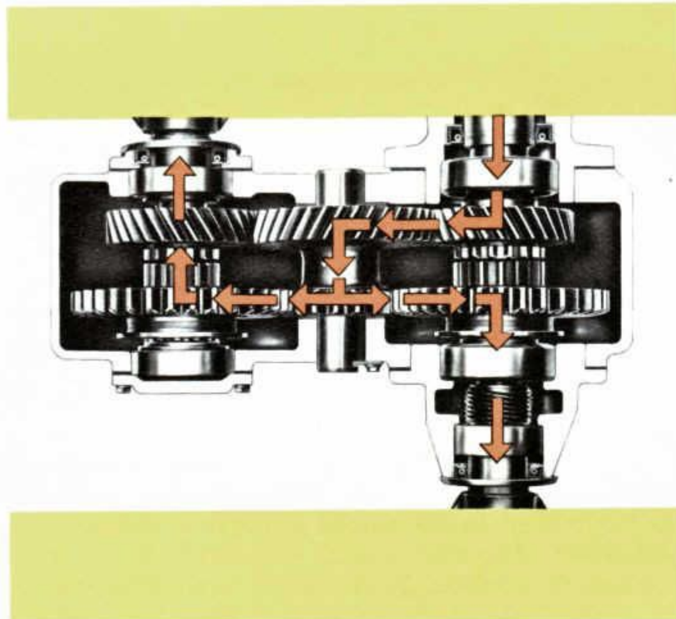


Fig. 16–4L Power Flow

front and rear drive shafts.

Our transfer case gear reduction is from the main drive gear to the larger idler shaft drive gear, and also from the idler (smaller) low-speed gear to the larger sliding gears. The transfer case reduction in 4L is 2.46 to 1.

NEUTRAL POWER FLOW

When the transfer case shift lever is in neutral (Fig. 14), the sliding gears are not locked to the main drive gear or the front output shaft high-speed gear, nor are they meshed with the idler shaft low-speed gear. They simply loaf.

In case you're wondering why have a neutral position, think about the sport who needs a power take-off for his boat winch. Remember, if there's any action at the input shaft, the idler gears and the high-speed gear are turning. Either the front output shaft high-speed gear or the idler low-speed gear can be used for a power take-off.

2H POWER FLOW

When the driver moves the transfer case shift lever rearward to the 2H position (Fig. 17), the rear output shaft sliding gear is moved fully forward and engages with the main drive gear. This locks the main drive gear to the rear output shaft. (The front output shaft sliding gear remains in the neutral position so the high-speed gear is still free-running and there's no action at the front axle.)

Power flow in 2H, then, is straight through the input shaft and main drive gear, the rear output

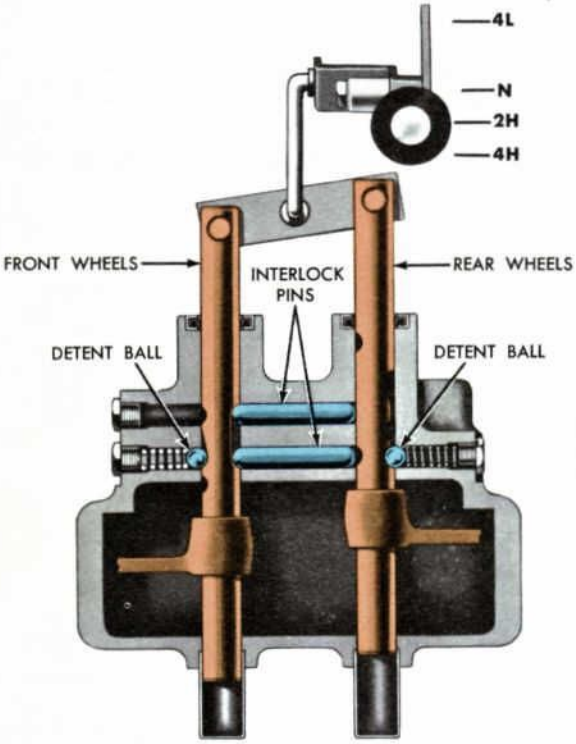


Fig. 17—2H Shift

shaft sliding gear, the rear output shaft, and to the rear wheel drive shaft (Fig. 18). Power is transmitted through the transfer case to the rear axle only and without a change in gear ratio.

Fig. 18—2H Power Flow

4H POWER FLOW

In the 4H position (Fig. 19), both sliding gears are moved fully forward. The rear output sliding gear locks the main drive gear to the rear output shaft, just as in 2H. Also, the front output shaft

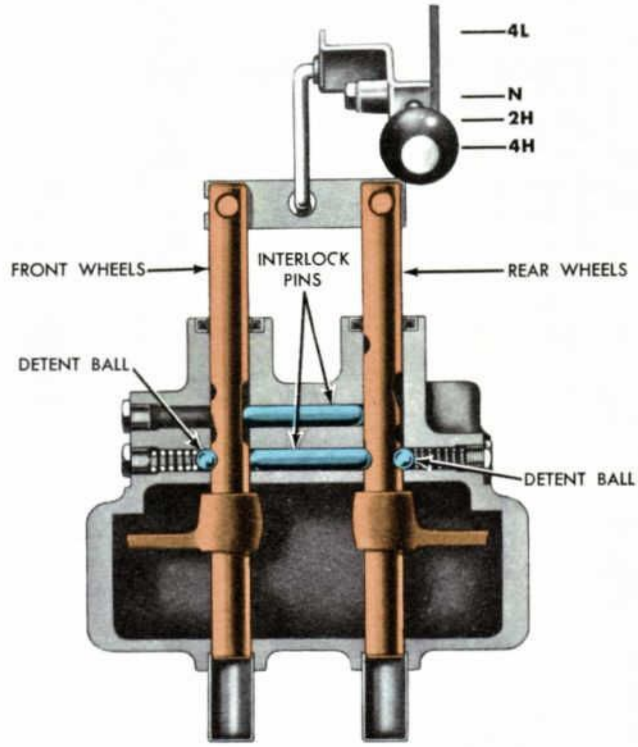


Fig. 19—4H Shift

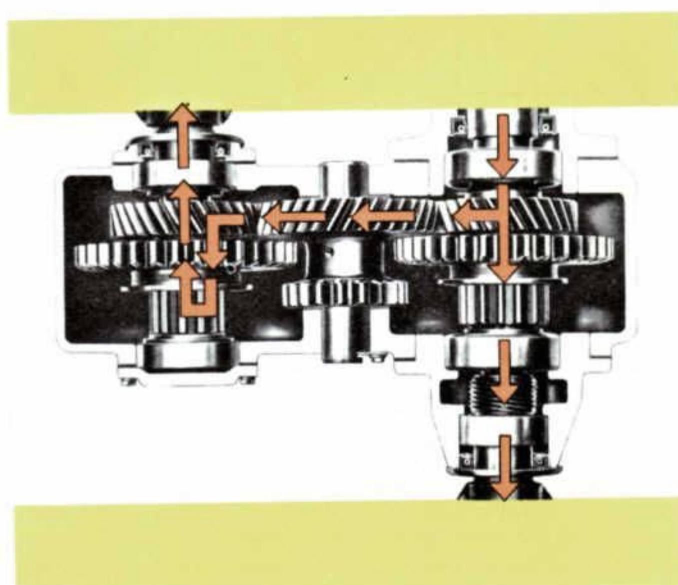


Fig. 20—4H Power Flow

sliding gear locks the front output shaft to the front output shaft high-speed gear.

Power flow in 4H splits at the main drive gear (Fig. 20). It continues through to the rear output shaft and also goes through the idler shaft drive gear to the high-speed gear and to the front output shaft.

OPTIONAL FREERUNNING HUBS

Now, with the transfer case action out of the way, we might take a little closer look at the drive at the front wheels. In the standard axle (Fig. 21), the wheel hub is splined to a driving hub which is

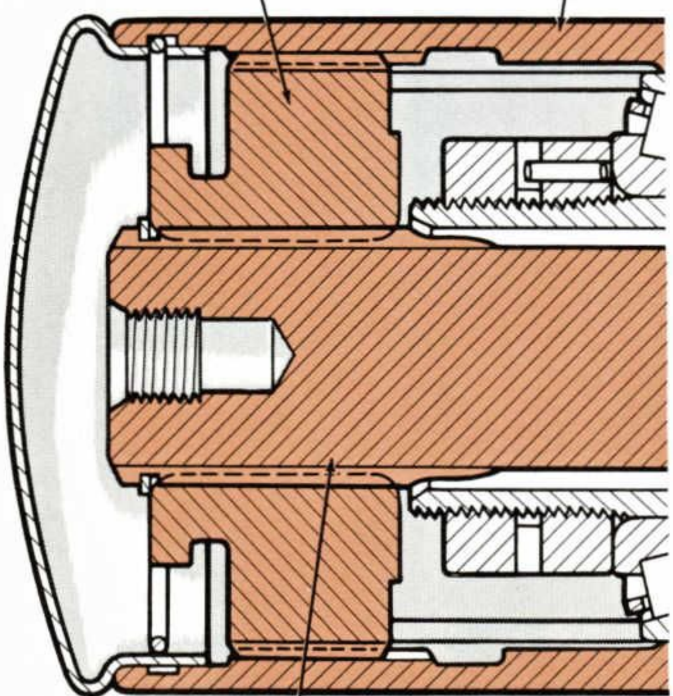


Fig. 21–Front Wheel Driving Hub

splined to the outer end of the axle shaft. We might expect this, because we want the wheel to turn whenever the axle shaft turns in 4-wheel drive.

On the other hand, we'd just as soon **not** have the axle shafts turning with the wheels when we're in 2-**wheel** drive, because when the axle shafts turn, the differential and the front drive shaft will have to turn too. The owner who uses his Bronco on the highway a lot and is concerned about gas mileage won't want his front wheels dragging all that iron around in 2-wheel drive. So you'll see a lot of Broncos with the freerunning front hub option.

JAW CLUTCH

In the optional freerunning hub (Fig. 22), a spring-loaded jaw clutch is used to lock the wheel hub to the axle shaft. The inner jaw is splined to the wheel hub. The outer jaw is splined to the axle shaft.

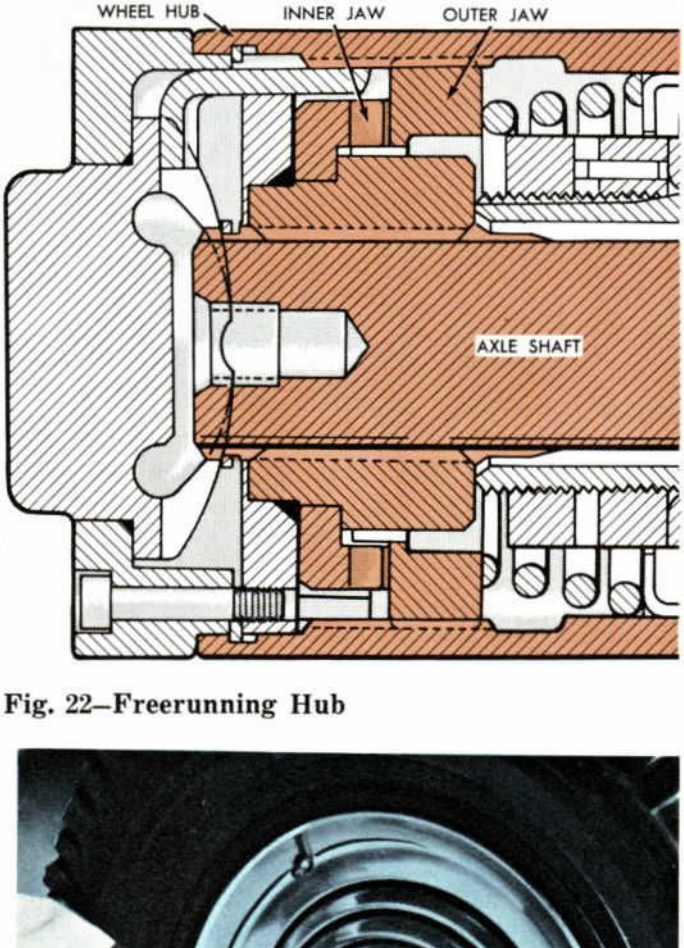


Fig. 22–Freerunning Hub

Fig. 23–Hub Selector Knob

Unlocking the jaw clutch is as simple as turning the selector knob on the end of the hub 90 degrees either way (Fig. 23). When you turn the knob, cam action forces the outer jaw back out of engagement with the inner jaw (Fig. 24). Then, the front wheels can roll without dragging the axle and drive shaft.

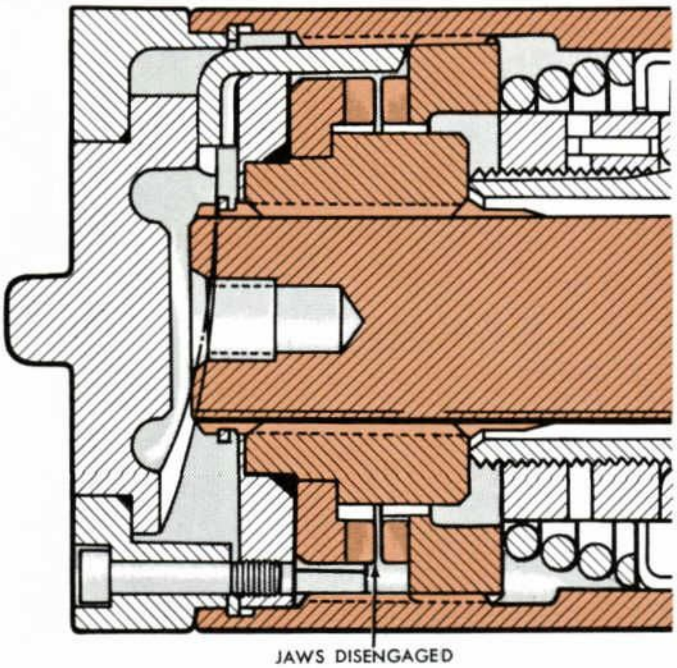


Fig. 24—Freerunning Hub Unlocked

FRONT AXLE DRIVE

You can see from Fig. 2 that the front axle drive pinion is on the left side on the ring gear. Thus, looking forward, the front drive shaft and the drive pinion turn counterclockwise to drive the ring gear and the wheels forward. The rear axle drive pinion turns clockwise (as viewed from the front of the car) to drive the rear wheels forward.

LEFT-HAND DRIVE

We say then, that the rear axle is a right-hand drive, which is conventional. The **front axle,** because of the counterclockwise pinion rotation, is referred to as a **left-hand drive.**

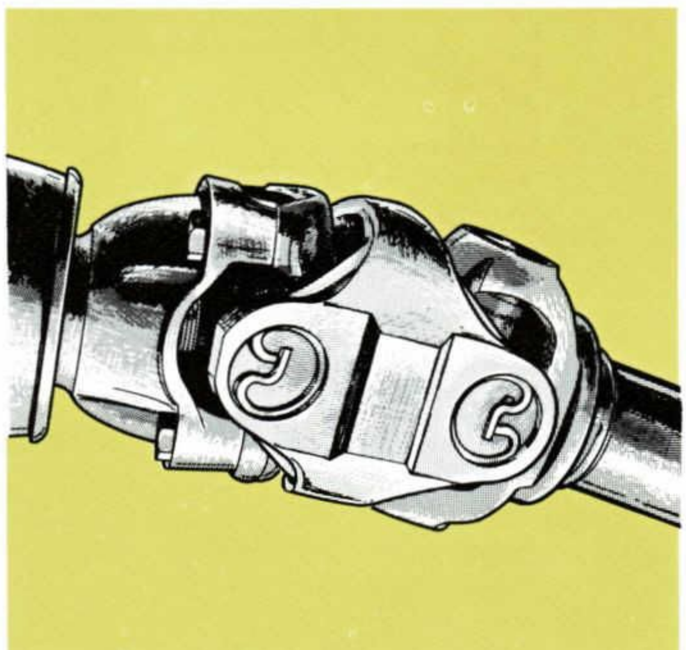
With this exception, the principles of operation of the front driving axle are the same as any other axle. These principles are covered in your Service Training Handbook 4000.1—"Rear Axle and Drive Line—Principles of Operation."

CONSTANT-VELOCITY U-JOINTS

Also in handbook 4000.1, there is a detailed explanation of why the angular velocity output of a single universal joint is not constant when the joint is "working" or operating at an angle.

Briefly, because the driving and driven yokes are rotating in different planes, the driven shaft is accelerated twice and decelerated twice in each revolution. Normally, with small operating angles, this "nonconstant velocity" effect is slight and is compensated for by flexibility in the drive line or by matching the axle drive pinion angle with the transmission output shaft angle. When the angles are matched, the axle pinion turns at the same angular velocity as the transmission output shaft, and only the drive shaft turns at a nonconstant velocity.

With large working angles, though, accelerating and decelerating the drive shaft can cause some



serious noise and vibration, and can cause early joint failure, especially at high speeds. On the Bronco, the "working" angles at the axle ends are small, but there are some pretty respectable angles —more than 10 degrees—at the transfer case ends. Even forgetting about the possibility of vibration and early failure, a single Cardan joint would hardly have room to work at these angles—considering the problems of working clearance and slip-yoke travel. And so we have the double Cardan or constant-velocity universal joints in the Bronco.

SPLITS THE ANGLE

The double Cardan joint is constructed so that the working angle is always split exactly in half between the two joints (Fig. 25). This is accomplished by a ball-and-socket mechanism inside the joint.

CONSTANT VELOCITY

Dividing the angle equally between the two joints has the same effect as cancelling or matching angles at the two ends of a drive shaft. The first joint's input yoke and spider turn at a constant velocity. The **center** yoke of the double Cardan joint is accelerated and decelerated. (In effect, the center yoke is a very short drive shaft—far too short to have a resonant frequency low enough to cause noise or vibration at drive shaft operating speed.) Since the double Cardan joint provides cancelling angles, the **output** spider and yoke turn at a constant (same as input) velocity.

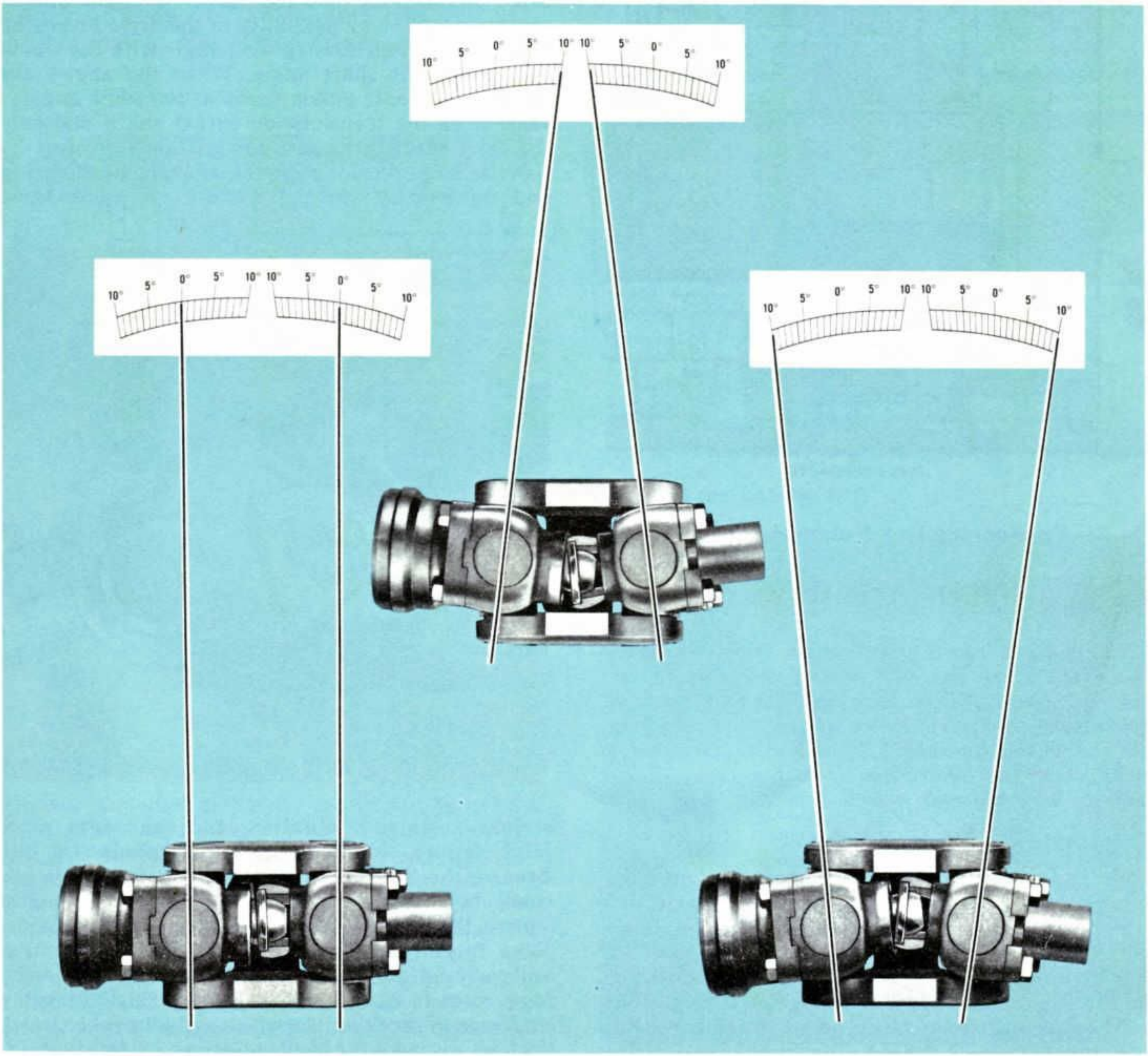


Fig. 25—The Angle is Split

Operating a four-wheel drive vehicle requires a little driver education. It's important to know which transfer case ranges to use, and which ones **not** to use for various driving conditions. This is information **you,** as a service technician must have, to be able to check the vehicle out, and to be able to educate the owners when necessary.

ON DRY PAVEMENT

The first thing you **must** know about this 4-wheel drive is that two wheels driving are enough for highway operation. And four wheels driving on the highway are too many. Here's why:

When you're in 4-wheel drive, both drive shafts, being interconnected in the transfer case, must turn at exactly the same rpm. So you take off, and maybe you're okay for a short stretch, with the front and rear wheels having exactly the same combined rolling radii. Most often, though, the combined front wheel rotation does **not** exactly equal the combined rear wheel rotation.

In mud or loose dirt, that's okay. The tires can slip easily and adjust the difference. But they can't slip so easily on dry pavement and something's got to give.

Actually, even the slight difference in axle ratios or a variation in the tire diameter can get you into a torque build-up or lock-up condition in a hurry—without ever turning the wheels. You'll probably end up having to back up or jack up a wheel before you can move the transfer case shift lever.

From Missouri?

Here's a little demonstration you can make for your own interest and for the benefit of anyone in your shop who is from Missouri and who "has to be shown." With the vehicle on a dry, hard surface, put the transfer case in 4H and the transmission in neutral. The transmission won't have any effect on the wheels, but the drive shafts will be interconnected through the transfer case (Fig. 26).

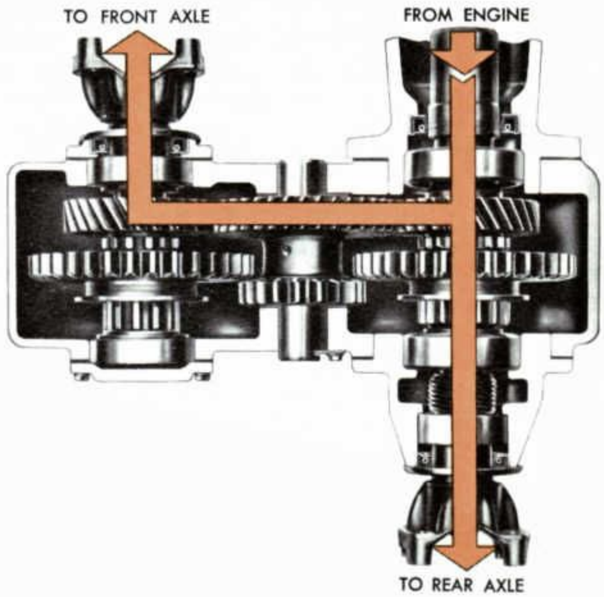
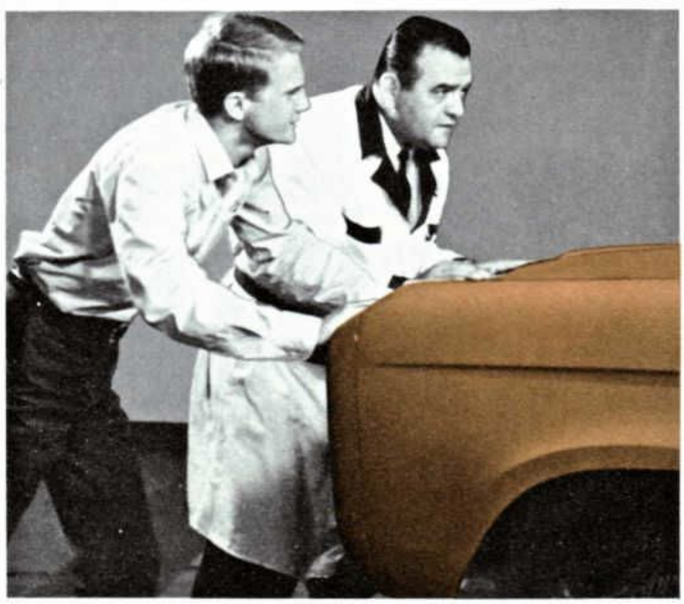


Fig. 26—Drive Shafts Interconnected

If the car has freerunning hubs, be sure they're in the locked position.



Then cut the wheels (this gets quicker results) and get two or three strong backs to give the car a push. For a few feet that is. You won't be able to go any farther.

Breaking the Lock

So you've got yourself a torque lockup. How are you going to break it? Easy. Take it out of 4-wheel drive. Probably you'll find it very difficult or impossible to move the shift lever or the hub selector. The thing to do is jack up a wheel (front or rear—anyone will do). When you hear the "Twang," it's unwound and you can move the transfer case shift lever and the hub selector.

Conclusion? 2-wheel drive only on dry pavement.

SHIFTING THE TRANSFER CASE

Now, you're ready to try out the 4-wheel drive. You can shift the transfer case gears into any position with the clutch pushed in and the car standing still. Move the shift lever first to 2H and leave it there until you pull off the highway. Of course, you can go through all the transmission gears without touching the transfer case shift lever.

4H Range

When you leave the highway, look for some mud or soft dirt where your wheels tend to spin in 2-wheel drive. Then, let up on the accelerator momentarily and at the same time pull the shift lever all the way back to 4H. Whenever you're shifting within high range—from 2H to 4H or from 4H to 2H—you don't need to declutch.

In 4H, you have drive at all four wheels for extra traction. As a general rule, use 4H, not 4L, when traction is a problem. The added reduction in 4L could just have you spinning four wheels.

4L Range

Shifting in and out of 4L you go through neutral and you must declutch.

To shift into 4L, stop the car. Push in the clutch and move the shift lever all the way forward. If you have any difficulty geting into 4L, you may have a little gear abutment in the transfer case. Put the transmission in gear and momentarily engage the clutch partially to get the gears rolling. The lever then will slide into position easily.

Be sure to shift all the way forward into 4L for full engagement. When the rear output shaft sliding gear shift rail is all the way back, the detent ball drops into position and gives a drop-into-gear "feel." This is only half of the 4L shift. Keep on going until you feel the second drop-into-gear "feel."

To shift out of 4L into either high range, you needn't stop—just push in the clutch until the shift is completed; then let it out and continue on your way.

Use the 4L range for bumpy terrain or climbing hills, where you need extra torque as well as extra traction. Four-low also provides maximum engine braking.

The Bronco 4-wheel drive story would hardly be complete without passing on a few service tips. We're not going to get into any heavy repair procedures here. That information is all easily accessible in the applicable shop manual. We're just going to pass on a few miscellaneous service tips.

ADJUSTING THE AXLE GEARSET

Remember that the Bronco front axle is operated in left-hand drive. That means you're using the coast side of the ring gear for drive in the forward gears. If you have occasion to adjust a gearset in this axle, set the pattern on the **drive** side.

DIAGNOSING GEAR TROUBLES

Deciding whether gear trouble is in the transfer case or transmission is simplified by the neutral position in the transfer case. Running the transmission through the gears with the transfer case in neutral should tell you quickly if there's a bad gear in the transmission or not.

TRANSFER CASE SHIFT LINKAGE ADJUSTMENT

If it is necessary to adjust the transfer case shift linkage, remove the pin that attaches the shift rod clevis to the shift rail link (Fig. 27). Turn the clevis on the rod to lengthen or shorten the connection, as necessary. Proper adjustment will position the shift lever straight up-and-down (vertical) in neutral.

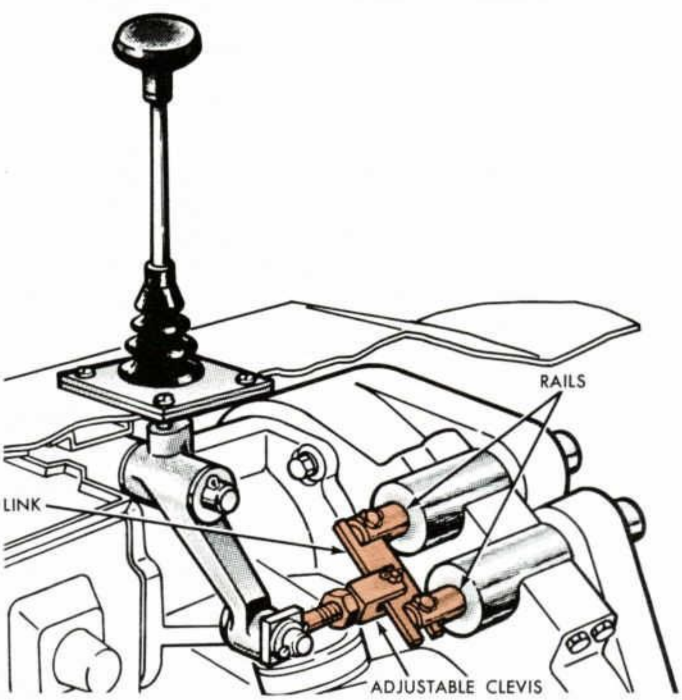


Fig. 27—Transfer Case Shift Linkage Adjustment

HARD SHIFTING IN 4L

If you have a complaint of hard shifting in four-low, and the linkage is properly adjusted, the difficulty is probably due to gear tooth abutment.

Show the owner how to let out the clutch slightly with the transmission in gear and move the shift lever fully forward to complete the shift.

CLUTCH PEDAL ADJUSTMENT

Proper clutch pedal adjustment is also necessary for proper shifting. Total pedal travel should be $6\frac{5}{8}$ to $6\frac{7}{8}$ inches.

Adjust the clutch pedal stop at the upper end of the pedal to obtain the specified travel. Then tighten the stop nut to 12-16 foot-pounds torque.

CLUTCH PEDAL FREE PLAY

Clutch pedal free play is $1\frac{3}{16}$ to $1\frac{3}{8}$ inches.

Adjust the free play by backing off the lock nut and turning the sleeve on the release pushrod (Fig. 28). This adjustment should be made with the retracting spring removed, then checked with the spring in place.

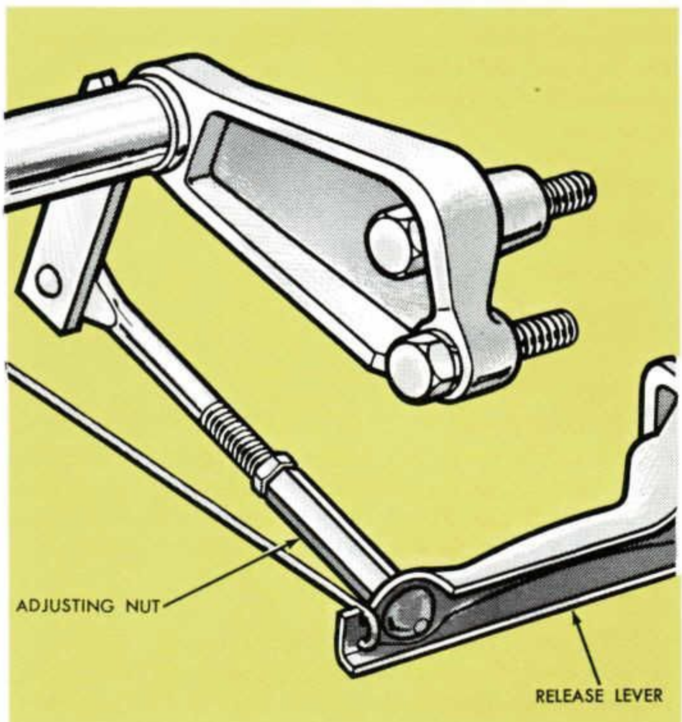


Fig. 28—Clutch Free Play Adjustment

FRONT WHEEL TOE-IN

Front wheel toe-in is the only front suspension adjustment required. Toe-in is $\frac{1}{32}$ to $\frac{5}{32}$ inch.

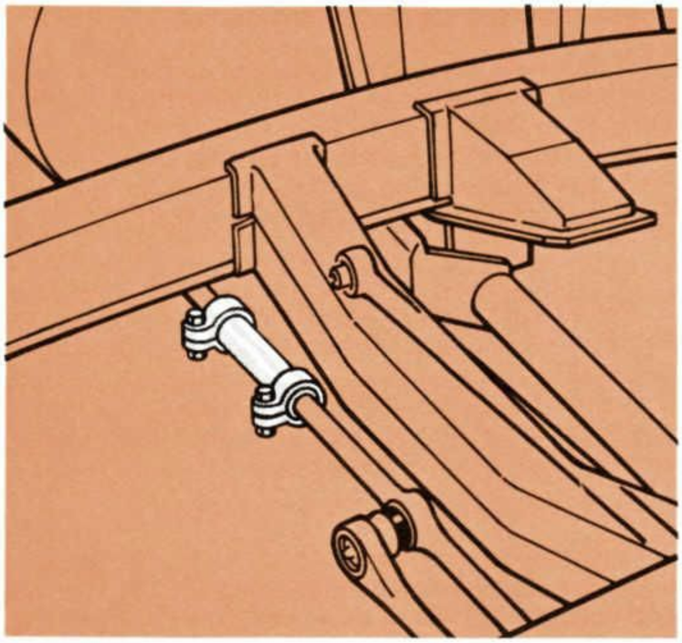


Fig. 29—Toe-In Adjustment Sleeve

Adjust toe-in to this dimension by loosening the two tie-rod end clamp bolt nuts (Fig. 29) and turning the tie-rod sleeve, as required. Tighten the clamp nuts securely.

LUBRICATION

Transfer Case

The lubricant specified for the transfer case is:

Above 10°
Engine oil SAE 50 Ford Spec. ESE-M2C39
Below 10°
Engine oil SAE 30 Ford Spec. ESE-M2C37

The capacity is 2¾ pints. This should bring the level to the bottom of the filler plug hole. The lubricant covers the front output shaft and idler gear only. The other gears are lubricated by splash.

3-Speed Transmission

Lubricant C3RZ-19C457-B, Rotunda R139-B is specified for the 3-speed transmission. The capacity is 3½ pints, which brings the level to the bottom of the filler plug hole.

A double-lip sealer between the transmission and the transfer case prevents mixing the lubes. Give careful attention to this seal anytime you separate the two units.

FRONT AXLE "KINGPIN" BEARING PRELOAD

When servicing the spindle arms on these vehicles, it is important that the "kingpin" bearing preload be adjusted so that a torque of 5 to 10 foot-pounds is required to turn the entire front wheel with the tie rod removed (Fig. 30).

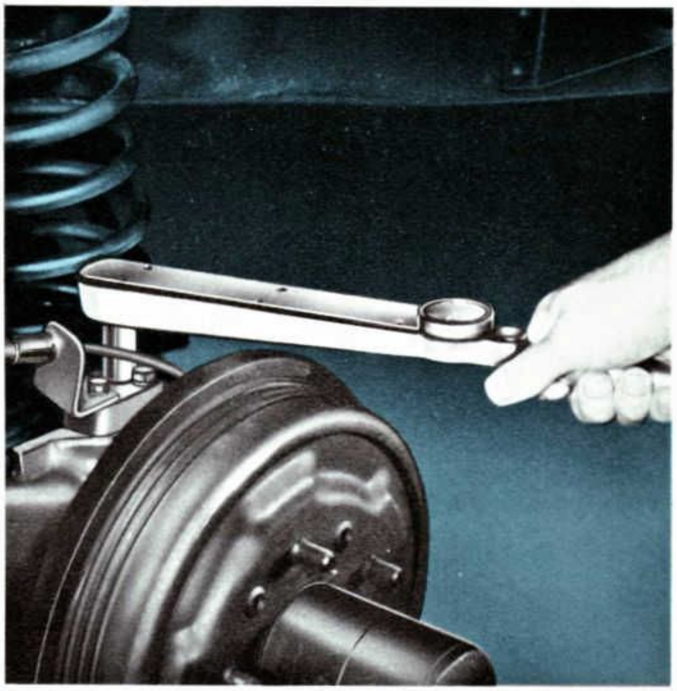


Fig. 30—Checking "Kingpin" Bearing Preload

WATER IMMERSION

After exposure to water immersion, be sure to check the lubricant in the front wheel bearings for contamination. If water has leaked into the bearings and washed out the lubricant, or mixed with it, remove the hubs and clean and repack the bearings with the specified lubricant (C2AZ-19585-A, Rotunda R-152-A).

CHECK THE SEALS

Periodically, inspect the seal areas of the transfer case for oil leaks. If a leak is detected at the output shafts, and seals are replaced, also carefully check the front output shaft flange retainer flat washer O-ring. Tighten the yoke nuts to specifications. Also, be sure the power take-off cover plate screws are properly tightened.

AXLE VENT HOSES

Whenever the vehicle is serviced for any reason, you might check the axle vent hoses for obstructions and proper attachment. Proper venting of the axles is dependent upon the hoses being clear. Be sure they are properly attached to the fittings on the carriers and the upper ends are properly secured by the clips in the frame side rails.

FORD DIVISION Ford MOTOR COMPANY

QUALITY CAR CARE

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