

STEERING

The stability and proper functioning of the steering system depends in a large measure upon correct alignment and a definite procedure for inspection of the steering system is recommended. In so doing, nothing is overlooked and the trouble is ascertained in the shortest possible time. It is suggested that the following sequence be used:

1. Equalize tire pressures and level car.
2. Inspect king pin and wheel bearing looseness.
3. Check wheel runout or wobble.
4. Test wheel balance.
5. Check for spring sag.
6. Inspect brakes and shock absorbers.
7. Check steering assembly and connecting rod.
8. Check caster.
9. Check toe-in.
10. Check toe-out on turns.
11. Check camber.
12. Check king pin inclination.
13. Check tracking of front and rear axle.
14. Check frame alignment.

The steering gear Fig. 1, is the cam and twin lever variable ratio type. The steering gear cam lever shaft is serrated for attachment to the steering pitman arm. The gear case is attached to the inside of the left frame side member by three bolts.

The cam thrust is taken at top and bottom by ball bearings which are adjustable through shims No. 13 at the upper housing cover No. 12.

When making adjustments free the steering gear of all load by disconnecting the steering connecting rod from the steering arm, loosen instrument panel bracket and steering gear frame bolts to allow the steering post to align itself.

Do not tighten the steering gear to dampen out steering troubles, adjust the steering only to remove play within the steering gear.

Adjustment of Ball Thrust Bearings on Cam

Adjust to a barely perceptible drag but allow the steering wheel to turn freely, with thumb and forefinger lightly gripping the rim.

Before making this adjustment, loosen the housing side cover adjusting screw No. 19 to free the pins in the cam groove.

To adjust, remove cap screws and move up the housing cover No. 12 to permit the removal of shims No. 13. Shims are of .002", .003", and .010" thickness.

Clip and remove a thin shim or more if required. Install cap screws and tighten. Test adjustment and if necessary remove or replace shims until adjustment is correct.

Adjustment of Tapered Pins in Cam Groove

Adjust so that a very slight drag is felt through the mid position when turning the steering wheel slowly from one extreme position to the other.

Backlash of the pins in the groove shows up as end play of lever shaft, also as backlash of steering at ball on steering arm.

Note that the groove is purposely cut shallow in the straight ahead driving position for each pin. Fig. 2. This feature permits a close adjustment for normal straight ahead driving thereby avoiding

swaying in the road and also permits take-up of back-lash at this point after wear occurs without causing a bind elsewhere.

Adjust within the high range through the mid position of pin travel. Do not adjust the positions off "straight ahead". Backlash in turn positions is not objectionable.

Removal of Steering Gear from Chassis

To remove steering gear assembly from chassis, the following procedure should be followed:

1. Remove left front fender.
2. Remove horn button and steering wheel.
3. Remove steering post bracket at instrument board.
4. Remove steering post cover plates on toe board.
5. Remove horn wire contact brush, No. 37, Fig. 1.
6. Remove connecting rod at Pitman arm ball.
7. Remove three bolts holding steering gear housing to frame side rail.
8. Remove steering post by bringing it down through floor boards and over outside of the frame.

The installation of the steering gear assembly would be the reverse of the above operations. Frame bolts, torque wrench reading, 36-40 ft. lbs.

Disassembly of Steering Gear

First remove pitman arm No. 21, Fig. 1 with puller. Loosen lock nut No. 20 and unscrew adjusting screw No. 19 a few turns. Remove side cover screws and washers and remove side cover No. 18 with gasket. This will permit removal of lever shaft No. 16.

Remove upper cover plate screws and remove from housing the cam, wheel tube and bearing assembly.

When upper cup or upper cover plate requires replacement, the contact ring on wheel tube must be removed. To do this unsolder horn cable from ring and pull cable from tube, mark on wheel tube the location of ring and then press ring off of tube.

Inspect cam threads for wear, chipping and scoring, also the ball races on the cam ends and the separate ball cups. Existence of any of these conditions indicate necessity for replacement.

Inspect taper studs of lever shaft for flat spots and chipping. In the case of either, replacement is usually advisable. Inspect lever shaft for wear and test fit of shaft in bushing. Inspect condition of oil seal at outer end of lever shaft and the bearing in top end of jacket tube.

Assembling Steering Gear

Reassemble all parts to wheel tube in reverse order of disassembly and flatten cable and solder to ring. Assemble cam, wheel tube and bearing assembly in housing, seating well the lower bearing ball cup in the housing.

With adjusting shims in place, assemble upper cover plate with pin on top side of housing and adjust cam bearings.

Assemble lever shaft in housing and with gasket in place assemble side cover and make adjustment for a minimum backlash of studs in cam groove.

When assembling upper bearing spring No. 26, and spring seat No. 25 in jacket tube make sure that spring seat is positioned correctly. It must be placed with the lengthwise flange down against bearing and not up inside of spring coil.

Install pitman arm No. 21 to lever shaft No. 16 so that the line across the face of arm and end of shaft correspond, with the ball end down. Install lockwasher No. 23 and nut No. 22.

Install steering gear assembly in chassis in the reverse order in which it was removed.

When installing the steering wheel the steering gear should be in its mid position when the

front wheels are in the straight ahead position. To check, turn the steering wheel as far to the right as possible then rotate the wheel in the opposite direction as far as possible and note the total number of turns. Turn the wheel back just one half of this total movement thus placing the gear in mid position at which point the front wheels should be straight ahead. The steering wheel spoke with moulded trade mark on underside will point down toward drivers seat and in line with the steering post. If not it will be necessary to remove the steering wheel and shift it on the serrations of the shaft.

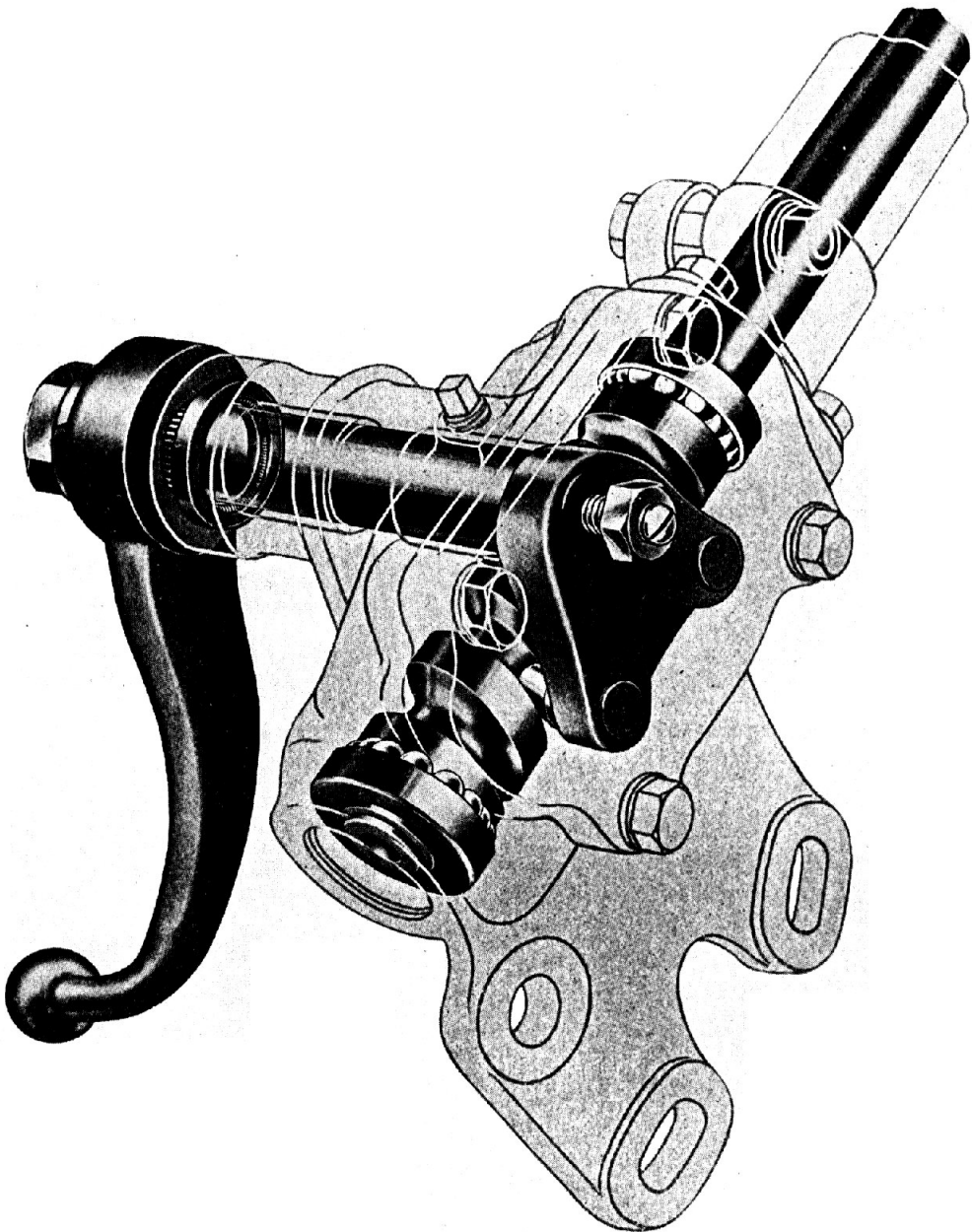


FIG. 2—SECTIONAL VIEW OF STEERING

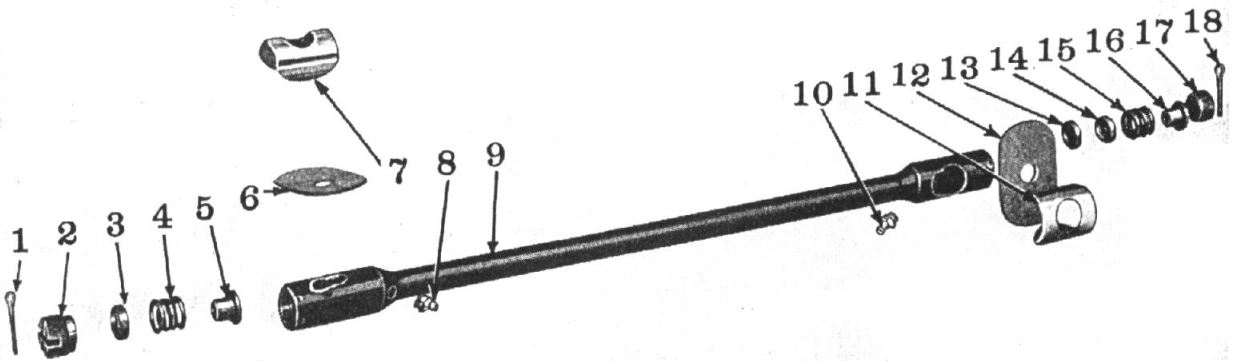


FIG. 3—STEERING CONNECTING ROD

No.	Willys Part No.	Ford Part No.	Name
1	5134	72089-S	Steering Connecting Rod Cotter Pin—Front
2	630756	GPW-3323	Steering Connecting Rod Adjusting Plug—Large
3	630755	GPW-3320	Steering Connecting Rod Ball Seat
4	630754	GPW-3327	Steering Connecting Rod Spring
5	630753	GPW-3326	Steering Connecting Rod Safety Plug
6	A-622	GPW-3332-A2	Steering Connecting Rod Dust Cover
7	A-623	GPW-3336	Steering Connecting Rod Dust Cover—Small
8	392909	353027-S7-8	Hydraulic Straight Grease Fitting
9	A-619	GPW-3304	Steering Connecting Rod Assembly

No.	Willys Part No.	Ford Part No.	Name
10	392909	353047-S7-8	Hydraulic Straight Grease Fitting
11	A-623	GPW-3336	Steering Connecting Rod Dust Cover—Small
12	A-622	GPW-3332	Steering Connecting Rod Dust Cover
13	630755	GPW-3320	Steering Connecting Rod Ball Seat
14	630756	GPW-3323	Steering Connecting Rod Adjusting Plug—Large
15	630754	GPW-3327	Steering Connecting Rod Safety Plug
16	630753	GPW-3326	Steering Connecting Rod Spring
17	630757	GPW-3328	Steering Connecting Rod Assembly
18	5134	72089-S	Steering Connecting Rod Cotter Pin—Rear

Steering Connecting Rod

The steering connecting rod is the ball and socket type. At front or axle end, the spring and spacer are assembled between rod (bottom of socket) and ball seat while at the steering gear end, spring and spacer are between ball seat and end plug. See Fig. 3.

When removing springs and seats for any reason make sure they are reassembled as above because this method of assembly relieves road shock from the steering gear in both directions. To adjust ball joint at axle, screw in plug firmly against the ball, then back off one half turn and lock with new cotter pin inserted through hole in tube and slot in adjusting plug.

To adjust ball joint at steering Pitman Arm, screw in end plug firmly against the ball, then back off one full turn and lock with new cotter pin inserted through hole in tube and slot in adjusting plug.

This will give the proper spring tension and avoid any tightness when swinging the wheels from maximum left to right turn.

Ball joints must be tight enough to prevent end play and yet loose enough to allow free movement.

Tie Rod

The tie rods, No. 11 and 14, Fig. 4 are of three piece construction consisting of rod and two ball and socket end assemblies. Ball and socket end assemblies are threaded into rod and locked with clamps around each end of tie rod. Right and left hand threads on tie rod end assemblies provide for toe-in adjustment without removing the tie rod ends from steering arms.

The length of the left hand tie rod No. 14 center to center of ball joint is $17\frac{1}{2}$ ", the right hand tie rod No. 11 is $24\frac{1}{4}$ " center to center.

When wear takes place on tie rod end ball and socket, it will be necessary to replace the ball and socket assembly and rubber seal.

Front Wheel Alignment

Proper alignment of front wheels must be maintained in order to insure ease of steering and satisfactory tire life. Most important factors of front wheel alignment are wheel camber, axle caster and wheel toe-in.

These points should be checked at regular intervals particularly where the front axle has been subjected to heavy impact. When checking wheel alignment, it is important that wheel bearings and knuckle bearings be in proper adjustment. Loose bearings will affect reading of instruments when checking camber, knuckle pin inclination and toe-in.

Wheel toe-in is the distance the wheels are closer together at the front than at the rear.

Wheel camber is the amount wheels incline outward at the top from a vertical position.

Front axle caster is the amount in degrees that the steering knuckle pins are tilted toward the front or rear of the vehicle. Positive caster is inclination of top of knuckle pin toward rear of vehicle. Zero caster is vertical position of pin. Negative or reverse caster is the inclination of top of pin towards the front of the vehicle.

Front Wheel Toe-in

Toe-in Fig. 5, is the amount which wheels point inward at front and is necessary to offset the effect of camber.

Toe-in is usually measured at edge of rim, flange or at tire centers with wheels in straight ahead position, however in view of the tread being the same, front and rear, a straight edge or rope can be used.

It is highly important that the toe-in be checked regularly and if found to be excessively out of adjustment, correction should be made immediately.

To Adjust Toe-in

1. Set tie rod end of steering bell crank at right angles with front axle.
2. Place a straight edge or rope against the left rear wheel and left front wheel to determine if wheel is in straight ahead position. If the rear of tire on front wheel does not touch straight edge, it will be necessary to adjust the tie rod by loosening clamps on each end and turning the rod in a clockwise direction until the tire touches the straight edge both front and rear. If the front of the tire does not strike the straight edge, it will be necessary to lengthen the tie rod by turning the rod in a counter-clockwise direction.

3. Check the right hand side in the same manner adjusting the tie rod if necessary, making sure that the bell crank remains at right angles to the axle.
4. Set the toe-in to $\frac{3}{64}$ "- $\frac{3}{32}$ " by shortening each tie rod approximately one half turn.

Front Wheel Camber

The purpose of camber Fig. 6 is to more nearly place the weight of the vehicle over the center of the steering knuckle pins and facilitate easy steering.

The result of excessive camber is irregular wear of tires on outside shoulders and is usually caused by bent axle parts.

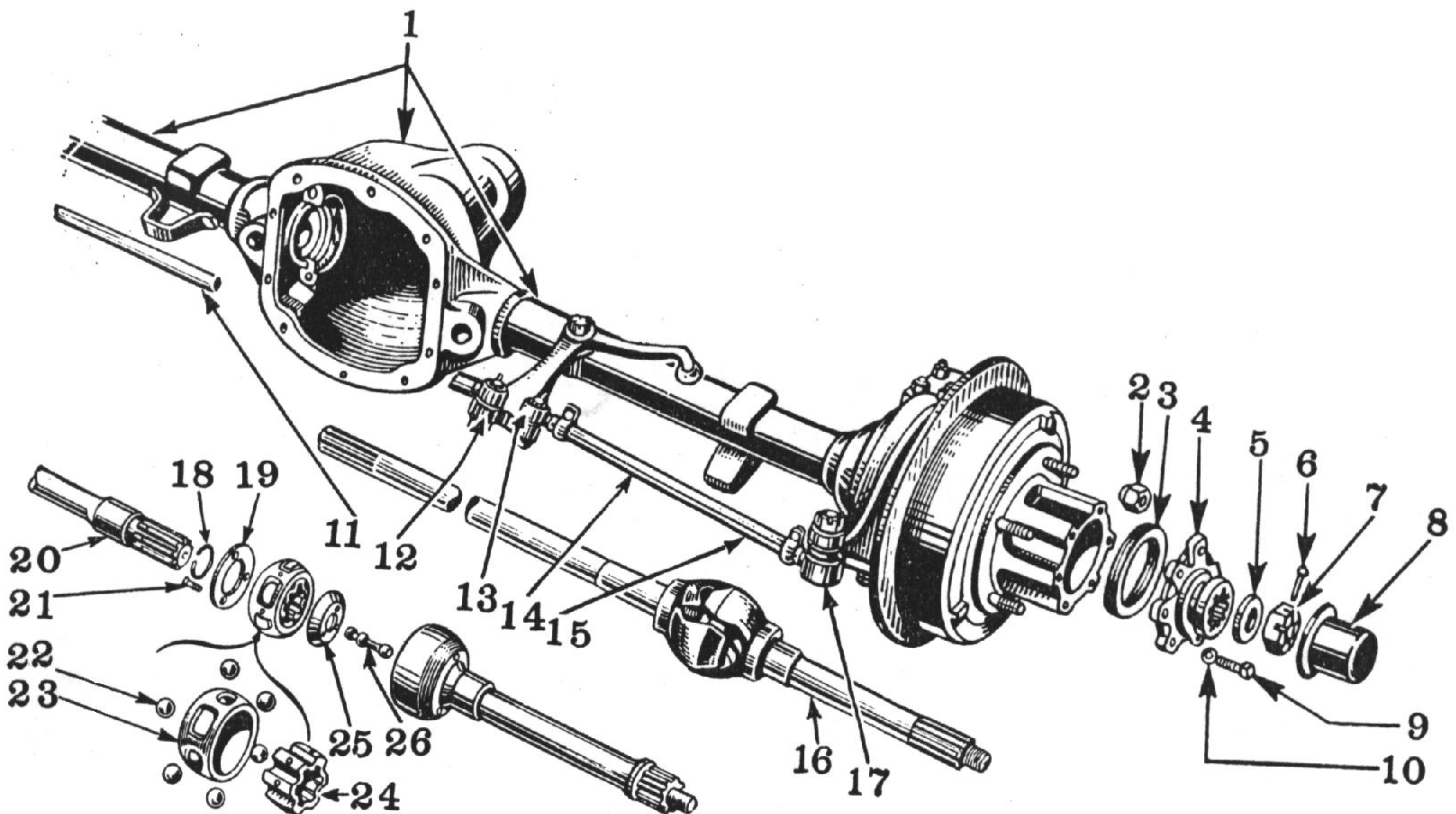


FIG. 4—FRONT AXLE ASSEMBLY

No.	Willys Part No.	Ford Part No.	Name	No.	Willys Part No.	Ford Part No.	Name
1	A-1703	GPW-3074	Gear Carrier Housing and Tube Assembly	17	A-847	GP-3290	Tie Rod Socket Assembly—Left
2	A-476	GP-1012	Wheel Hub Bolt Nut R.H. Thread (Ford GP-1013; Willys A-475 L.H. Thd.)	18	A-1726	GP-3216	Axle Shaft Retainer Snap Ring
3	A-862	GP-3208-A	Universal Joint Adjusting Shims	19	A-1724	GP-3217	Axle Shaft Retainer
4	A-868	GP-3204	Axle Shaft Drive Flange	20	A-1729	GPW-3017-A	Axle Inner Shaft—Left (Ford GPW-3016-A; Willys A-1727-Right Inner)
5	636570	356504-S	Axle Shaft Nut Washer	21	A-1725	24622-S	Axle Shaft Retainer Screw
6	5397	72071-S	Axle Shaft Nut Cotter Pin	22	A-1721	358074-S	Axle Shaft Universal Joint Ball
7	636569	356126-S	Axle Shaft Nut	23	A-1719	GP-3215	Axle Shaft Universal Joint Cage
8	A-869	GP-1139	Hub Cap	24	A-1720	GP-3221-A	Axle Shaft Universal Joint Inner Race
9	A-760	GP-1110	Axle Shaft Drive Flange Cap Screw	25	A-1722	GP-3219	Axle Shaft Universal Joint Pilot
10	5010	34807-S	Axle Shaft Drive Flange Screw Lockwasher	26	A-1723	GP-3218	Axle Shaft Universal Joint Pilot Pin
11	A-1705	GPW-3281	Tie Rod Tube—Right				
12	A-1211	GPW-3131	Drag Link Bell Crank				
13	A-838	GP-3289	Tie Rod Socket Assembly—Right				
14	A-1709	GPW-3282	Tie Rod Tube—Left				
15	A-1708	GPW-3279	Tie Rod Assembly—Left				
16	A-809	GPW-3206-A2	Axle Shaft and Universal Joint Assembly R.H. (Bendix) (Ford GPW-3207-A; Willys A-810 Left Hand)				

The result of negative or reverse camber, if excessive, will be hard steering and possibly a wandering condition. Tires will also wear on inside shoulders. Negative camber is usually caused by excessive wear or looseness of front wheel bearings, axle parts or the result of a sagging axle.

Result of unequal camber may be any or a combination of the following conditions—unstable steering, wandering, kick-back or road shock, shimmy or excessive tire wear. The cause of unequal camber is usually a bent steering knuckle or axle center.

Correct wheel camber is $1\frac{1}{2}^\circ$ and is set in the axle at the time of manufacture and cannot be altered by any adjustment. It is important that the camber be the same in both front wheels. Excessive heating of these parts to facilitate straightening destroys the heat treatment given them at the factory. Cold straightening of bad bends may cause a fracture of the steel and is unsafe. Replacement with new parts is recommended rather than any straightening of damaged parts.

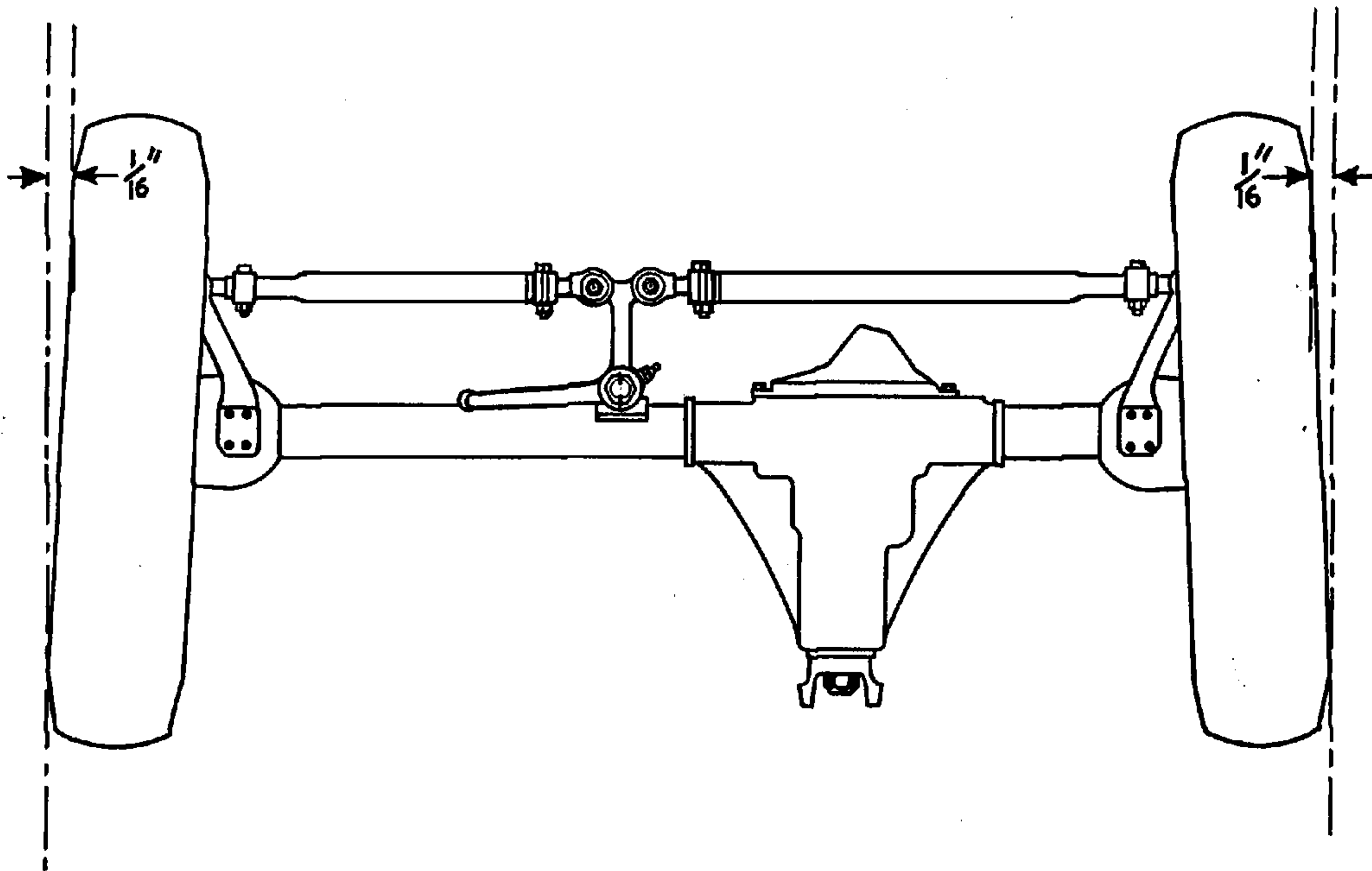


FIG. 5—FRONT WHEEL TOE-IN

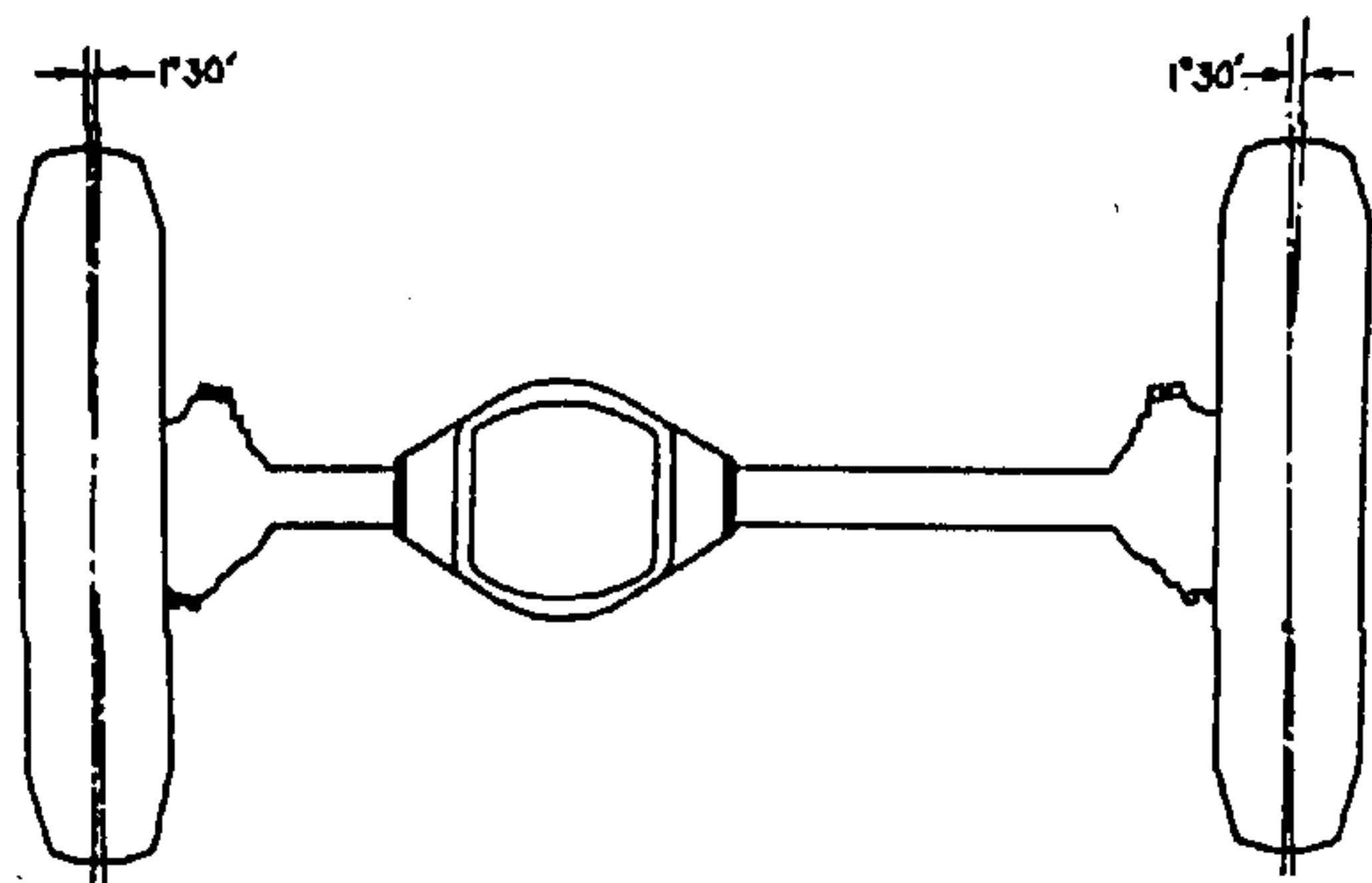


FIG. 6—WHEEL CAMBER

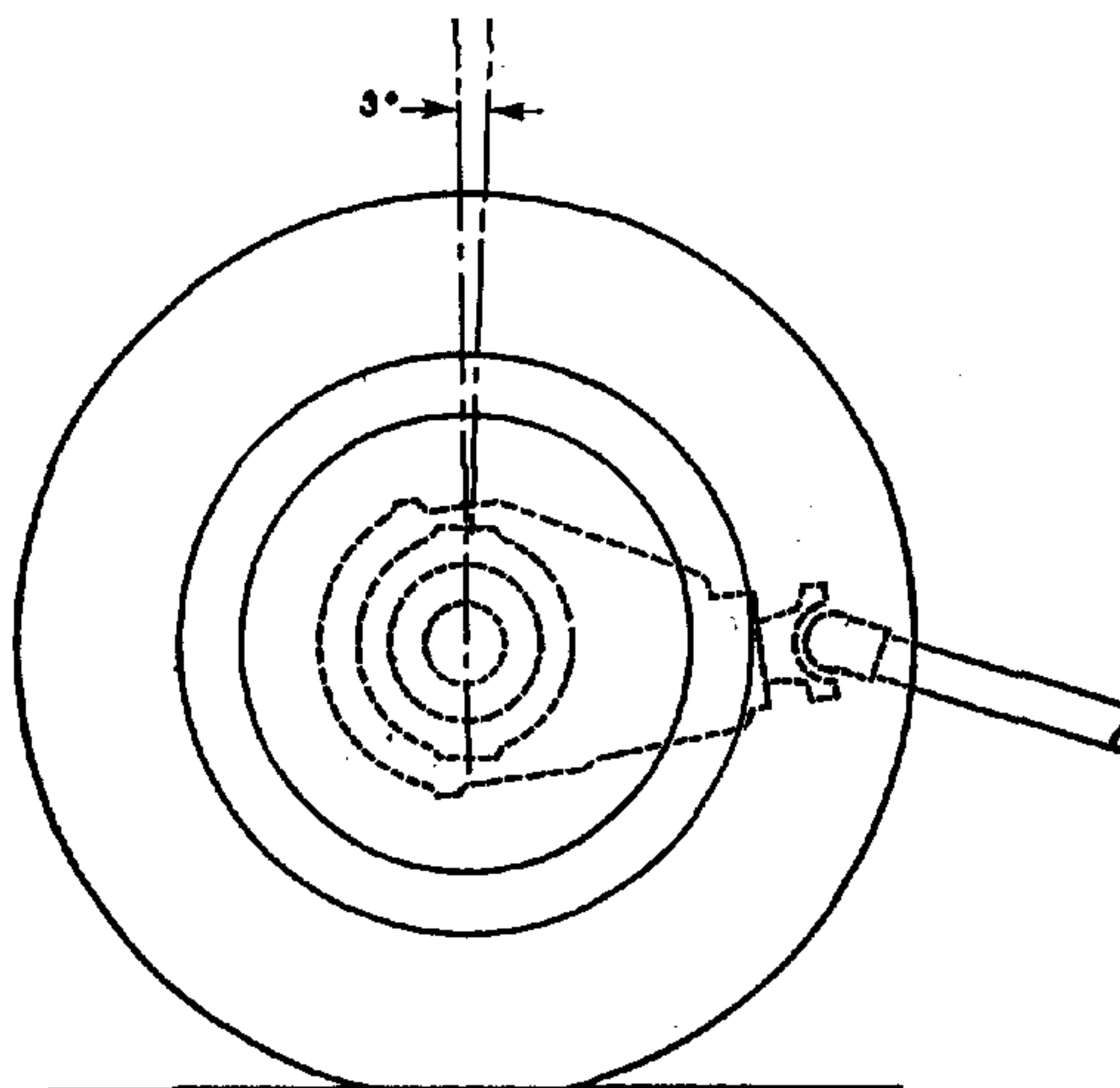


FIG. 7—AXLE CASTER

Axle Caster

The purpose of caster Fig. 7 is to provide steering stability which will keep front wheels in a straight ahead position and to assist in bringing wheels out of a turn on a curve.

The result of no caster is wandering or the vehicle will not come out of a turn normally.

No adjustment is provided for this angle but if checked with a suitable gauge and found to be incorrect, it should be investigated and if not excessive, correction made by the use of axle wedges or bending the axle cold.

If the camber and toe-in are correct and it is known that the axle is not twisted, a satisfactory check can be made by testing vehicle on the road. Before road testing make sure all tires are properly inflated, being particularly careful that both front tires are inflated to exactly the same pressure.

If vehicle turns easily to both sides but is hard to straighten out, this indicates insufficient caster for easy handling of vehicle.

Front Wheel Turning Angle

When the front wheels are turned the inside wheel on the turn travels in a smaller arc than the outside wheel; therefore it is necessary for the

wheels to toe out. This change in wheel alignment is obtained through the length and angularity of the steering knuckle arms in relation to the front axle. When the wheels are turned so the inside wheel is on an angle of 20° as shown by "I" in Fig. 8, the outer wheel angle "O" should be $19^\circ 45'$. The left steering knuckle arm controls the relationship of the front wheels on a left turn and the right arm controls the relation on a right turn. If a steering arm should be accidentally bent it can be straightened cold if the bend is not excessive, otherwise the arm should be replaced.

Steering Bell Crank

The bell crank is a drop forging, heat treated for strength with removable ball ends, steering connecting rod and tie rods.

The bell crank is mounted on the front axle and swivels on two needle bearings.

If bell crank becomes damaged or bent do not attempt to heat and straighten, straighten it cold or install new parts.

The bell crank shaft is removable from axle by driving out tapered lock pin, driving pin out toward left front wheel.

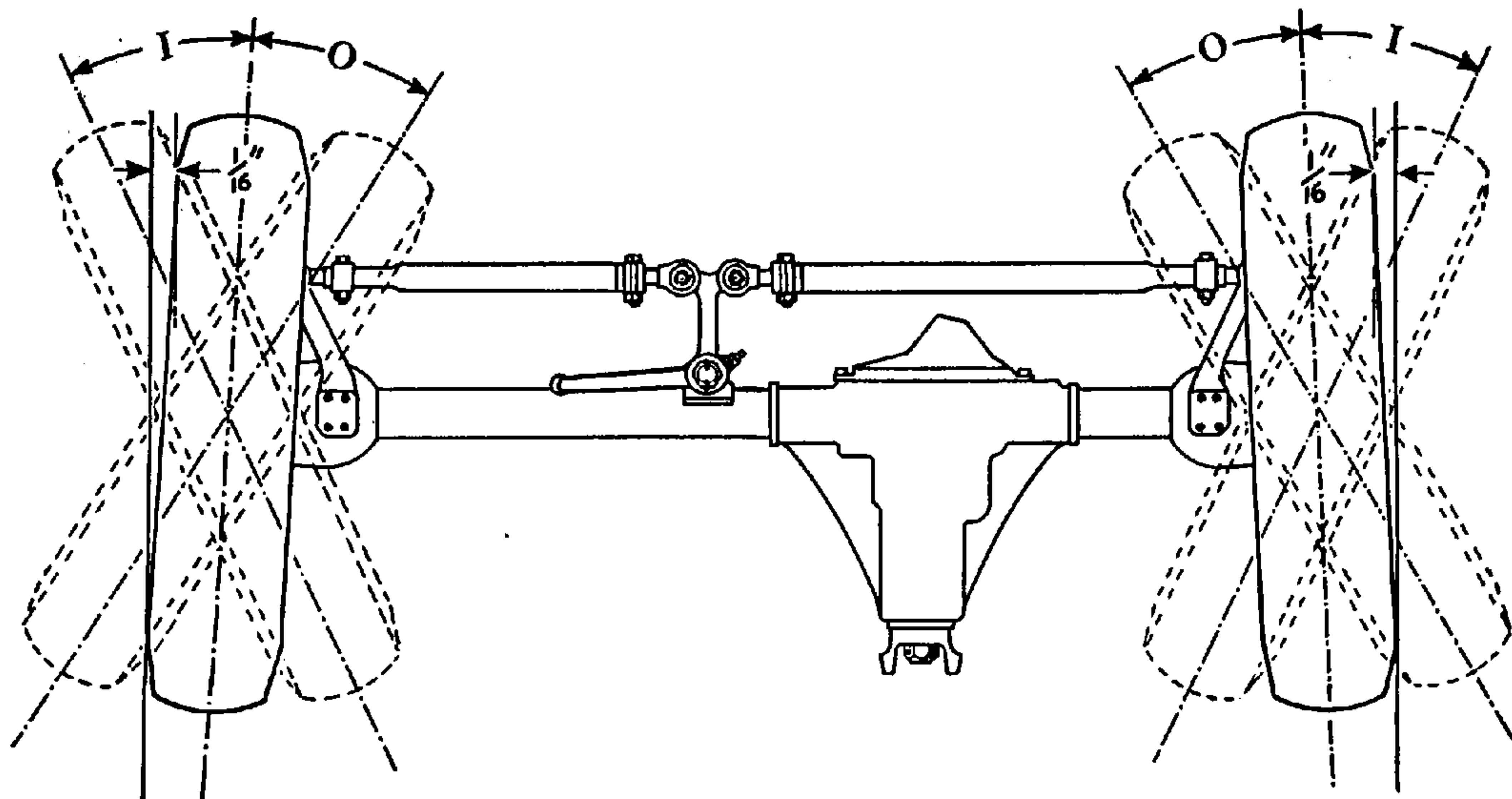


FIG. 8—FRONT WHEEL TURNING ANGLE

STEERING TROUBLES AND REMEDIES

SYMPTOMS PROBABLE REMEDY

Hard Steering	
Lack of Lubrication.....	Lubricate All Connections
Tie Rod Ends Worn.....	Replace
Connecting Rod Ball Joints Tight.....	Adjust
Cross Shaft Improperly Adjusted.....	Adjust
Steering Gear Parts Worn.....	Replace
Front Axle Trouble.....	See "Front Axle" Section
Steering Loose	
Tie Rod Ends Worn.....	Replace
Connecting Rod Ball Sockets Worn.....	Replace
Steering Gear Parts Worn.....	Replace
Steering Gear Improperly Adjusted.....	Adjust
Road Shock	Steering Connecting Rod too tight; Axle Spring Clips loose; Wheel Bearings loose; poor Shock Absorber control.
Turning Radius	
Short one side.....	Center Bolt in spring sheered off, Axle shifted, Steering Arm bent, Steering Arm not properly located on Steering Gear.

STEERING SPECIFICATIONS

Steering Gear:	
Make.....	Ross
Type.....	Cam and Twin Pin Lever
Model.....	T-12
Ratio.....	Variable Ratio, 14-12-14 to 1
Wheel.....	3 spoke—17 1/4", Safety type
Bearings:	
Cam Upper.....	Ball
Cam Lower.....	Ball
Levershaft.....	Bushing
Steering Column Upper.....	Ball
Lever Shaft:	
Clearance to Bushing.....	.0005"-.0025"
End Play.....	.000"
Lash at Cam (Straight ahead).....	Slight drag over high point
Steering Connecting Rod:	
Make.....	Columbus Auto Parts
Type.....	Spring loaded
Adjustment.....	Threaded Plug
Steering Geometry:	
Toe-in.....	3/64"-3/32"
Camber.....	1 1/2°
Caster.....	3°
Toe out	
Inside wheel.....	20°
Outside wheel.....	19°45'