

**MAINTENANCE  
MANUAL**

**ROSS STEERING GEARS  
(Cam and Lever Design)**



**ROSS GEAR AND TOOL COMPANY  
Lafayette, Indiana, U.S.A.**

The steering gear is one of the functional units of a motor vehicle that requires maintenance service, and inasmuch as Ross steering gears are in use in many makes of vehicles that are in Army service this Maintenance Manual is offered as a help in maintaining them in good condition and proper adjustment to assure satisfactory performance at all times.

Each vehicle manufacturer provides specific and complete data on the steering gear in its manual, but this manual will serve as a reference on Ross steering gears in general and make it convenient to study them and to learn the general practice in servicing them.

## INDEX

	Page
Descriptive Data --	
Design .....	2
Operation .....	3
Adjustments .....	3
Illustrations .....	4-5-6-7-8-9-10
Service Data --	
Adjustment Procedure .....	11-12
Lubrication .....	13
Column Alignment .....	13
Steering Gear Connection with Front Wheels .....	13
Reconditioning Procedure --	
Remove Steering Gear from Chassis .....	13
Dis-assembly of Gear .....	14
Inspection .....	14
Replacement of Parts .....	14-15
Re-Assembly of Gear .....	15
Installation .....	15
Stud-Roller Bearing Units .....	16
Wheel Tube Bearings .....	17
Lever Shaft Bushings .....	18

## DESIGN

Ross steering gears are exclusively of the Cam and Lever design. There are several variations in the structural design of the complete steering gear assembly but all have the basic cam and lever principle. This principle of design embodies a special worm of variable ratio which engages an internal lever on the side of the worm. This gives long internal leverage in combination with variable ratio which provides the mechanical advantage and steering characteristics desirable for steering automotive vehicles.

The name Cam and Lever is derived from the names of the actuating and the actuated parts of the gear.

The worm has a tapered groove which engages a tapered stud, or studs, on the lever. This worm is usually of variable ratio, hence the name "cam". It can be and sometimes is of a straight ratio. The lever is an integral part of the cross shaft to which the steering gear arm is attached. This part is named "lever shaft".

There are four general types of Ross gears as follows:

1. Single lever with sliding stud - per Ill. 1, 2, and 5.  
(One lever with an integral stud that has a sliding contact with the cam.)
2. Single lever with rolling stud - per Ill. 3 and 4. (One lever with the stud mounted in the lever with tapered roller bearings so that it has a rolling contact with the cam.)
3. Twin-lever with sliding studs - per Ill. 6. (Two levers forged integral and two studs riveted in the lever so that the studs have a sliding contact with the cam.)
4. Twin-lever with rolling studs - per Ill. 7. (Two levers forged integral and two studs mounted in the lever with

tapered roller bearings so that the studs have a rolling contact with the cam.)

## OPERATION

The operating action of Ross Cam and Lever Steering Gears is extremely simple. When the cam is turned left or right the stud (or studs) of the lever shaft is (or are) moved through the groove of the cam thus rotating the lever shaft and providing angular movement of the steering arm.

## ADJUSTMENTS

There are only two principal adjustments on Ross steering gears and a supplemental adjustment on the roller-mounted stud units. None of the adjustments are indexed but can be set at the most desirable point. The principal adjustments are -

1. Adjustment of ball thrust bearings on cam.
2. Adjustment of tapered studs in cam groove for backlash.

The cams in all Ross gears are mounted between two ball bearings which are adjustable by means of shims between the housing and upper cover plate or by an adjusting plug that screws into the upper end of the housing.

Backlash of the stud, or studs, of the lever shaft in the cam groove can be quickly and accurately adjusted by means of a screw and lock nut on the side cover. All cams are ground slightly higher in the mid-position range to provide close adjustment where usually the straight-ahead driving action takes place.

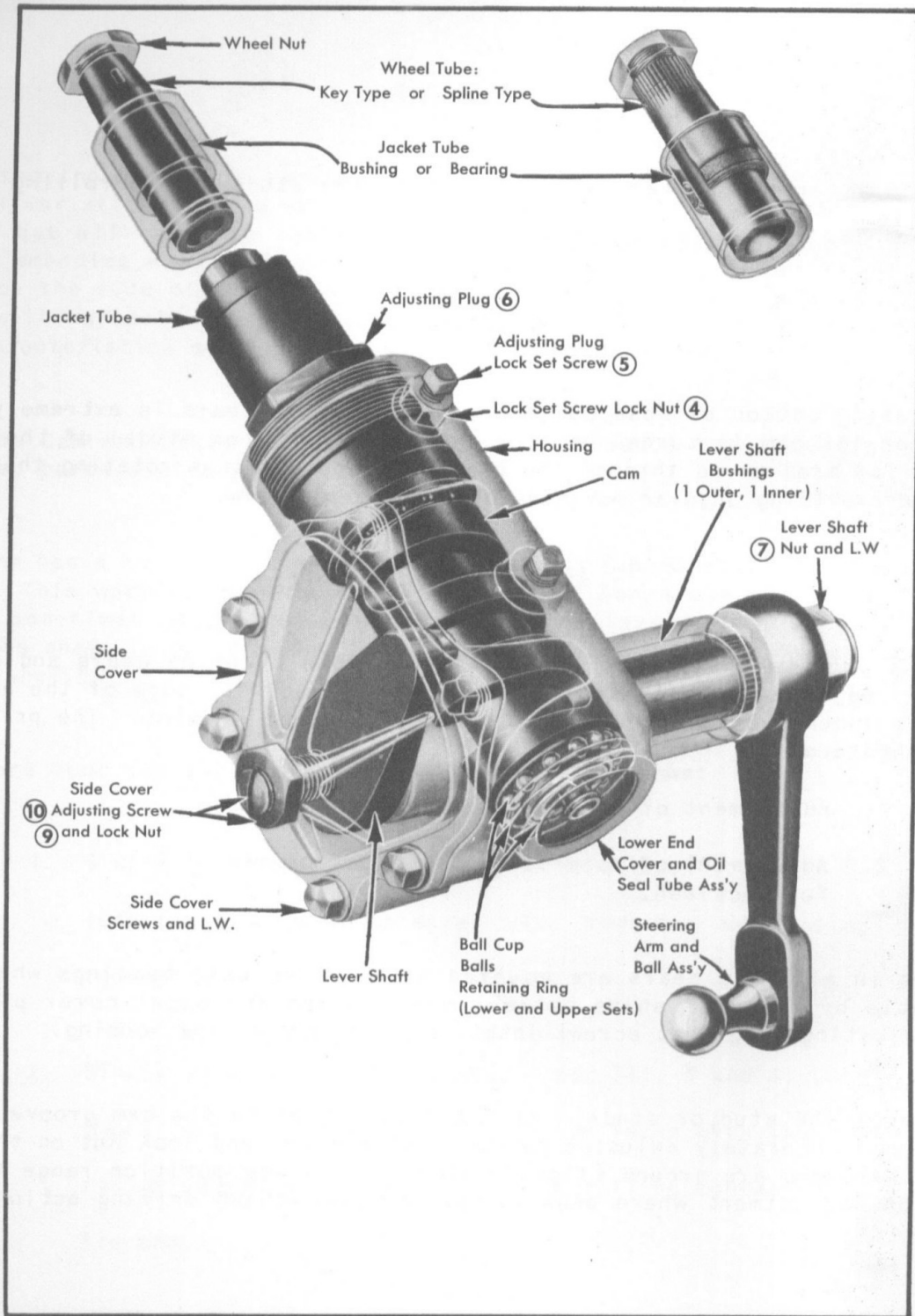


Illustration No. 1

**SINGLE LEVER --- SLIDING STUD TYPE**

TO ADJUST:

Thrust bearings on Cam follow Adjustment I, Procedure No. 1, Page 11.

Lever Shaft Stud in Cam Groove for Backlash follow Adjustment II, Page 12.

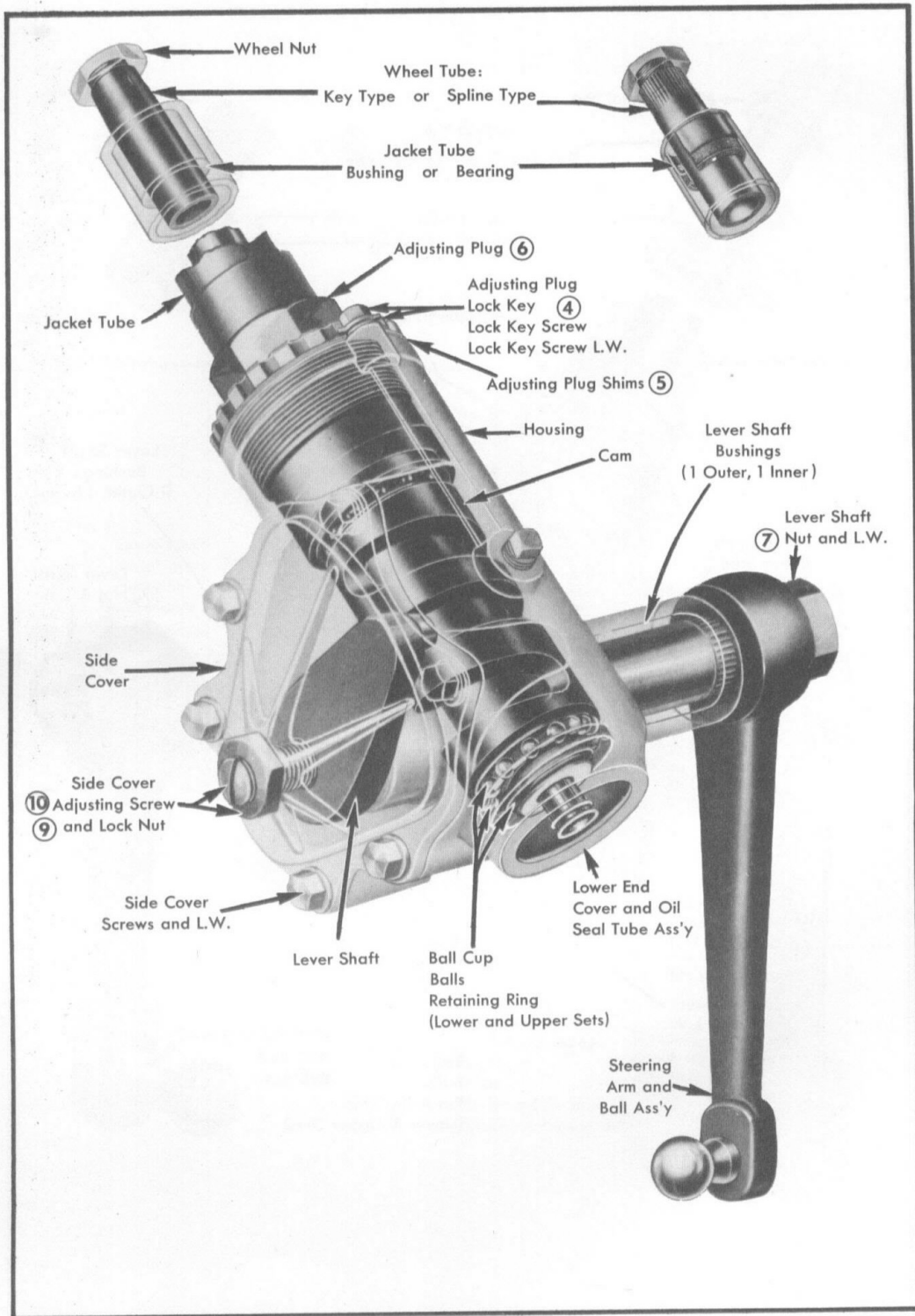


Illustration No. 2

SINGLE LEVER --- SLIDING STUD TYPE

TO ADJUST:

Thrust bearings on Cam follow Adjustment I, Procedure No. 2, Page 11.

Lever Shaft Stud in Cam Groove for Backlash follow Adjustment II, Page 12.

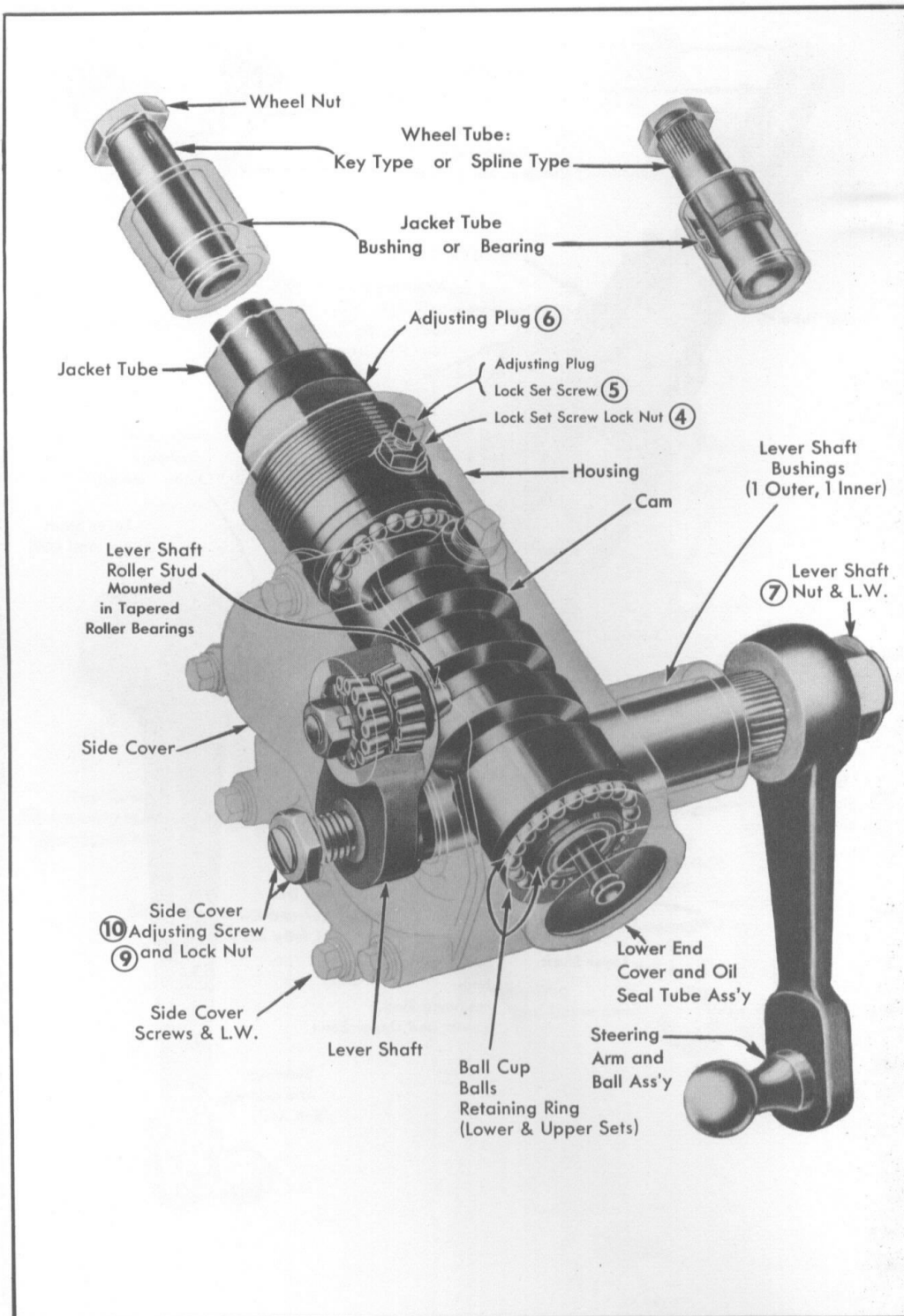


Illustration No. 3

**SINGLE LEVER - ROLLER MOUNTED STUD TYPE**

TO ADJUST:

Thrust Bearings on Cam follow Adjustment I, Procedure No. 1, Page 11.  
 Lever Shaft Stud in Cam Groove for Backlash follow Adjustment II, Page 12.  
 Stud-Roller Bearing Unit in Lever Shaft follow Adjustment III, Page 13.

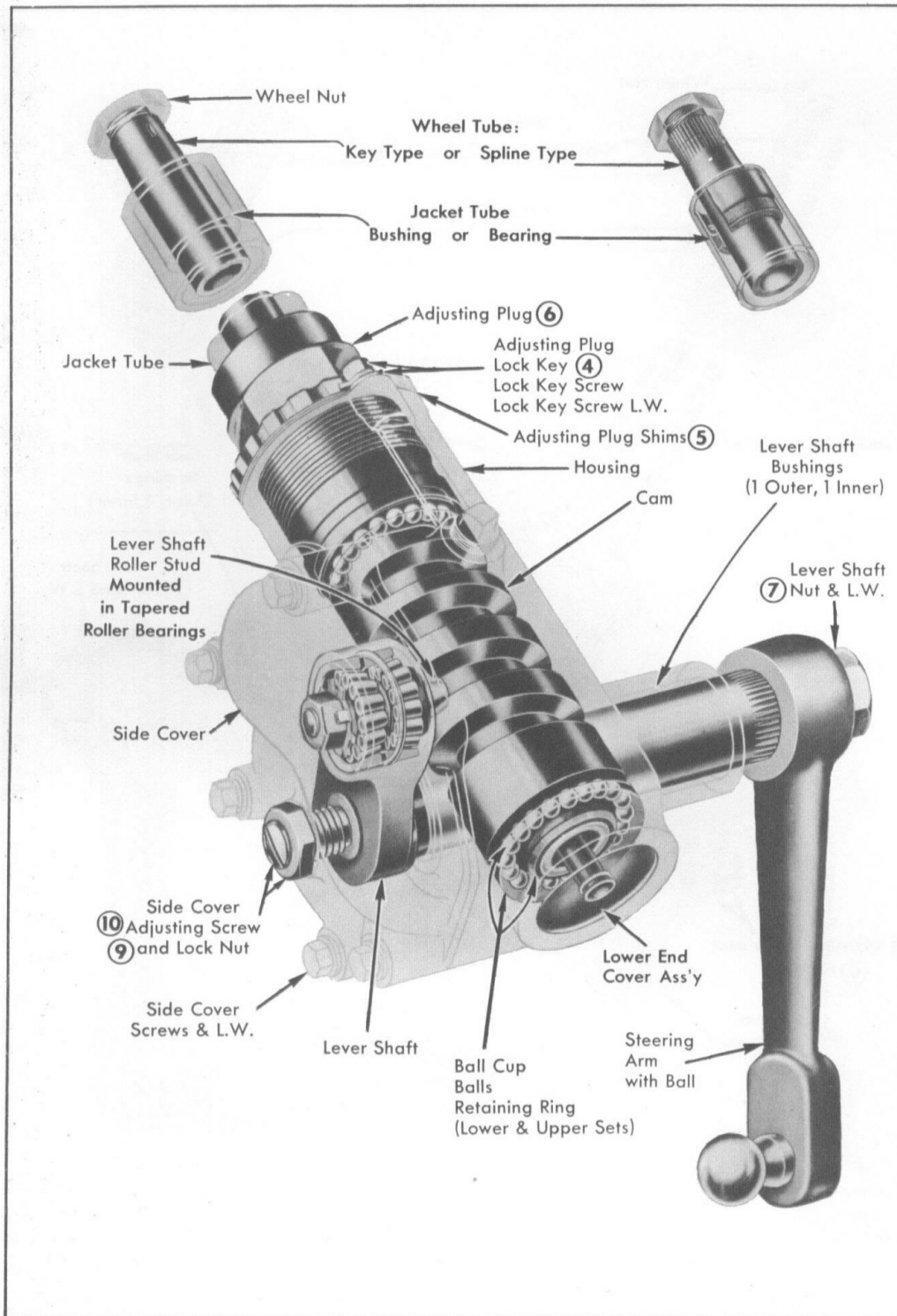


Illustration No. 4

**SINGLE LEVER - ROLLER MOUNTED STUD TYPE**

TO ADJUST:

Thrust Bearings on Cam follow Adjustment I, Procedure No. 2, Page 11.  
 Lever Shaft Stud in Cam Groove for Backlash follow Adjustment II, Page 12.  
 Stud-Roller bearing Unit in Lever Shaft follow Adjustment III, Page 13.



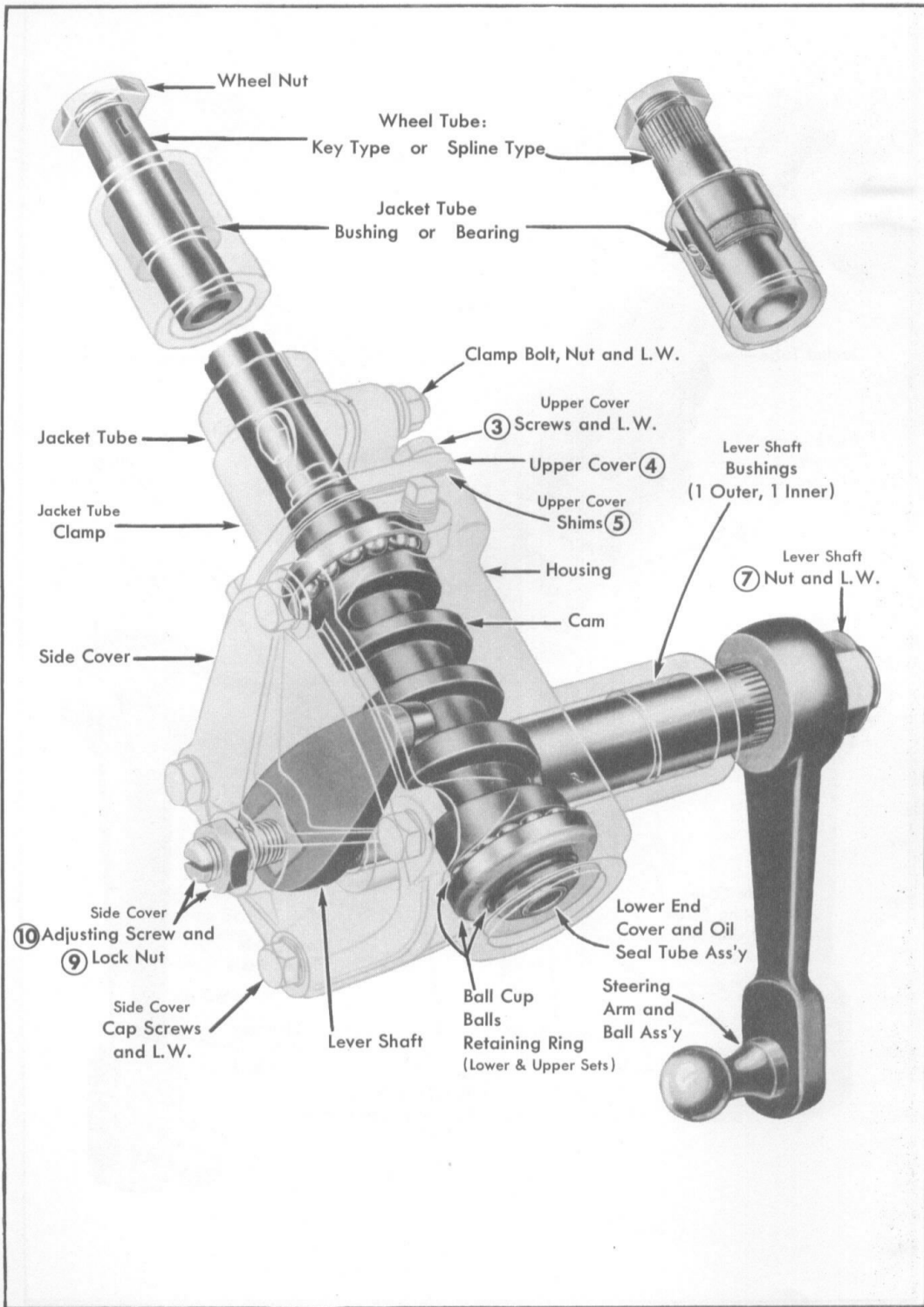


Illustration No. 5

SINGLE LEVER --- SLIDING STUD TYPE

TO ADJUST:

Thrust Bearings on Cam follow Adjustment I, Procedure No. 3, Page 11.

Lever Shaft Stud in Cam Groove for Backlash follow Adjustment II, Page 12.

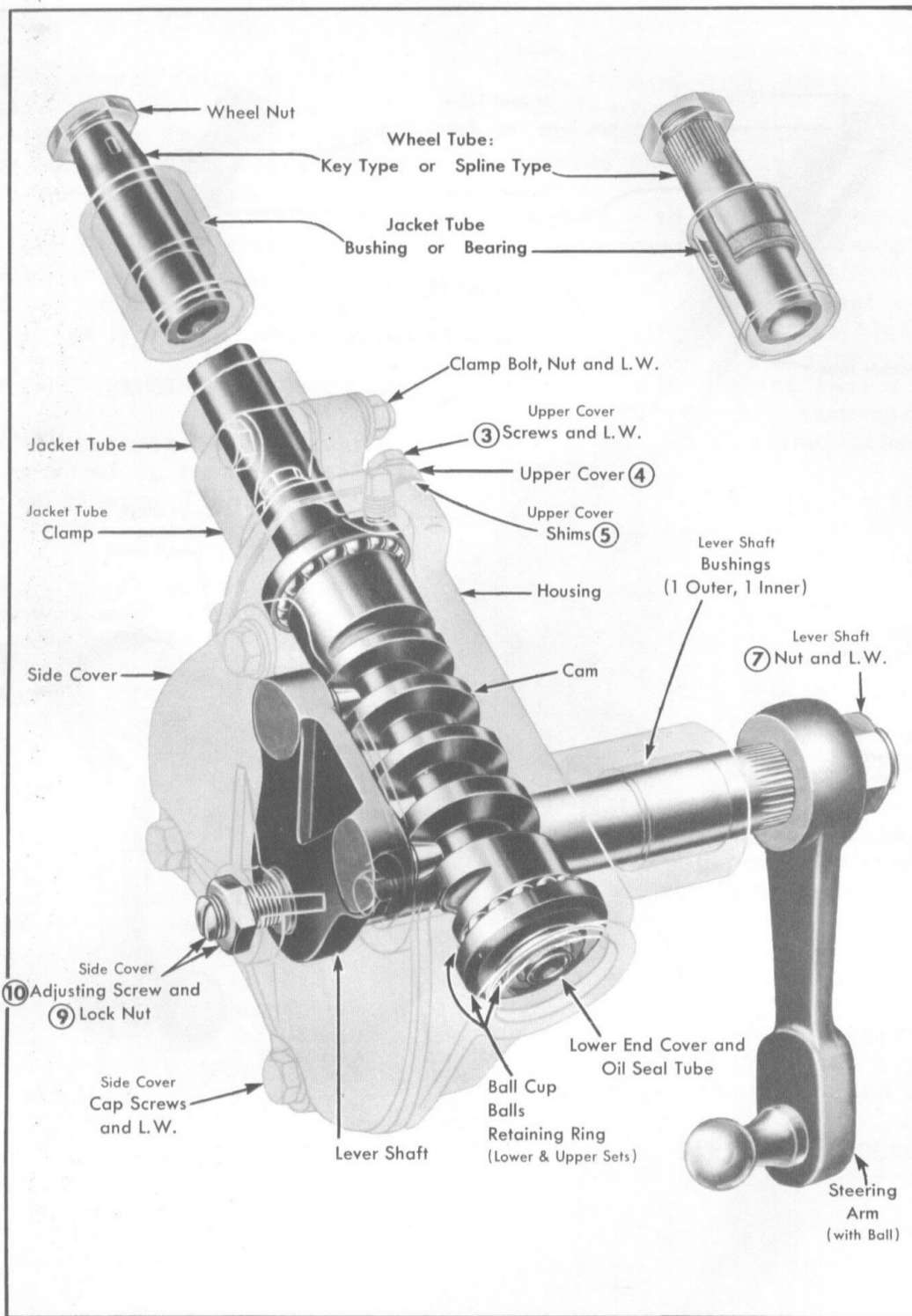


Illustration No. 6

TWIN LEVER --- SLIDING STUD TYPE

TO ADJUST:

Thrust Bearings on Cam follow Adjustment I, Procedure No. 3, Page 11.

Lever Shaft Studs in Cam Groove for Backlash follow Adjustment II, Page 12.

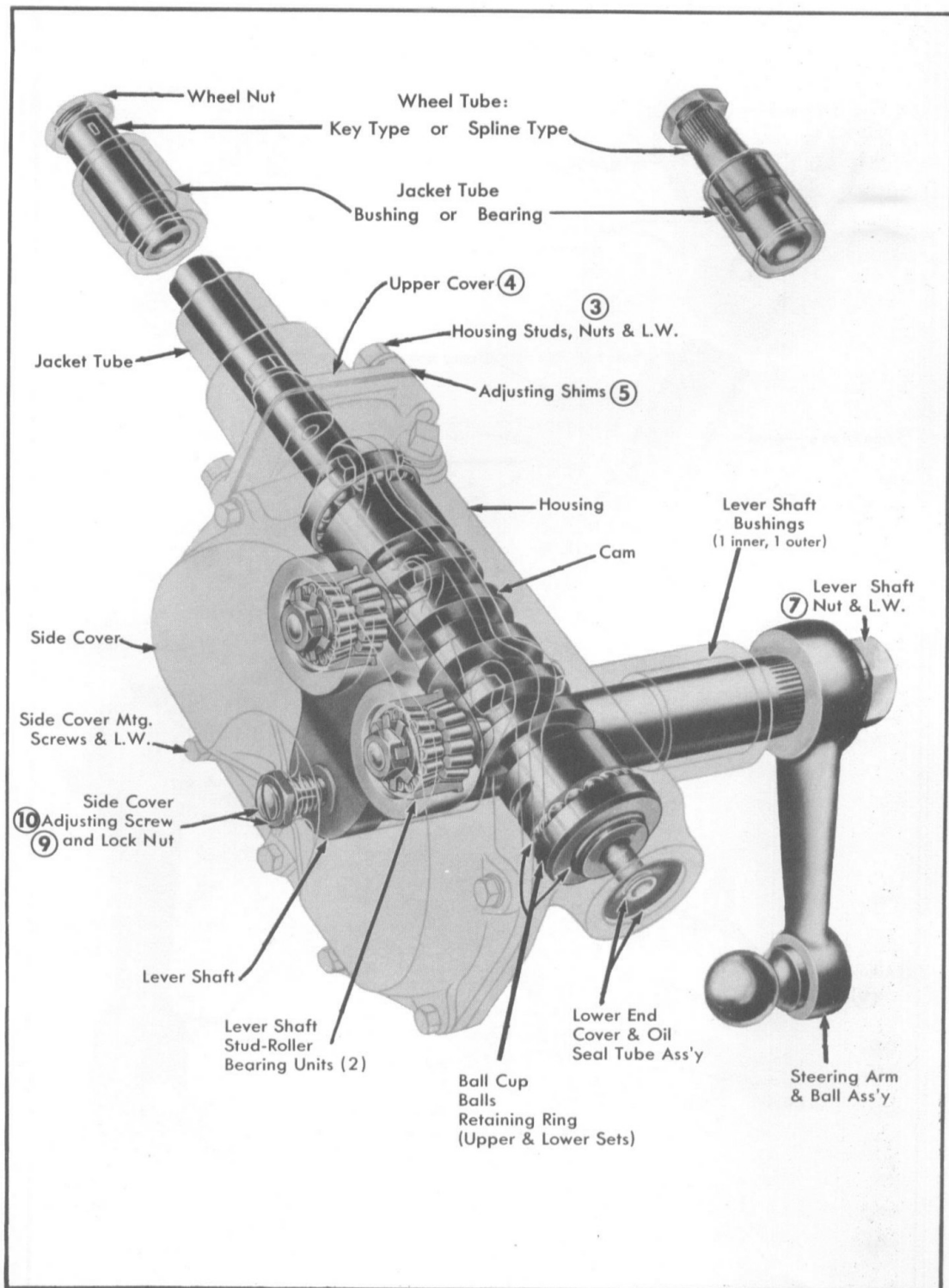


Illustration No. 7

**TWIN LEVER - ROLLER MOUNTED STUD TYPE**

TO ADJUST:

Thrust Bearings on Cam follow Adjustment I, Procedure No. 3, Page 11.  
 Lever Shaft Studs in Cam Groove for Backlash follow Adjustment II, Page 12.  
 Stud-Roller Bearing Units in Lever Shaft follow Adjustment III, Page 13.

## ADJUSTMENT PROCEDURE

When making adjustments, free the steering gear of all load, preferably by disconnecting the drag link from the steering gear arm, and loosen the instrument board bracket clamp on steering gear column.

If the ball thrust bearings on the cam must be adjusted, make this Adjustment I before making the side Adjustment II for backlash of studs in the cam groove.

### I ADJUSTMENT OF BALL THRUST BEARINGS ON CAM.

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

Before making this adjustment loosen the housing side cover adjusting screw (9,10) to free the stud or studs in the cam groove.

**Procedure No. 1** (Applies to type gears of illustrations 1 and 3.) Back off lock screw (4, 5) and screw in adjusting plug (6) to obtain the proper adjustment, then tighten set screw (5) and lock nut (4).

**Procedure No. 2** (Applies to type gears of illustrations 2 and 4.) Back off lock screw (4) to release lock key from adjusting plug (6).

Unscrew adjusting plug to permit removal of shims (5). Shims are of .003" and .007" thickness. Clip shims to remove them, or to add them.

Remove a .003" shim, or more if considered necessary, and screw in adjusting plug until the proper adjustment is obtained. (Note and Caution: The adjusting plug should always be drawn tight against the shims to provide a tight assembly. A three foot or longer wrench may be necessary; however, in the event that too many shims have been removed, take care not to draw so tight as to brinell the ball races.)

Remove or add shims, or do both to get the necessary combination to obtain the correct adjustment and a tight assembly, then set lock key (4) in place and tighten lock screw.

**Procedure No. 3** (Applies to type gears

of illustrations 5, 6 and 7.) Unscrew the clamp screws or nuts (3) and move up the housing upper cover (4) to permit removal of shims (5). Shims are of .002", .003" and .010" thickness. Clip shims to remove them, or to add them.

Remove a thin shim, or more if considered necessary. Re-assemble clamp screws or nuts, with lock washers in place, and tighten. (Note and Caution: The cover should always be drawn tight against the shims to provide a tight assembly; however, in the event that too many shims have been removed, take care not to draw so tight as to brinell the ball races.)

Remove or add shims, or do both to get the necessary combination to obtain the correct adjustment and a tight assembly.

### II ADJUSTMENT FOR MINIMUM BACKLASH OF TAPERED STUD IN CAM GROOVE

Backlash of the stud in the cam groove shows up as end play of levershaft, also as backlash at steering wheel, and at ball on steering arm.

**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.**

Before making this adjustment learn about the variation in groove depth and consequent variation in lash between the straight-ahead-driving position and the end positions as shown in illustrations No. 8 and 9.

#### SINGLE STUD GEAR

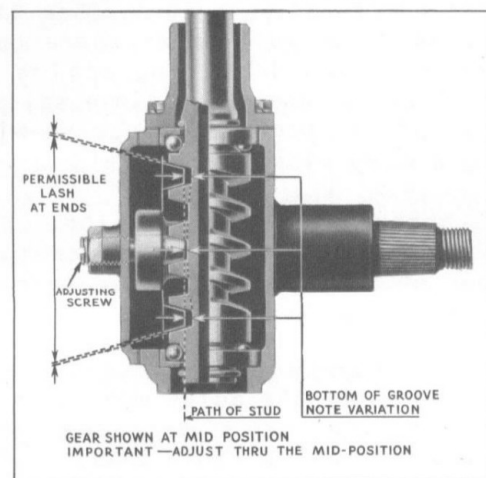


Illustration No. 8

The groove is purposely cut shallower, therefore narrower, in the mid-position range of stud travel (see Ill. 8) to provide close adjustment where usually the straight-ahead-driving action takes place. It also makes this close adjustment possible after normal wear occurs without causing a bind elsewhere.

Adjust through the mid-position. Do not adjust in the end positions. Backlash in the end positions is normal and not objectionable.

### TWIN STUD GEAR

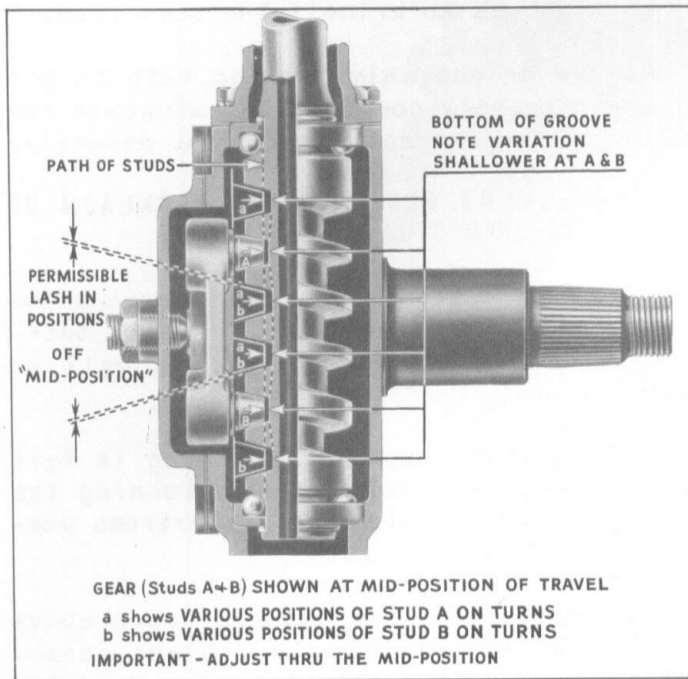


Illustration No. 9

The groove is purposely cut shallower, therefore narrower, in the mid-position range of travel of each stud (See Ill. 9) to provide close adjustment where usually the straight-ahead-driving action takes place. It also makes this close adjustment possible after normal wear occurs without causing a bind elsewhere.

Adjust through the mid-position. Do not adjust in positions off mid-position as backlash at these positions is normal and not objectionable.

**TO ADJUST**, tighten side cover adjusting screw (10) until the adjustment is correct and tighten the lock nut (9) to hold it. Then give the gear a final test.

After this adjustment, secure the gear at

all points loosened prior to making the adjustments. Also check tightness of mounting bracket bolts and nuts, of steering arm on lever shaft and the nut and lock-washer (7).

### III ADJUSTMENT OF STUD-ROLLER BEARING UNITS

The foregoing adjustments will suffice in nearly every instance, but in some cases it may be necessary to adjust the stud-roller bearing unit (or units) in the lever shaft.

The roller bearings should be pre-loaded at all times. Adjust to a heavy drag.

Used units should be set tighter than new replacement units but never below the low limits given below. Factory adjustments on new units are within the following limits:

Unit	Torque to Revolve Stud (in Inch Pounds)
In 1-1/4" dia. Shaft	3 to 4
" 1-3/8" " "	3 to 4
" 1-1/2" " "	3 to 4
" 1-3/4" " "	5 to 11

#### To Adjust:

- (a) Wash bearings in kerosene and lubricate with light oil.
- (b) Straighten out prong of locking washer and replace washer now.
- (c) Tighten nut as required (while holding stud from turning by using spanner wrench on washer, or by clamping stud, but do not nick or burr stud surface.)
- (d) Turn stud back and forth and test adjustment.
- (e) Lock adjustment by bending a prong of washer against a side of the nut. Bend the prong that is at right angle to a side of the nut. DO NOT USE A WASHER TWICE unless the prongs used before have been removed.
- (f) Lubricate with lubricant used in gear.

## LUBRICATION

Periodic lubrication and kind of lubricant used are important factors affecting the service life of a steering gear and preventing objectionable noise. Use only a recommended or approved lubricant. Do not use ordinary grease. A mild EP is not forbidden providing it is a non-corrosive mild inactive gear lubricant.

Ross has approved several lubricants and classified them for summer use only, for winter use only, and for summer and winter use. They are listed by trade names in a separate bulletin, No. 210A.

**For Army vehicles Ross has also approved the use of Universal Gear Lubricant of the U. S. Army specifications.**

Lubricate through the pipe plug hole or fitting in the top of the housing. Fill housing slowly until lubricant begins to run out of vent hole in the jacket tube.

Add lubricant periodically according to usage - every few thousand miles or at least spring and fall.

## COLUMN ALIGNMENT

Alignment of the column is of paramount importance. Misalignment of the column places a bend in the column, consequently the wheel tube must undergo reverse bending stresses during each revolution. This is a serious condition that must be avoided. THE STEERING COLUMN MUST NOT BE SPRUNG IN ANY DIRECTION FROM ITS FREE POSITION. If misalignment exists, correct according to methods provided by the vehicle manufacturer.

Misalignment, also, is a cause of stiff steering.

To determine whether misalignment exists, release upper column bracket and note whether the column moves to a different position, its free position. If it does it has been out of line and should be re-clamped in the new position or the gear shifted or shimmed at the lower support to relieve the condition.

**CAUTION:** If the column has been permanently bent because of severe misalignment, the above test may not be reliable,

and replacement of the tubes will be necessary.

## STEERING GEAR CONNECTION WITH FRONT WHEELS

The steering gear should be connected to the front wheels so as to obtain as nearly as possible the specified turning radius, on both left and right turns, and so that the gear will not "bottom". This is accomplished by "centering" the steering gear and properly setting the axle stops.

It must be kept in mind that due to manufacturing tolerances in parts, in location of spring brackets, in length of drag links, in angle of columns, etc., the steering gear cannot always be right on center with the front wheels straight ahead unless an adjustable drag link is used. For practical procedure, however, it must be assumed that normally the steering gear should be in approximately its mid-position when the front wheels are in the straight-ahead position. To check, (the drag link must be disconnected from the steering gear arm) turn the steering wheel to the right as far 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. Place front wheels straight ahead. The ball on the steering gear arm should now line up, or nearly so, with the ball socket for the drag link.

If necessary, the steering arm can be shifted on the splines of the lever shaft to change the ball position. Shifting it one spline will shift the ball 10°.

The axle stops should be set out sufficiently to prevent the steering gear from "bottoming", that is, to stop the gear short of its absolute limit of travel. If the gear is permitted to bottom, damage to certain internal parts will occur. Check to see if the axle stops are set to do this on both left and right turns.

## RECONDITIONING PROCEDURE

### REMOVAL FROM CHASSIS

Details involved in removing the steering gear from the chassis vary so much in the

different models and makes that all cannot be covered here.

Usually the steering gear arm and steering wheel must be removed from the gear in order to remove it from the chassis.

Before removing the steering gear arm punch mark the face of the steering arm hub and end of lever shaft, unless already marked, to facilitate re-assembly of the arm on the shaft in the same position.

**CAUTION:** Do not hammer off arm without support against the end of the shaft. Use arm puller if possible. If necessary to remove arm with hammer or wedge, light blows are more effective.

Remove the steering wheel with a recommended puller.

In some cases, part of the chassis must be removed or loosened to permit removal of the gear.

#### DIS-ASSEMBLY OF GEAR

Loosen lock nut (9) and unscrew adjusting screw (10) a few turns.

Remove side cover.

Slide the levershaft from the housing but first make sure there are no burrs on outer end to damage the bushings.

Remove jacket tube assembly as follows:

Gears of Illustrations 1 and 3 --

Loosen lock nut (4) and unscrew set screw (5). Unscrew adjusting plug from housing and remove whole assembly.

Gears of Illustrations 2 and 4 --

Unscrew lock key screw and remove key (4). Unscrew adjusting plug from housing and remove whole assembly.

Gears of Illustrations 5, 6 and 7 --

Unscrew upper cover screws or stud nuts (3). Remove cover and jacket tube assembly.

Remove cam and wheel tube assembly from housing.

To remove the ball bearings from the cam remove the snap lock rings. Be sure to

catch the balls as each bearing is removed.

#### INSPECTION

Give the gear a careful <sup>all</sup>overhaul inspection.

Inspect operating parts as follows --

- (a) Cam thread for brinelling from abnormally heavy blows, chipping and scoring, also the ball races on the ends of the cam and the separate ball cups for brinelling, pitting, and deep wear. (Cam thread is copper plated for initial service. Disregard worn-off condition.)
- (b) Upper end of wheel tube for bearing wear.
- (c) Lever shaft at all bearing points for wear, also splines for twisted condition and for wear from a loose steering arm, also threads for stripping.
- (d) Stud, or studs, of levershaft for flat spots or chipping. (Disregard small flat spots if satisfactory adjustment can be obtained.)
- (e) Adjustment of stud-roller bearing units in levershaft. (See Adjustment III, page 12.) If unit feels unduly rough, disassemble by removing nut and pressing stud out of cone and inspect cone and cups.
- (f) Lever shaft bushings in housing for scoring.
- (g) Fit of lever shaft in bushings. (See page 18 for clearance limits.)
- (h) Condition of oil seal in housing.
- (i) Bearing in top end of jacket tube. (See Page 18.)
- (j) Steering arm ball for wear.

#### REPLACEMENT OF PARTS

The following parts are not individually replaceable, but normally all other parts are:

Cam nor wheel tube.

Lever shaft nor stud, or studs, of sliding type.

Jacket tube nor adjusting plug, or upper cover, if welded together.

Steering arm nor ball stud unless ball stud is type held on with nut.

For replacement of stud-roller bearing units in lever shaft, refer to Page 16.

For replacement of wheel tube bearing units in upper end of jacket tubes refer to Page 17.

For replacement of bushings in housing refer to Page 18.

### RE-ASSEMBLY OF GEAR

Place cam, wheel tube and bearings assembly in housing, seating well the lower bearing cup in the housing.

Assemble jacket tube and, adjusting plug or upper cover, assembly to the housing as follows:

Gears of Illustrations 1 and 3 --

Place assembly over wheel tube and screw adjusting plug in housing and adjust cam bearings per Adjustment I, Page 11, paragraph 1. Tighten set screw (5) and lock nut (4).

Gears of Illustrations 2 and 4 --

With adjusting shims in place on the adjusting plug, place assembly over wheel tube and screw adjusting plug in housing and adjust cam bearings per Adjustment I, paragraph 1, and Procedure No. 2, paragraphs 3 and 4 (on Page 11.)

Gears of Illustrations 5, 6 and 7 --

With adjusting shims in place on top of housing, place assembly over wheel tube and assemble upper cover to housing and adjust cam bearings per Adjustment I, paragraph 1, and Procedure No. 3, paragraphs 2 and 3 (on Page 11.)

Place lever shaft in housing, first making sure there are no burrs to damage bushings. Check fit of shaft in bushing. Refer to Page 18. (If lever shaft is

roller mounted type and needs replacement of stud-roller bearing unit or parts, refer to Page 16.)

Assemble side cover, with gasket in place, to housing, first making sure the adjusting screw is unscrewed so that it will not bear against the lever shaft while the cover is tightened to the housing. Use lockwashers under heads of cap screws except use copper washers with the screws in the holes that are tapped through to the oil chamber.

Adjust lever shaft stud, or studs, in cam groove for minimum backlash. Tighten adjusting screw (10) until a very slight drag is felt through the mid-position when turning the steering wheel slowly and tighten lock nut (9). (For information on backlash in positions off mid-position, refer to Pages 11 and 12).

### INSTALLATION

When installing a steering gear, free alignment is of paramount importance. Refer to the chapter on Column Alignment, paragraph 1.

Follow instructions of the vehicle manufacturer, but in lieu of such specific instructions observe the following:

- (a) When clamping the support brackets, clamp the upper column bracket first so as to position the gear for clamping at the lower support.
- (b) If the lower support bracket is integral with the gear housing, determine whether shims are necessary between bracket and frame to prevent bending the column when the bracket is pulled up tight.
- (c) If the gear binds after it is clamped in the brackets, although properly adjusted beforehand, it indicates misalignment.
- (d) When connecting steering gear to front wheels center gear and check axle stops per chapter "Steering Gear Connection With Front Wheels".



## STUD-ROLLER BEARING UNITS

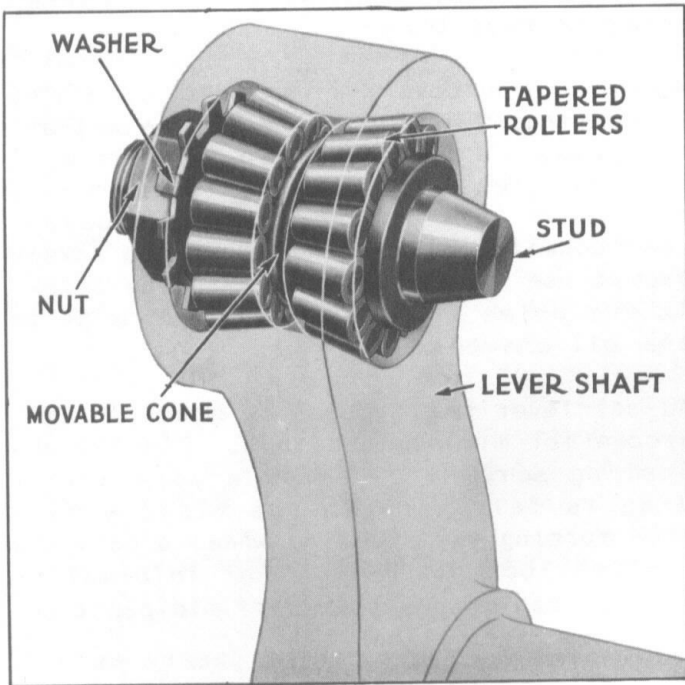


Illustration No. 10

### CUPLESS TYPE IN SINGLE LEVER GEARS

The cups (outer races) are formed integrally in the levershaft.

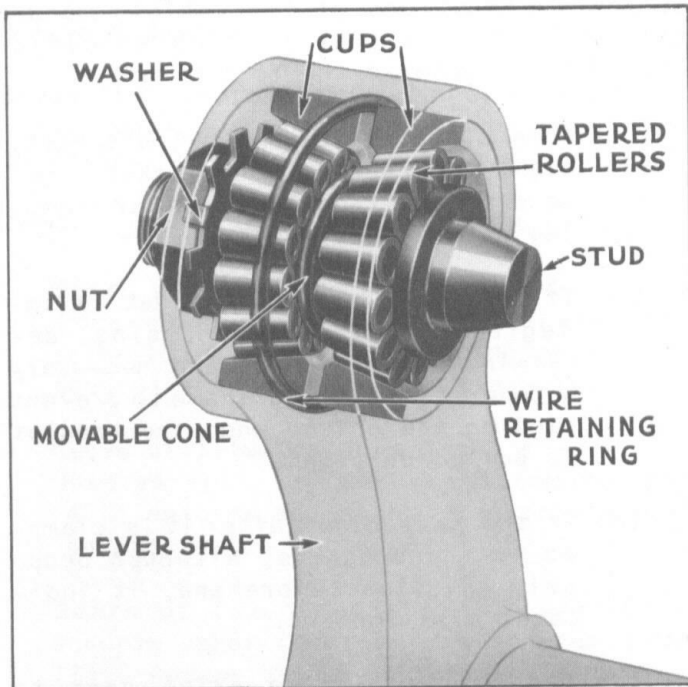


Illustration No. 11

### CUP TYPE IN SINGLE LEVER GEARS

Two separate cups, each forming an outer race, are used.

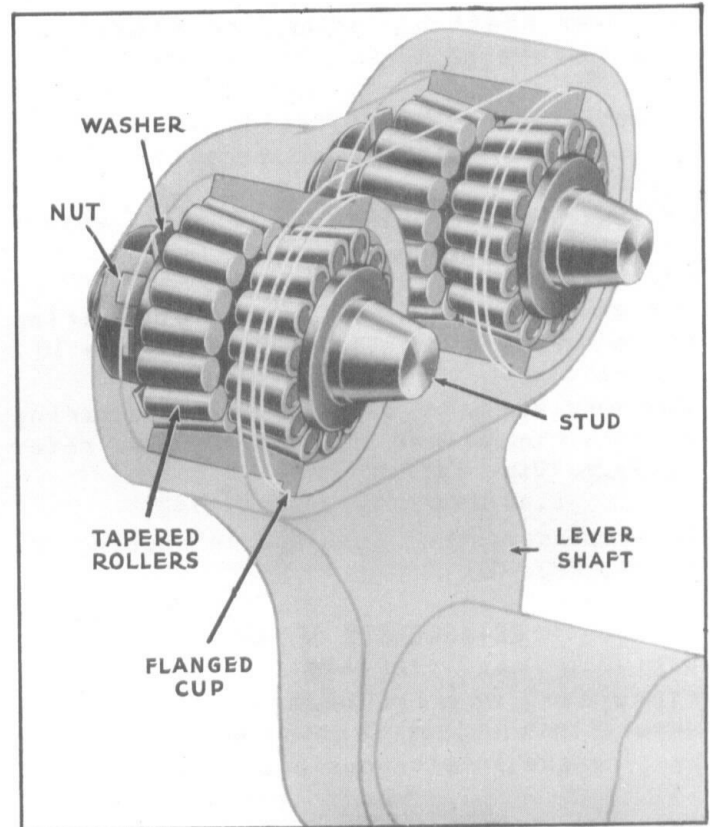


Illustration No. 12

### CUP TYPE IN TWIN LEVER GEARS

Each unit has a flanged cup with the two outer races formed in it.

### REPLACEMENT AND INSTALLATION OF UNITS OR PARTS.

#### CUPLESS TYPE IN SINGLE LEVER GEARS

Dis-assembly is quickly accomplished by removing nut and driving stud out of movable cone.

The stud and movable cone are not separately replaceable. This is to assure use of a cone having proper fit on shank of stud. The stud and cone are furnished together and with nut and washer. The rollers, nut and washer are separately replaceable.

An assembled unit cannot be furnished. The assembly is made while installing the unit in the levershaft. To make this assembly, grease must be used to hold rollers on the

cone. Place stud on end, also movable cone. Apply soft grease to cones and place rollers around cones, placing large end of roller on large end of cone. Place shaft in vise with threaded end down and carefully place movable cone with rollers in lever. Hold cone in place and up end shaft and insert stud with rollers in lever and through movable cone. Assemble washer and nut and adjust per Adjustment III, page 12.

### CUP TYPE IN SINGLE LEVER GEARS

The preceding instructions on the cupless type apply to this type plus the following:

The cups and wire retaining ring are separately replaceable. The cups cannot be pressed out. Each one must be driven out carefully with a drift or nail-set.

To assemble cups, press each one in against retaining ring. Assembly of the rest of the unit is the same as the cupless type.

### CUP TYPE IN TWIN LEVER GEARS

Only the nut and washer are separately replaceable. If any of the other parts need replacing a complete unit must be installed, preferably both units in a matched set.

Uniform projection of the studs is desired to obtain equal loading and proper adjustment of the gear. To accomplish this each unit is marked on the end with either the figure 1, 2, 3, 4 or 5 indicating the amount of endwise variation of the stud location and two units numbered alike (matched set) are used in a shaft.

The assembled units can be assembled in the levershaft by pressing the cup into the shaft until the flange is uniformly tight against the shaft.

After assembling in the levershaft each unit must be adjusted - follow Adjustment III, page 12.

If units have been dis-assembled for inspection and re-assembly is desired, follow instructions for assembling cupless type.

### WHEEL TUBE BEARINGS

Rubber bushings and roller bearings have been the predominant types but the ball bearing units here illustrated are now predominant. They are a self-aligning and self-adjusting type. When this type can be used interchangeably in place of a rubber bushing or roller bearing, it is furnished for replacement. It is lubricated for its service life.

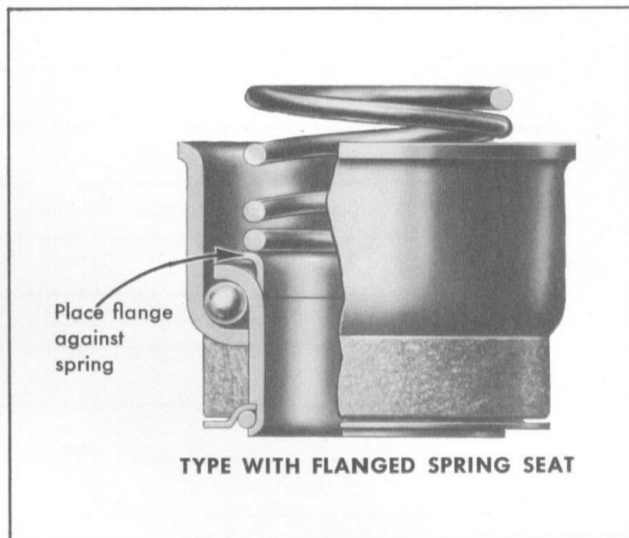


Illustration No. 13

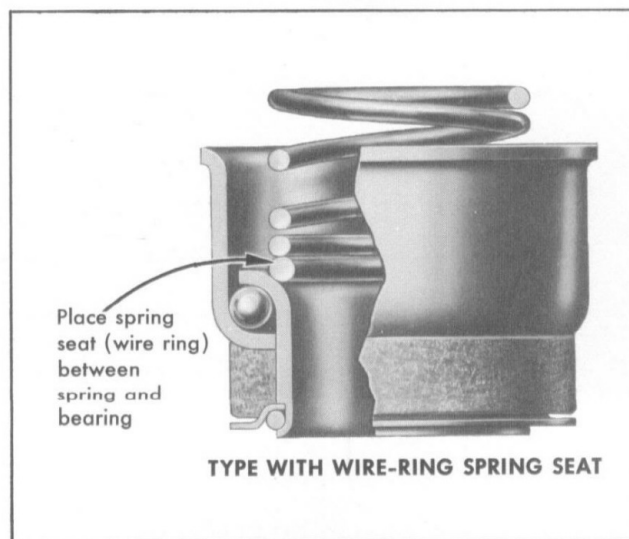


Illustration No. 14

## INSTALLATION --

Press bearing into jacket tube until flange is against tube end uniformly. After jacket tube with bearing is assembled to gear, assemble spring and spring seat on wheel tube underneath steering wheel taking care to place spring seat with flange against spring as shown in illustrations 13 and 14. (Rattle will result if placed opposite.) When steering wheel is assembled in place the spring tension keeps bearing in adjustment at all times.

## LEVER SHAFT BUSHINGS

Clearance limits between the lever shaft and bushings are .0005" to .0025".

Bushings must be sized after they are installed in the housing. At the factory, bushings of sizes up to and including 1-1/2 inch inner diameter are burnished to size. When reaming to size, it is recommended that the clearance be held close to .0005" because a reamed bushing will have a greater amount of initial wear.



