SAE International

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Nomenclature and Terminology for Truck and Bus Drive Axles

RATIONALE

Axle designs have not changed significantly for many years. There is no need for regular review of this document.

STABILIZED NOTICE

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1. ***Scope***—This SAE Recommended Practice outlines basic nomenclature in common use for truck and bus drive axle designs. Over a period of years there have been many different designs introduced; however, for this report, only the most common have been selected and only their general construction is illustrated to show the nomenclature of the various parts.

2. ***References***—There are no referenced publications specified herein.

3. ***Unitized Carrier-Housing Construction***—In this construction, the housing that supports the ring gear, bearings, and differential case, also supports the vehicle loads. This construction is also known as a "Salisbury axle." (See Figure 1.)

4. ***Separable Carrier-Housing Construction***—This construction is one in which the carrier that supports the ring gear, bearings, and differential case, is separable from the housing that supports the vehicle loads. (See Figure 2.)

5. ***Pinion Mounting Options***—This construction defines the manner in which the pinion drive gear is supported. There are two types: overhung mounted or straddle mounted.

    a. Overhung Mounted Pinion: This construction is one in which the pinion drive gear is supported in a cantilever fashion by a pair of bearings. (See Figures 1 and 2.)
    b. Straddle Mounted Pinion: In this construction, the pinion drive gear is supported by a pair of bearings on one side and a spigot bearing on the ring gear side. (See Figure 3.)

6. ***Single Speed Carrier***—This construction is one in which there is a single, fixed reduction ratio.

    a. Single-Speed Single Reduction Carrier: In this construction, the entire axle reduction is accomplished with a single gear set. See Figures 1, 2, and 3 for examples of ring and pinion gear sets. (Worm or helical gear sets are also used.)
    b. Single-Speed Double Reduction Carrier: In this construction, two gear sets are used to accomplish the total reduction. See Figures 4A and 4B for examples of single-speed double reduction gearing. Frequently, this construction is a two-speed carrier (see Section 7) in which the shifting device has been eliminated.

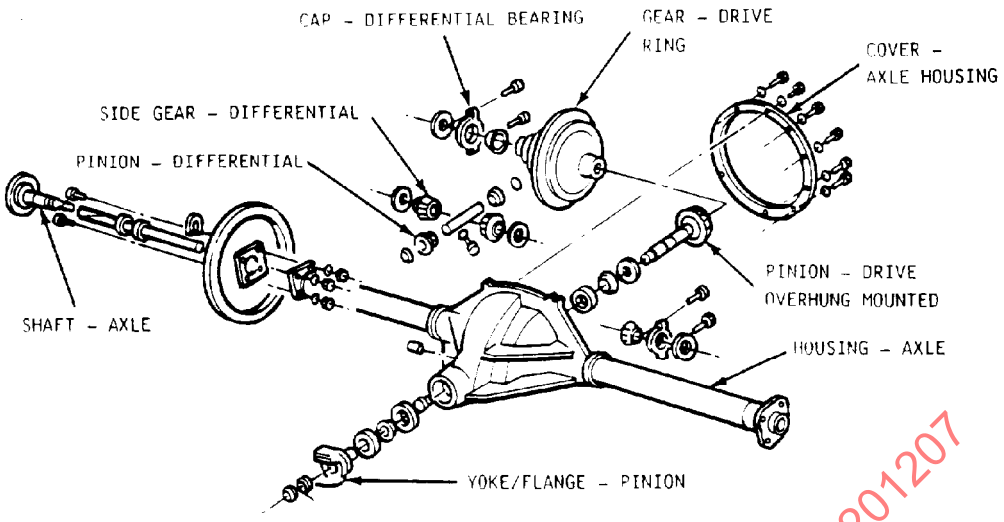

FIGURE 1—UNITIZED CARRIER-HOUSING CONSTRUCTION

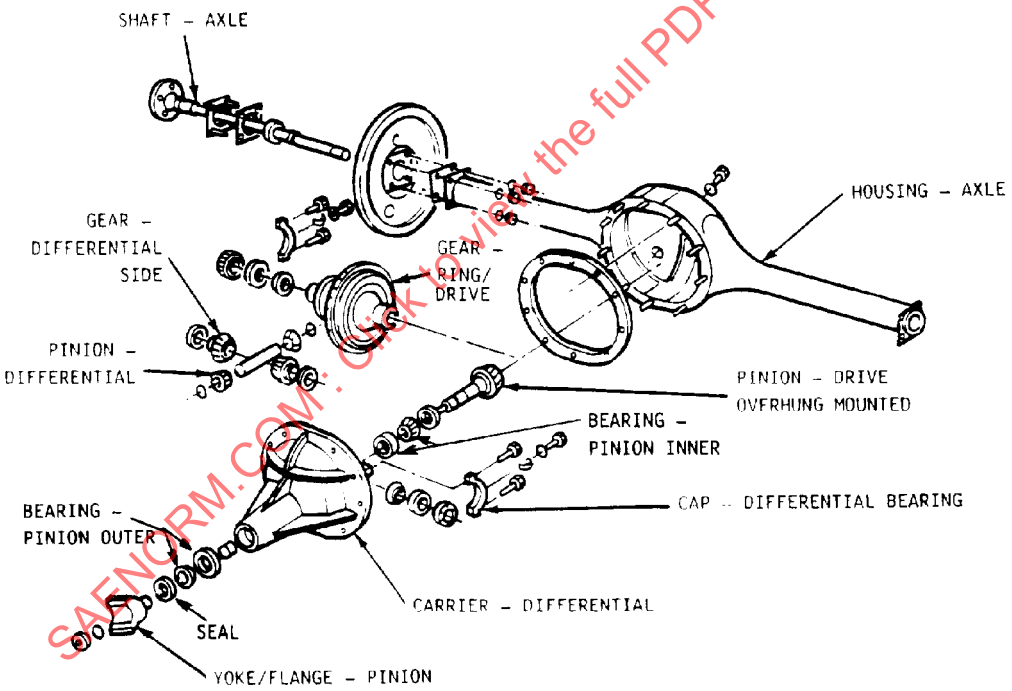

FIGURE 2—SEPARABLE CARRIER-HOUSING CONSTRUCTION

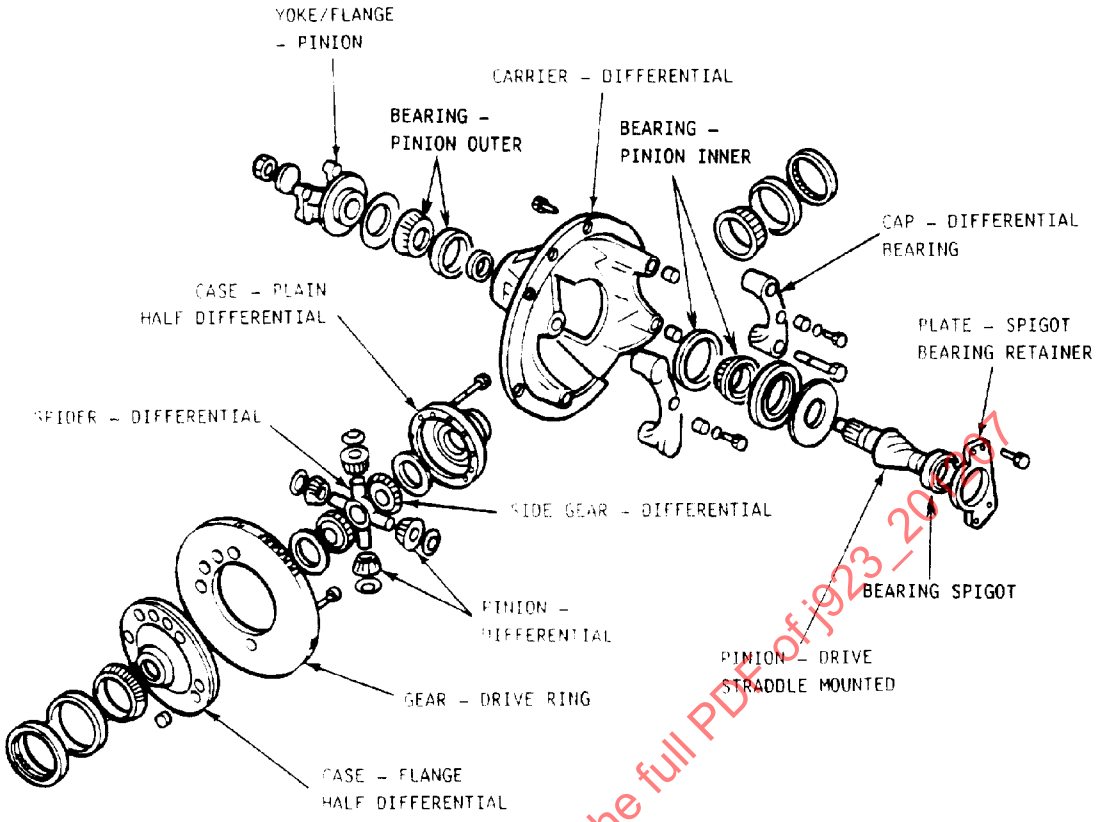

FIGURE 3—PINION MOUNTING OPTIONS

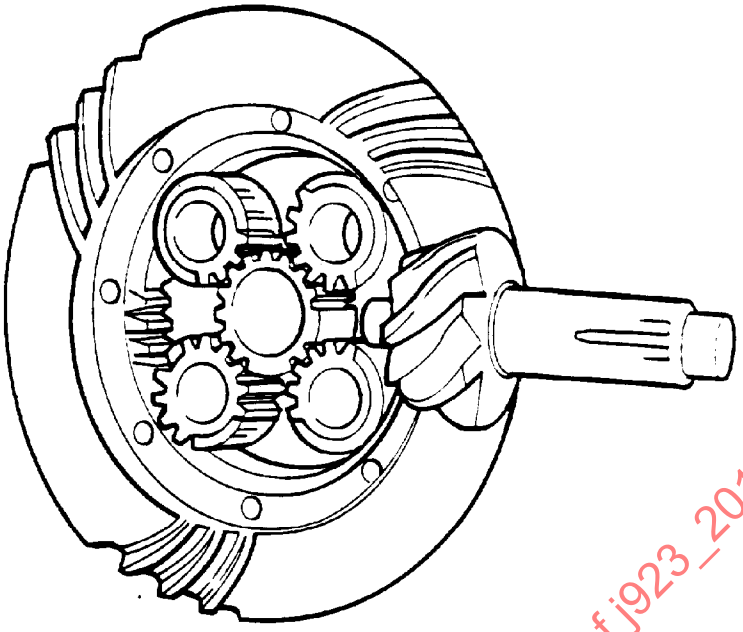

FIGURE 4A—DOUBLE-REDUCTION PLANETARY DIFFERENTIAL GEARING

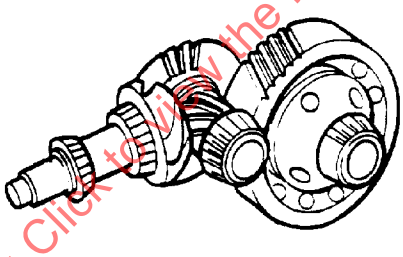

FIGURE 4B—HYPOID-HELICAL SINGLE-SPEED DOUBLE-REDUCTION GEAR TRAIN

FIGURE 4—TYPICAL SINGLE-SPEED DOUBLE-REDUCTION CONSTRUCTION

7. ***Two-Speed Carriers***—This construction is one in which two reductions are available and selectable by the operator.

   a. Planetary Carrier: In this construction, the first reduction is through the ring and pinion drive gear set. The ring and pinion reduction is combined with a planetary gear set to provide the second reduction. The ratio is selected by a slidable sun gear/clutching member. (See Figure 5A).
   b. Nose Box Construction: In this construction, the first reduction is through a shiftable gear set mounted in a case attached to the carrier ahead of the ring and pinion. The secondary reduction is accomplished with the ring and pinion. (See Figure 5B).
   c. Double Reduction Carrier: This construction is one in which the first reduction is through a ring and pinion gear set. The second reduction is through one of two sets of helical gears and pinions. Both low and high speed ratios are obtained by two sets of gear reductions. (See Figure 5C).

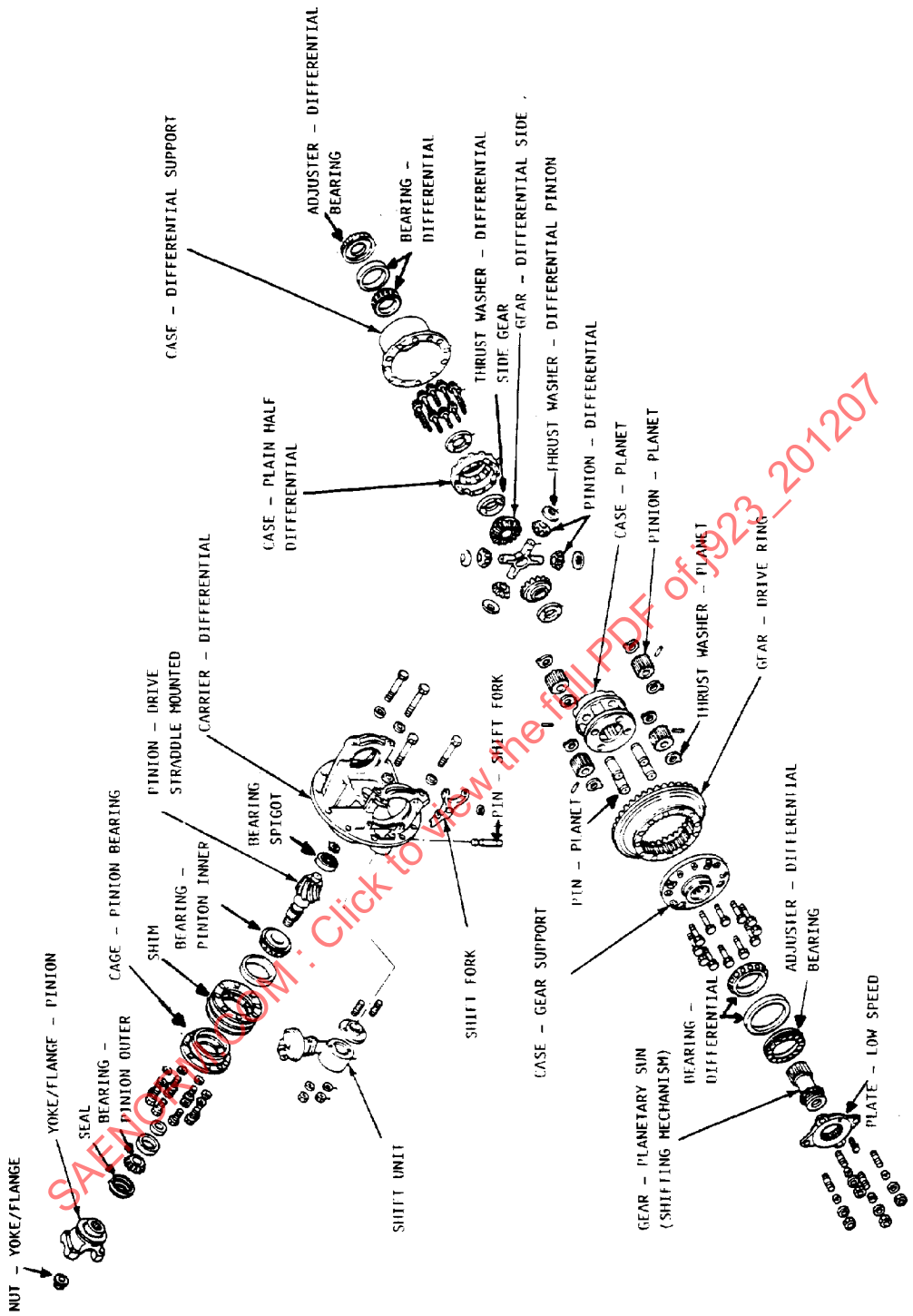

FIGURE 5A—TWO-SPEED CARRIER-PLANETARY CONSTRUCTION

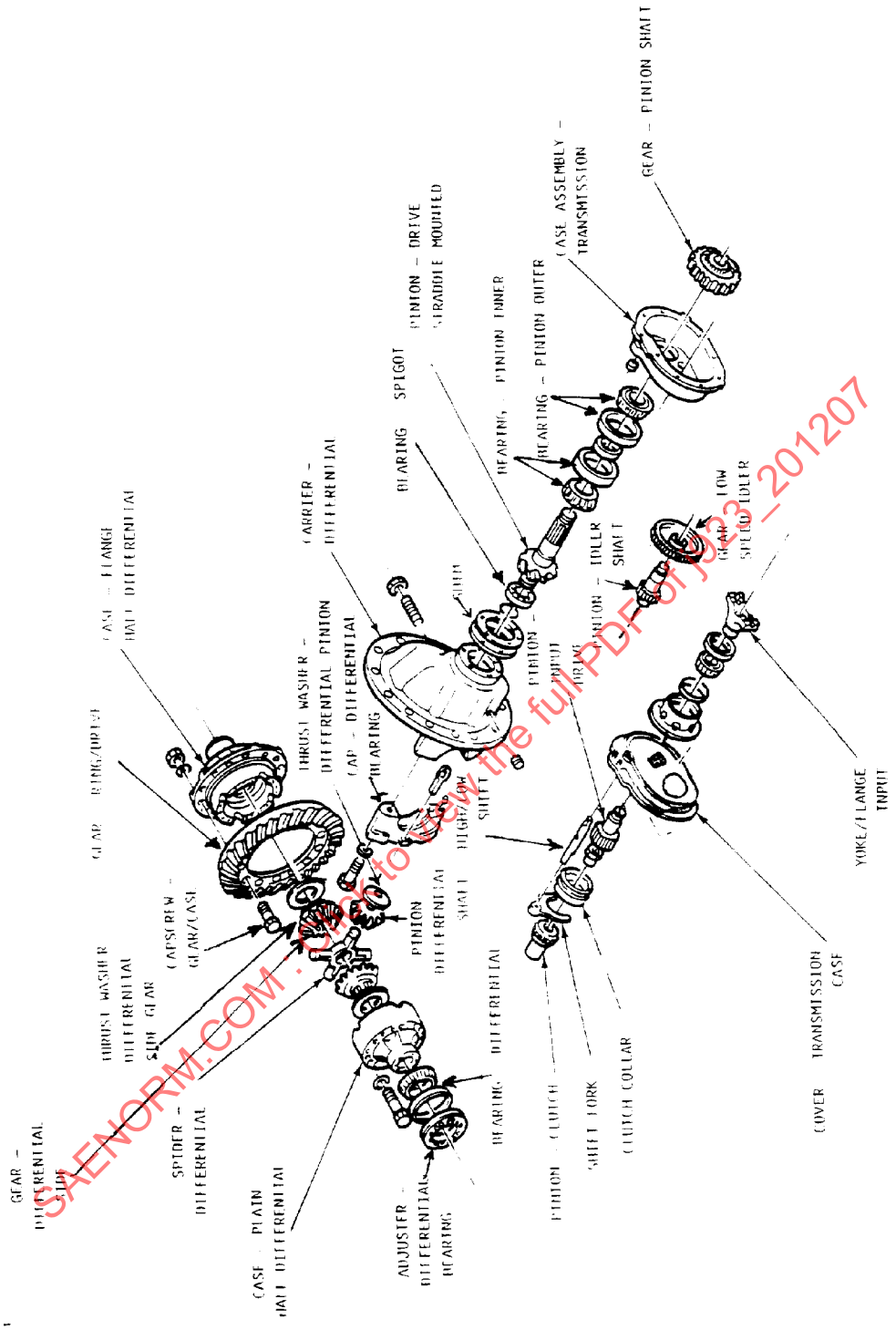

FIGURE 5B—TWO-SPEED CARRIER—NOSEBOX CONSTRUCTION

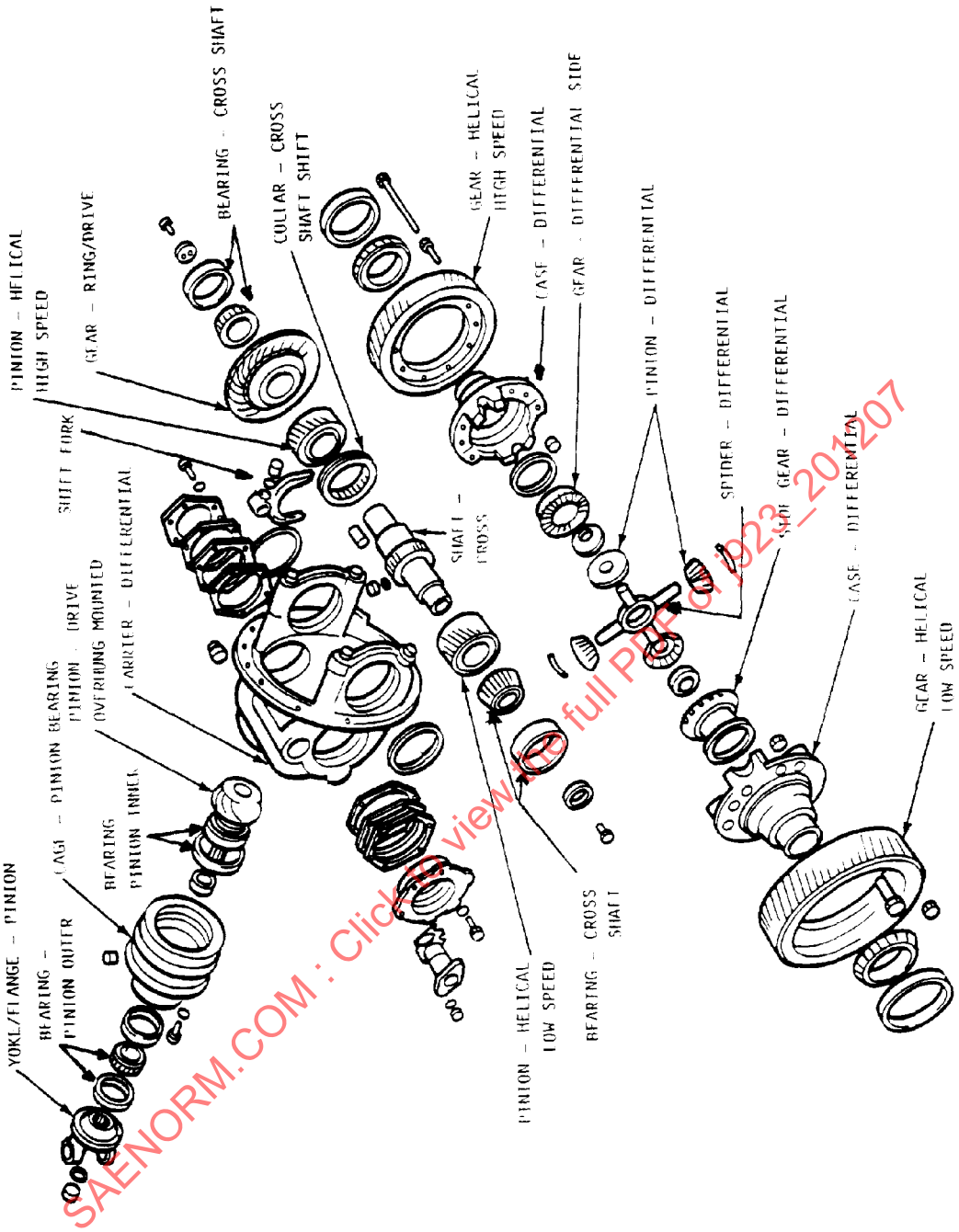

FIGURE 5C—TWO SPEED DOUBLE REDUCTION CARRIER

FIGURE 5—TWO-SPEED CARRIER CONSTRUCTION

8. ***Tandem Axle Construction***—This construction is one in which drive power is provided to a pair of axles connected with an interaxle propshaft. The forward axle usually contains an interaxle differential and through shaft to split input power between the tandem set. If the interaxle differential is not required, a forward axle through shaft is still incorporated to drive the rear axle. The rear can be of any construction but should be matched in ratio to the forward axle. Three alternate designs for the forward axle of the tandem set are described as follows:

    a. Front Mounted Two-Gear Drop Construction: This construction uses a two gear drop to drive the forward axle pinion. This causes opposite pinion rotation requiring both left and right hand gearing for the two rear axles (unless a two-gear drop carrier construction is used in both of the tandem axles). (See Figure 6A). (The rear axle of the tandem set is usually a single speed-single reduction carrier.)
    b. Front Mounted Three-Gear Drop Construction: This construction uses a three gear train to drive the forward axle pinion. This concept permits the use of common ring and pinions in the two rear axles. (See Figure 6B). (The rear axle of the tandem is usually a single speed-single reduction carrier.)
    c. Top Mounted Axle Construction: This construction uses a ring and pinion reduction above the axle housing and a second helical gear set to develop the total axle reduction. (See Figure 6C). (The rear axle of this tandem set is nearly identical to the forward axle.)

9. ***Interaxle Differential***—This device divides the drive power between the two axles of a tandem, while permitting differential rotation capability. Its construction can be either a spider driven configuration as shown in Figure 7A, or a case driven construction as shown in Figure 7B. It is usually provided with a sliding clutch mechanism to lock out the differential during poor traction conditions. The interaxle differential is frequently referred to as the "power divider."

10. ***Traction Enhancing Differential Types***—Many design concepts have addressed the problem of differential spinout under unequal traction situations. Four examples of the more common concepts are discussed as follows:

    a. Limited Slip Differential: This construction controls wheel slip by a series of discs and friction plates. The design in Figure 8A shows discs and plates which are loaded by the differential side gears as they separate from the differential pinions due to the forces generated in the gear mesh. The bias increases as axle torque is increased. A second type incorporates springs to load the discs and plates and maintains constant bias independent of the torque through the differential.
    b. Automatic Locking Differential: In this construction, a device is mounted within the differential cases in place of the gears and pinions. It provides positive drive to both wheels until rotational bias is sensed (which is speed sensitive). This construction is also known as the "No-Spin." An example of an automatic positive locking differential is shown in Figure 8B.
    c. Positive Differential Lock: This construction provides a slidable clutch mechanism to permit locking of the wheel differential during poor traction situations. The construction shown in Figure 8C uses a sliding clutch collar with internal splines which engage mating external splines on the differential case. Figure 8D shows a sliding dog clutch arrangement.
    d. Torque Sensitive, Limited Slip Differential Utilizing Parallel Axis Helical Gears: In this construction, parallel axis planetary helical gears provide automatic splitting of torque between each axle shaft. This construction provides continuous, uninterrupted torque output with torque biasing between axle shafts to match ground conditions. An example of this differential is shown in Figure 8E.

11. ***Hub Reduction Axles***—An additional ratio reduction is attainable by placing a gear set in the wheel end. This is frequently done to increase ground clearance since the wheel end reduction permits a smaller carrier assembly or to increase overall axle ratio. Two types of wheel and hub reduction mechanisms are discussed as follows:

a. Planetary Wheel Hub Reduction: This construction uses a sun-gear-driven planetary gear set mounted in each wheel hub to provide a second reduction for the axle. (See Figure 9A.)
b. Bevel Gear Wheel Hub Reduction: This construction uses a side-gear-driven bevel gear set mounted in each wheel hub to provide a second reduction for the axle. This system provides a 2:1 ratio. (See Figure 9B.)

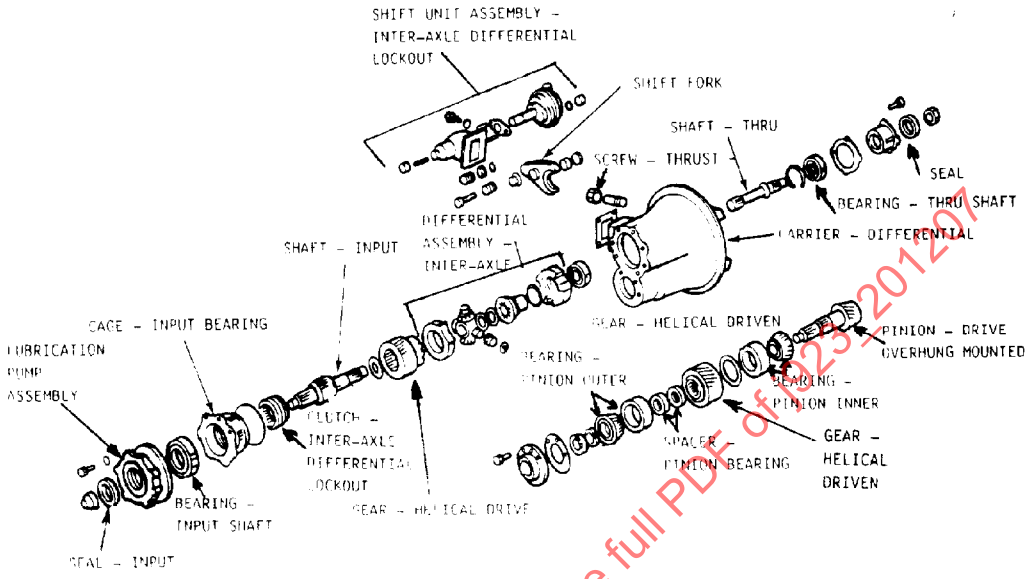

FIGURE 6A—TANDEM FORWARD/REAR AXLE—TWO GEAR TRANSFER TRAIN

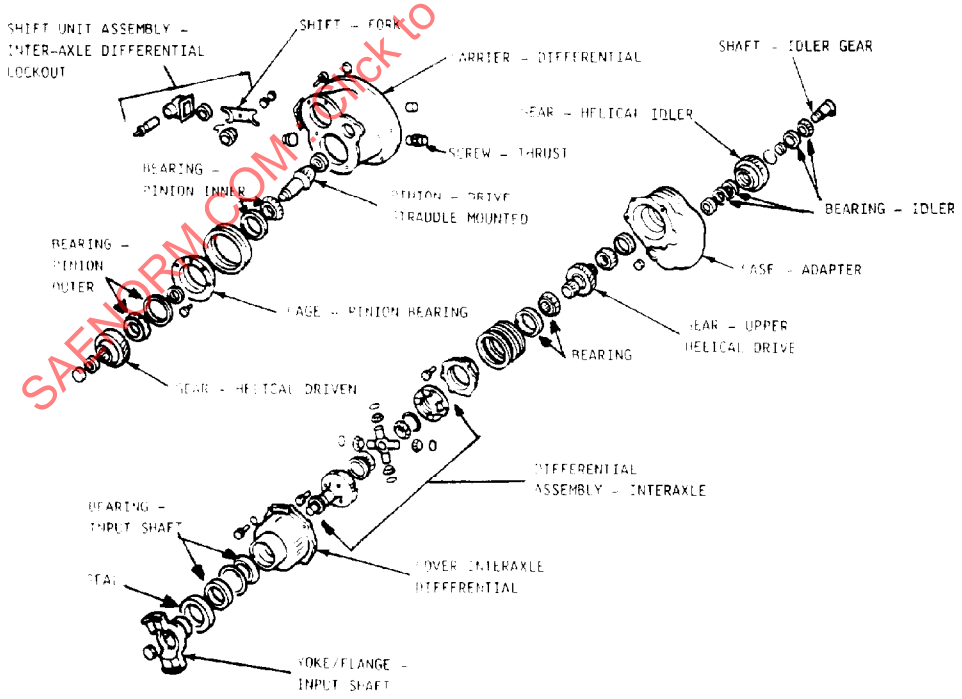

FIGURE 6B—TANDEM FORWARD/REAR AXLE—THREE GEAR TRANSFER TRAIN

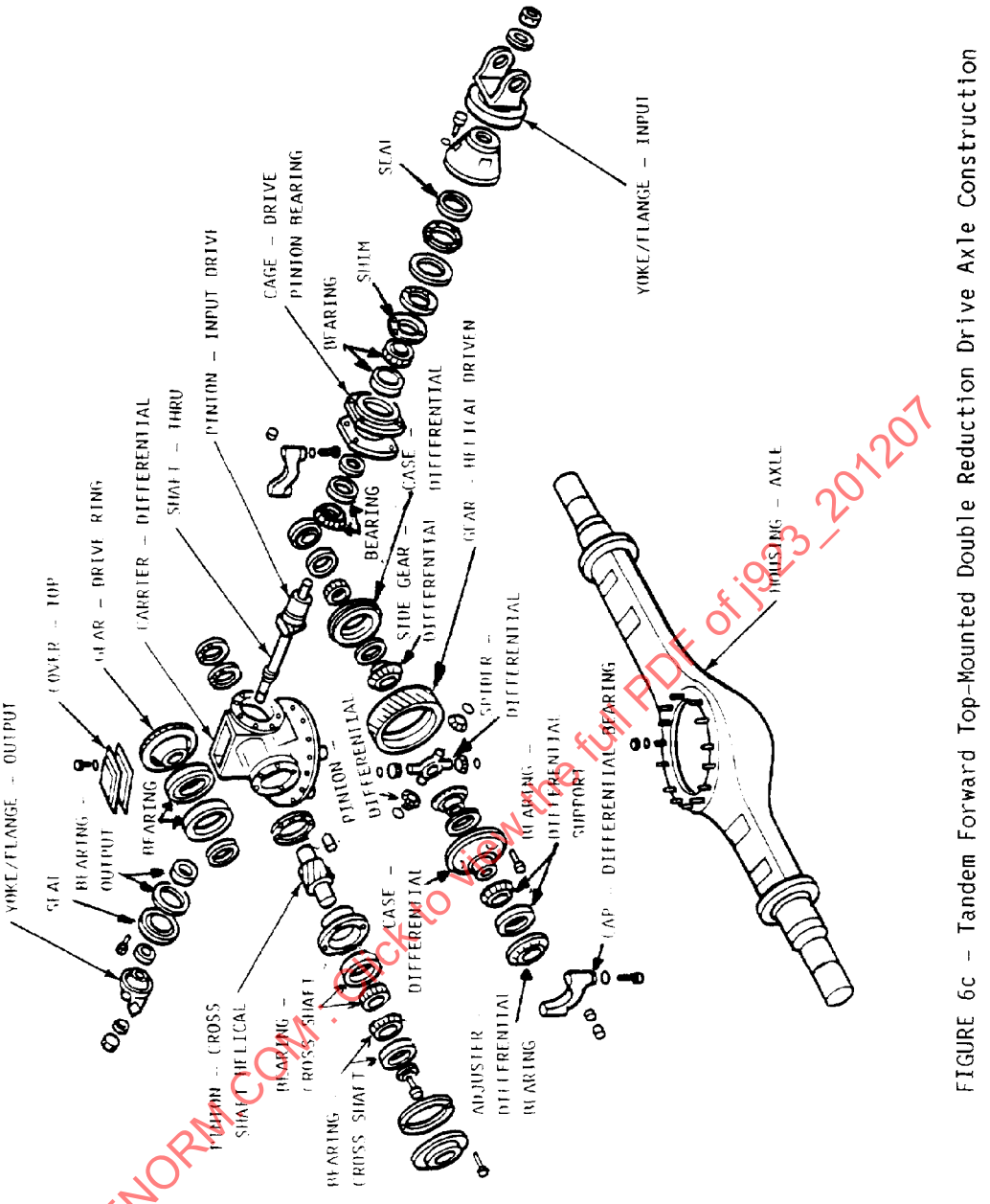

FIGURE 6c – Tandem Forward Top-Mounted Double Reduction Drive Axle Construction

FIGURE 6C—TANDEM FORWARD TOP-MOUNTED DOUBLE REDUCTION DRIVE AXLE CONSTRUCTION

FIGURE 6—TANDEM AXLE CONSTRUCTION

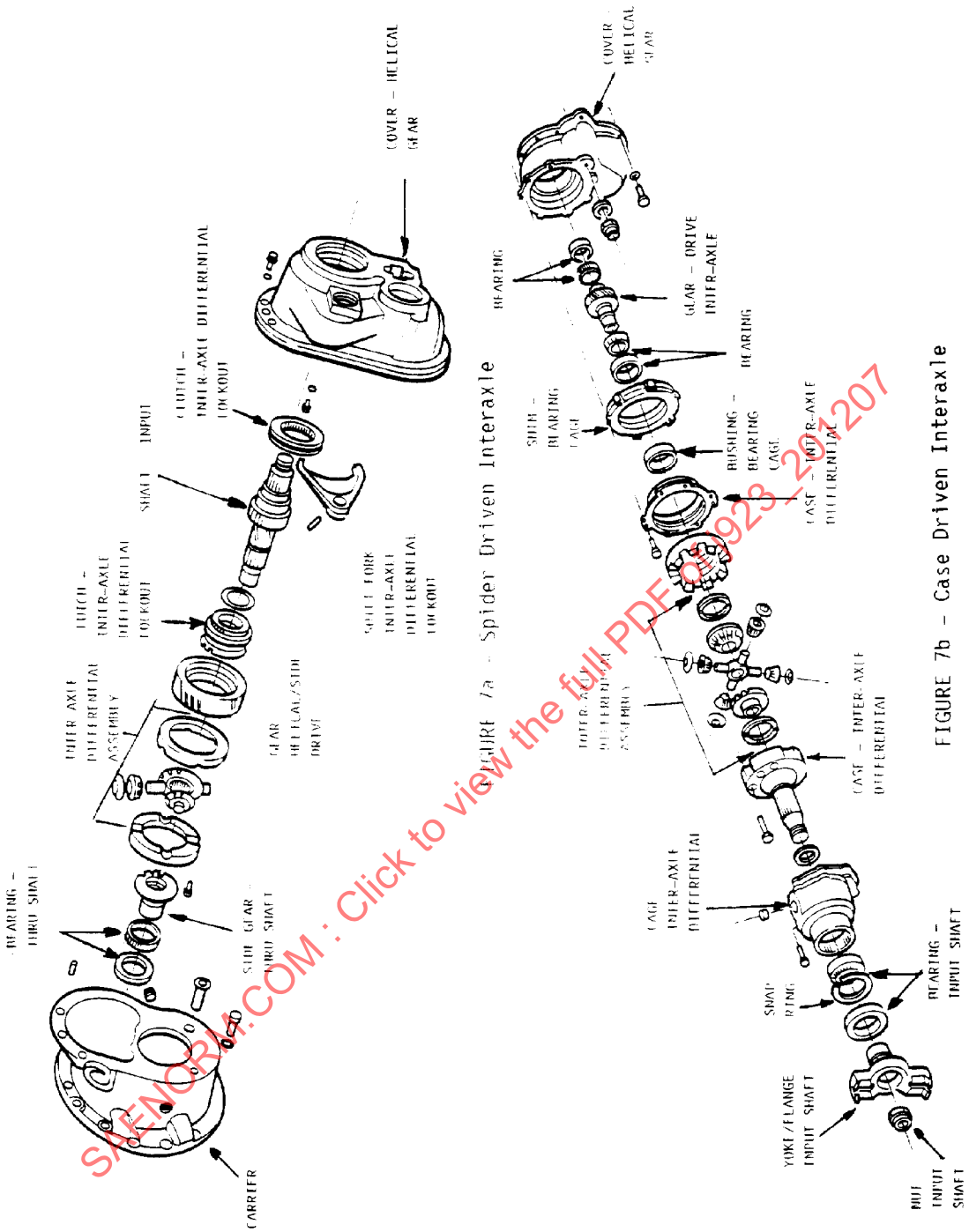

FIGURE 7—INTERAXLE DIFFERENTIAL CONSTRUCTION

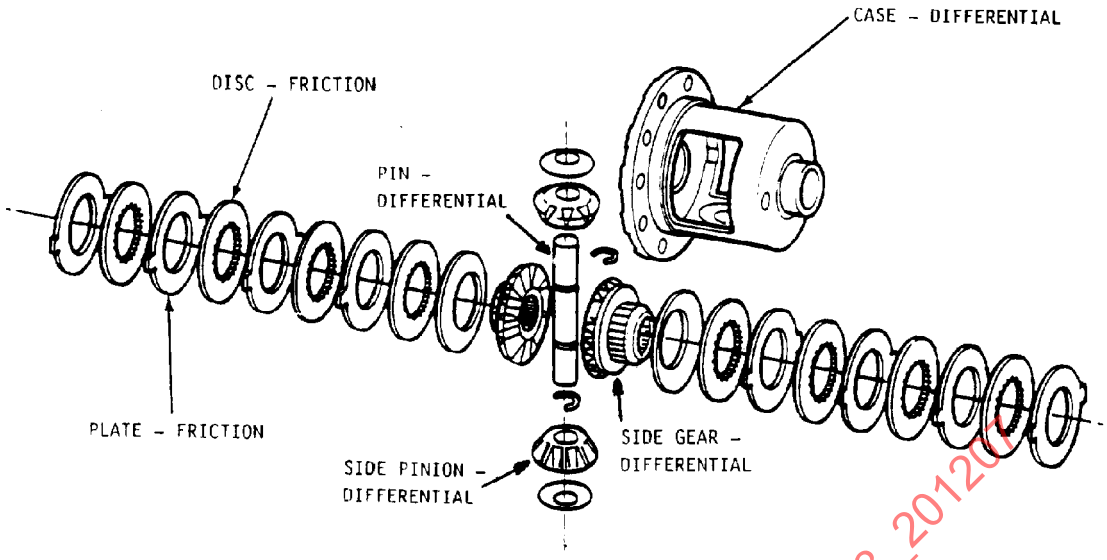

FIGURE 8A—LIMITED SLIP DIFFERENTIAL

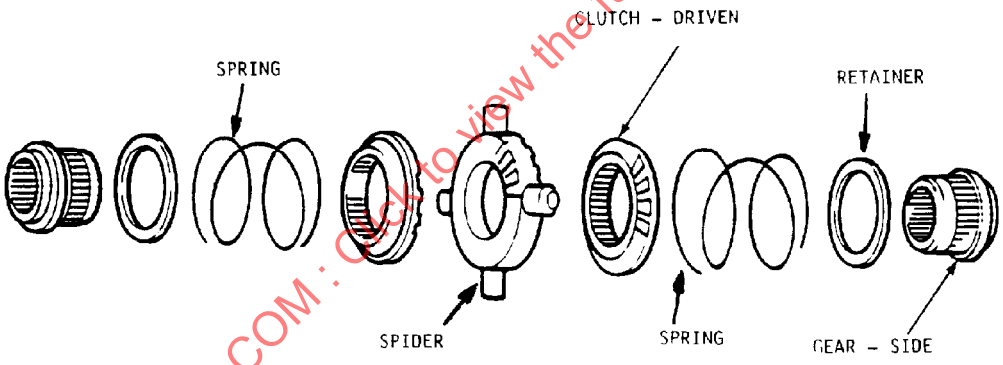

FIGURE 8B—AUTOMATIC POSITIVE LOCKING DIFFERENTIAL

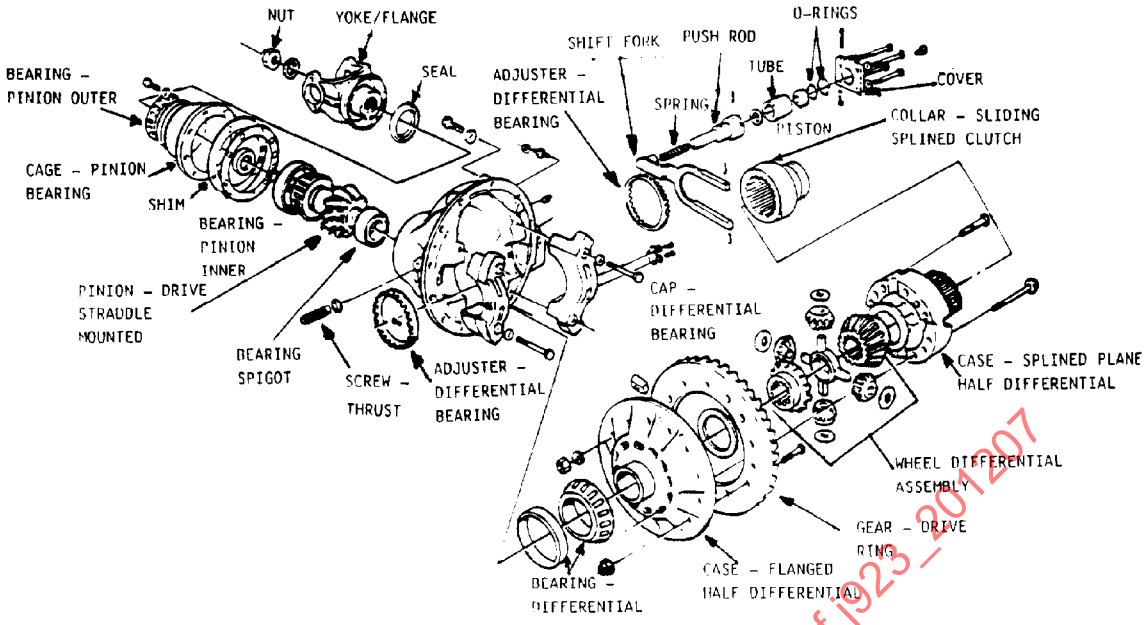

FIGURE 8C—POSITIVE DIFFERENTIAL LOCK—SLIDING SPLINED COLLAR CONSTRUCTION

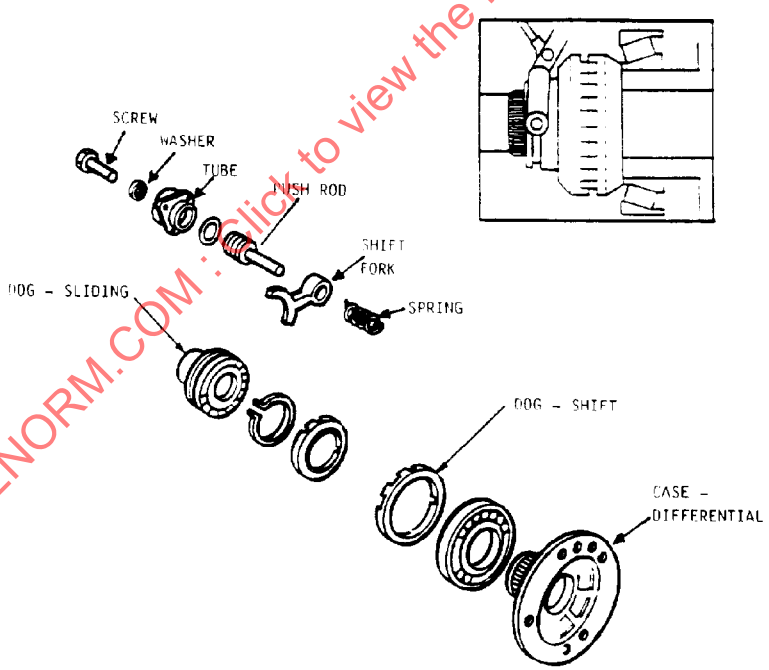

FIGURE 8D—POSITIVE DIFFERENTIAL LOCK—SLIDING DOG CLUTCH CONSTRUCTION

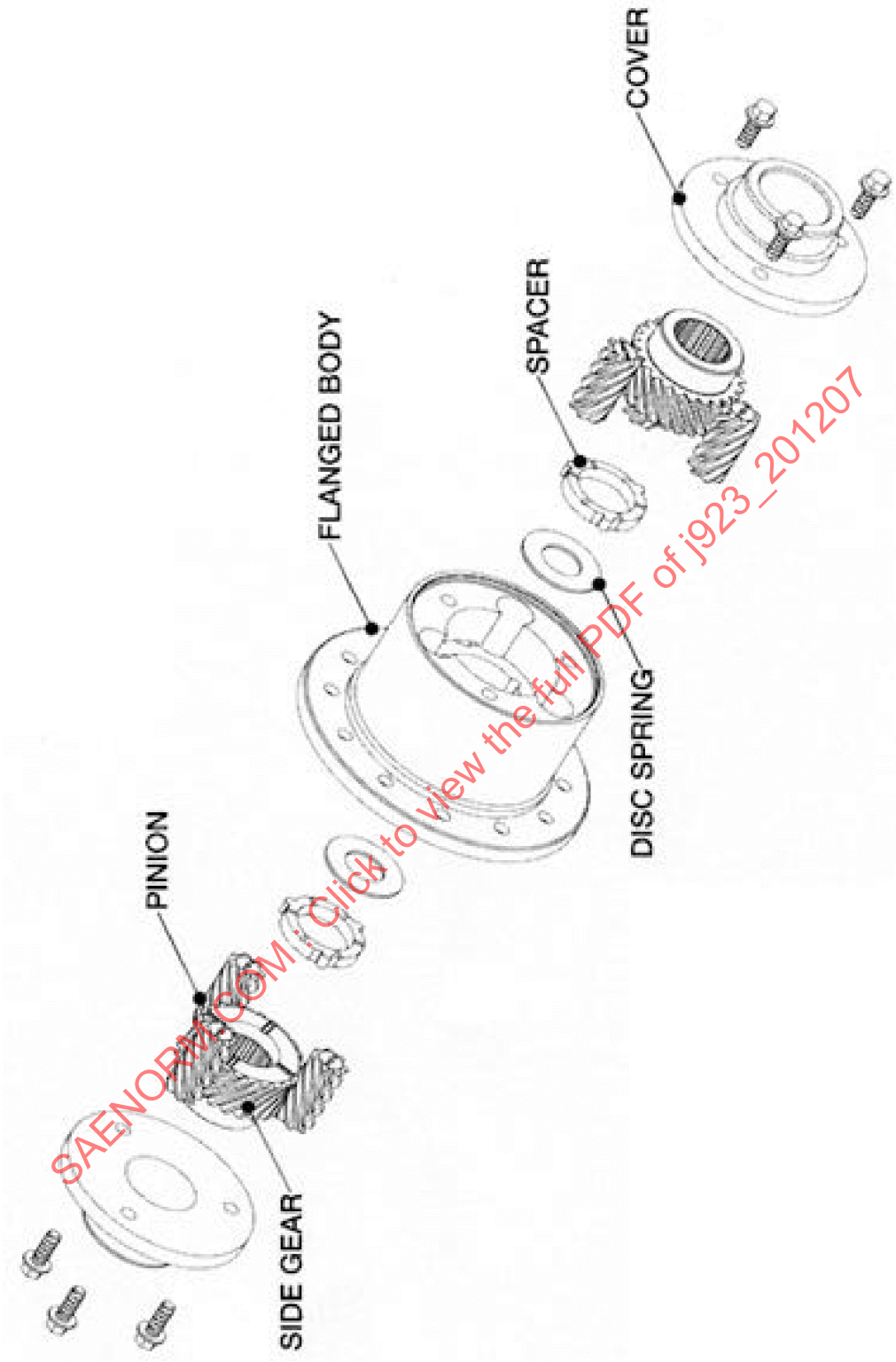

FIGURE 8E—LIMITED SLIP DIFFERENTIAL UTILIZING PARALLEL HELICAL GEARS

FIGURE 8—TRACTION ENHANCING DIFFERENTIAL TYPES