Differential Service
Basic Theory and Procedure

















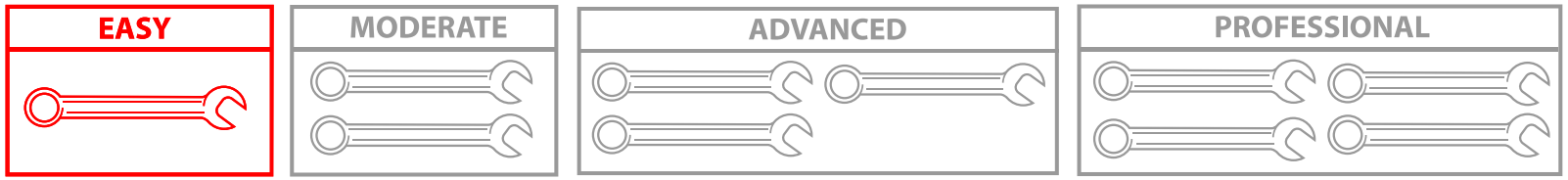
Proper service and repair procedures are vital to the safe, reliable operation of all motor vehicles as well as the personal safety of those performing the repairs. Standard safety procedures and precautions (including use of safety goggles and proper tools and equipment) should be followed at all times to eliminate the possibility of personal injury or improper service which could damage the vehicle or compromise its safety.

INTRODUCTION

ECS Tuning Technical Writings: Differential Service Basic Theory and Procedure

Differential service is one of the most overlooked maintenance items on most cars. In this edition of our technical writings we will cover the following topics:

- Basic Differential Construction
- Fluid Types
- Maintenance Intervals
- Tools
- Service Procedures



Differential service, while quite often overlooked, is a routine service that can be completed in an afternoon with relative ease. The differential(s) on your vehicle are a crucial part of the running gear and just like the engine or transmission, rely on their fluid for lubrication, cleaning, proper operation, and cooling. They are far more advanced than they used to be, and the fluids are increasingly becoming a more critical part of the differential operation on many of the modern AWD systems. Thank you for your interest in our technical writings. We appreciate your business!

TABLE OF CONTENTS

Differential Construction pg.4
Differential Types and Operation pg.5
Differential Fluid pg.7
Differential Service Tools pg.10
Service Procedures pg.13

GENERAL PREPARATION AND SAFETY INFORMATION

ECS Tuning cares about your health and safety. Please read the following safety information. This information pertains to automotive service in general, and while it may not pertain to every job you do, please remember and share these important safety tips.

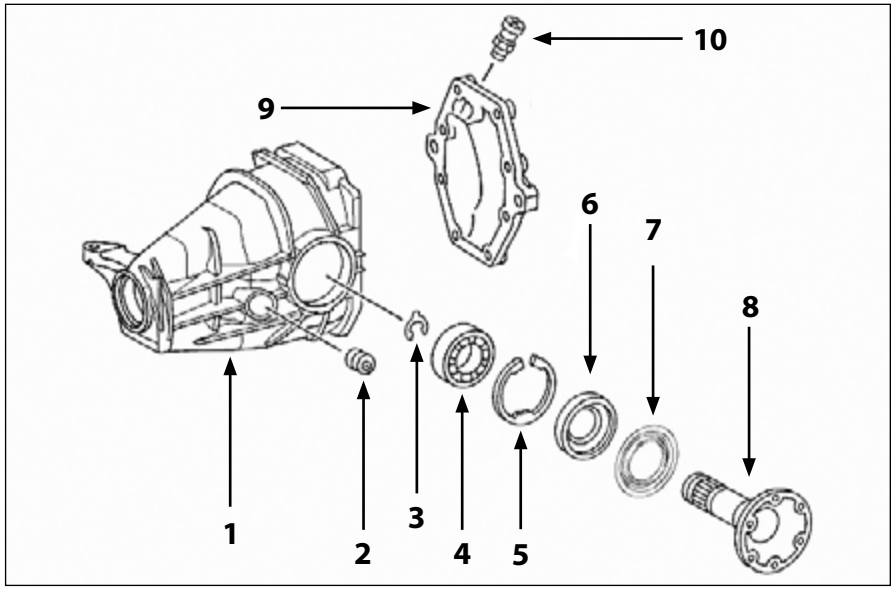
- Park your car in a safe, well lit, level area.
- Shut the engine off and remove the key from the ignition switch.
- Make sure any remote start devices are properly disabled.
- Always wear safety glasses.
- Make sure the parking brake is applied until the vehicle is safely lifted and supported.
- If using an automotive lift, be sure and utilize the factory specified lift points. Lifting a vehicle in an incorrect location can cause damage to the suspension/running gear.
- When lifting a vehicle using a jack, always utilize the factory specified lift points. Lifting a vehicle in an incorrect location can cause damage to the suspension/running gear. Always support the vehicle with jack stands.
- Always read and follow all safety information and warnings for the equipment you are using.

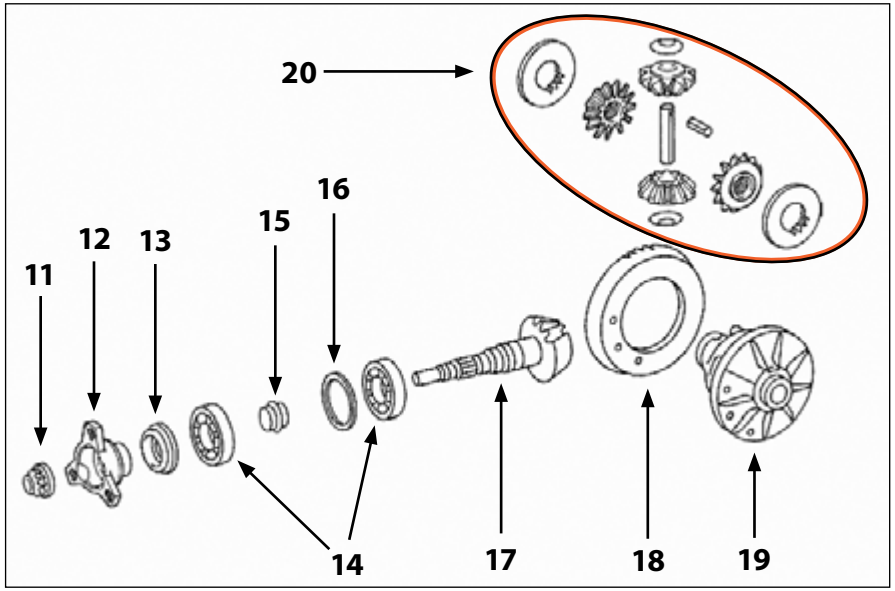


Never get underneath a vehicle that is supported only by a jack. Always make sure that the vehicle is securely supported on jack stands.

DIFFERENTIAL CONSTRUCTION

These diagrams show the basic internal construction of a standard differential.





(1) - Differential Housing
(2) - Differential Drain/Fill Plug
(3) - Axle Retaining Clip
(4) - Axle Bearing
(5) - Snap Ring
(6) - Oil Seal
(7) - Dust Seal
(8) - Axle Flange
(9) - Differential Cover
(10) - Differential Breather
(11) - Pinion Flange Nut
(12) - Pinion Flange
(13) - Pinion Seal
(14) - Inner And Outer Pinion Bearings
(15) - Pinion Crush Sleeve
(16) - Spacer / Washer
(17) - Pinion Gear
(18) - Ring Gear
(19) - Differential Carrier
(20) - Spider & Side Gear Set

Table of Contents

DIFFERENTIAL TYPES AND OPERATION

Operation

The purpose of a differential is to allow the drive wheels to rotate at different speeds when going around a corner. When turning, the inner wheel is traveling around a smaller circumference than the outer wheel. As a result, the inner wheel rotates slower and the outer wheel rotates faster.

Power is transferred into the differential from the driveshaft to the pinion flange which is splined to the pinion gear. It travels through the pinion gear, and from the pinion gear into the ring gear. The ring gear is bolted directly to the differential carrier, which houses the spider and side gear set. The power is therefore transferred through the ring gear and carrier into the spider gears, and then finally from the spider gears through the side gears and into the axles or output flanges. The "differential" function of the spider and side gear set is what allows the wheels to rotate at different speeds.

Open Differential

An "open" differential is the most basic type. The differential pictured on page 4 is an example of an "open" differential. Very basic and reliable, and only requiring a standard gear oil for lubrication, these are the most economical to produce. The disadvantage to an "open" style of differential is that if one wheel loses traction, all power will be transferred to that wheel and it will spin freely. This is an extreme disadvantage on slippery roads or for hard acceleration when the traction of both tires is required.

Limited Slip Differential

A "limited slip" differential is one in which a series of clutch discs and plates are located between the side gears and the differential carrier, and a spring pack keeps the side gears, clutches, and carrier pressed together. There are three keys to operation: 1: The plates are engaged into the carrier and the discs are splined to the axle or output shaft. When the clutches are engaged, the axle and side gears will turn with the carrier, eliminating the spider gears and "differential" function. 2: The spider and side gears are beveled and the more force that is applied to beveled gears, the more they attempt to push away from each other. 3: The spring pack keeps constant pressure on the clutches, keeping them partially engaged.

When turning a corner, speed and torque input is low, allowing the clutches to slip and normal differential action will occur. When one wheel is on a slippery surface, such as an icy road, the tire will slip and begin to spin. This is where the "limited slip" action takes over. Since a spinning wheel has no resistance, the force on the beveled gears on that side is low and the clutches will slip. On the side with traction, since the spring pack keeps the clutches partially engaged, a greater force is applied to the beveled gears on that side and they are pushed apart, applying the clutches and transferring power into the axle or output flange.

Table of Contents

DIFFERENTIAL TYPES AND OPERATION

Transaxles

A transaxle assembly is a front or rear wheel drive transmission in which the differential is housed in the transmission case along with the transmission shafts and gears. The differential operation is the same, however instead of the power entering the differential through the driveshaft and pinion gear, it is transferred from a gear on the transmission output shaft directly to the ring gear on the differential carrier.

AWD Differentials

There are many different types of all wheel drive systems in today's cars, they are very sophisticated, and the differentials are an integral part of these systems. Much more than your standard open or limited slip differential, many of these new units will ultilize clutch packs and planetary gear sets, the exact same components in an automatic transmission, as well as electric pumps to create the pressure to control these systems.

Transmission/Transaxle Types

There are many different types of transmission and transaxle configurations in todays cars. Both front and rear wheel drive vehicles can have either a transverse or longitudally mounted transmission or transaxle. All wheel drive vehicles can have the same possibilities, with the longitudal transmission containing an internally housed differential and an additional output in the tail shaft. A transversely mounted transmission on an AWD vehicle will typically have a small transfer case incorporated on the side of the differential to transfer power into a driveshaft. There are too many combinations to list, but the fluid is the most critical part of each one. Identify what your vehicle is equipped with so you do not overlook any fluids.

Table of Contents

DIFFERENTIAL FLUID

What is the role of the fluid in your differential? It is much more than you might think. Of course, lubrication is critical, the bearings must be constantly lubricated, as well as the gears and clutches. The fluid carries debris and wear particles away from the critical surfaces, and leaves them deposited on a magnet, generally located in the differential housing or quite often on the end of a drain plug. It also transfers the heat build up from the gears and bearings into the differential case or housing, which is subsequently cooled by the air around it. Some differentials designed for higher performance applications will have additional cooling fins built into the housing which aid in dissipating excess heat from the differential when driving. The correct fluid is critical for proper clutch operation in limited slip differentials, and in modern AWD systems, the fluid is critical to system operation.

How often should you change the differential fluid? Every vehicle manufacturer will have a specified maintenance interval for changing the differential oil. In some cases, it is a very high service interval such as 100,000 miles. Synthetic oils make a lot of this possible, however keep in mind that differentials do not have any filters or specific cooling systems, and can take a lot of abuse. A good general rule of thumb to follow is that you are not going to damage your differential by changing the fluid. You can only increase its lifespan.

Neglecting the differential fluid can lead to costly repairs. Differentials and transmissions require a number of special tools for proper assembly and set up, and many times you are faced with replacement with a costly used or rebuilt component. The fluid change is relatively easy, and it can save you a lot down the road. It is a good idea to check the differential fluid level and condition during routine service, especially if any signs of leakage are detcted around any of the seals.

Due to the complexity of today's differentials and AWD systems, always be sure to use the fluid that is specified by the vehicle manufacturer, and be sure the fluid is kept at the proper level.

ECS Tuning offers a wide selection of differential fluids to meet your needs, including fluid kits that have the specified fluid for your vehicle as well as drain and fill plugs for your application.

Table of Contents

DIFFERENTIAL FLUID

Always be sure to use only the fluid specified by the vehicle manufacturer for your differential.

When selecting a fluid, keep in mind the following points:

- Be sure to get a fluid with the correct viscosity rating



- Be sure to get a fluid with the correct GL rating



Table of Contents

DIFFERENTIAL FLUID

Always be sure to use only the fluid specified by the vehicle manufacturer for your differential.



• Some fluids require an additional additive for limited slip differentials

• ECS Tuning offers a number of service kits specifically designed for your car that contain the fluid as well as new drain and fill plugs.



Table of Contents

DIFFERENTIAL SERVICE TOOLS

Oil Drain/Fill Plug Wrench

This 8-n-1 drain/fill plug wrench features a swivel head with an assortment of hex and square drive bits that fit many differential and transmission drain plugs. The hex bit sizes are: 10mm, 12mm, 14mm, and 17mm. The square drive sizes are: 8mm, 10mm, 3/8" and 1/2". It is available at ecstuning.com as ES#2221248.



Drain Pan

It's essential to catch all the differential fluid as it drains and there's nothing better to do the job than this Schwaben 8 liter drain pan. Sturdy construction, an anti-splash lip, and a 1" drain spout make it convenient to use. It is availble at ecstuning.com as ES#2748892.



Table of Contents

DIFFERENTIAL SERVICE TOOLS

Fluid Extractor/Filler System

Some differentials are not equipped with drain plugs, making this fluid extractor an essential piece of equipment. It also offers the convenience of pumping the new fluid back in. It features a manual pump, extendable foot step, hoses and adapters. It can be used for manual and automatic transmissions as well. It is available at ecstuning.com as ES#2774825.



Pig Mats

These absorbent mats are excellent to place around your work area when draining fluid. They will catch and absorb any spills or splashes, keeping your garage floor clean. They are available at ecstuning.com as ES#2137110.



Table of Contents

DIFFERENTIAL SERVICE TOOLS

Fluid Pump

This Schwaben Multi Function Fluid Pump Kit is perfect for the differential that has a drain plug. Simply drain the fluid, then easily refill it with this fluid pump. This kit is also compatible with all automotive fluids, and comes with the adapters to use it as a pressure brake bleeder as well. It is available at ecstuning.com as ES#2774836.



Latex Gloves

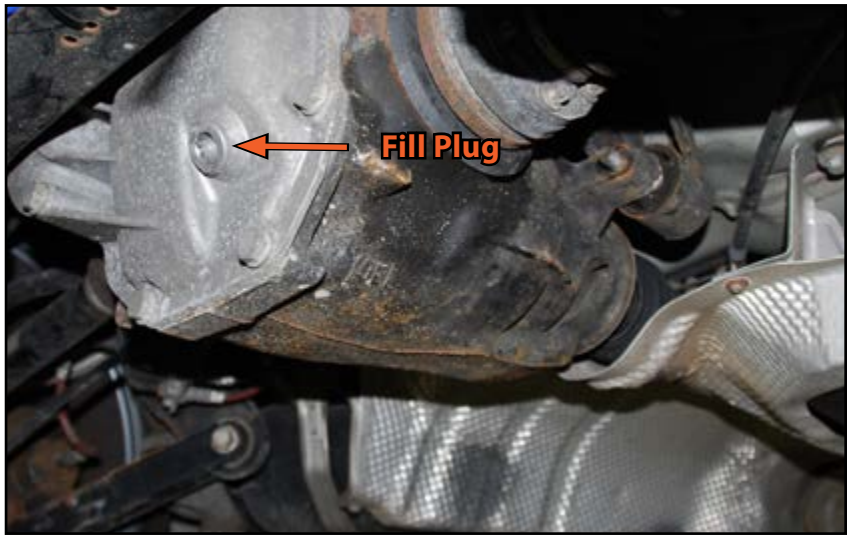
Protect your skin with latex gloves. Old fluid is dirty, smelly, and damaging to your skin. Wear these for all your vehicle's maintenance. These are available at ecstuning.com in medium (ES#2718810), large (ES#2718809), or extra large (ES#2718812).



Table of Contents

DIFFERENTIAL SERVICE PROCEDURES

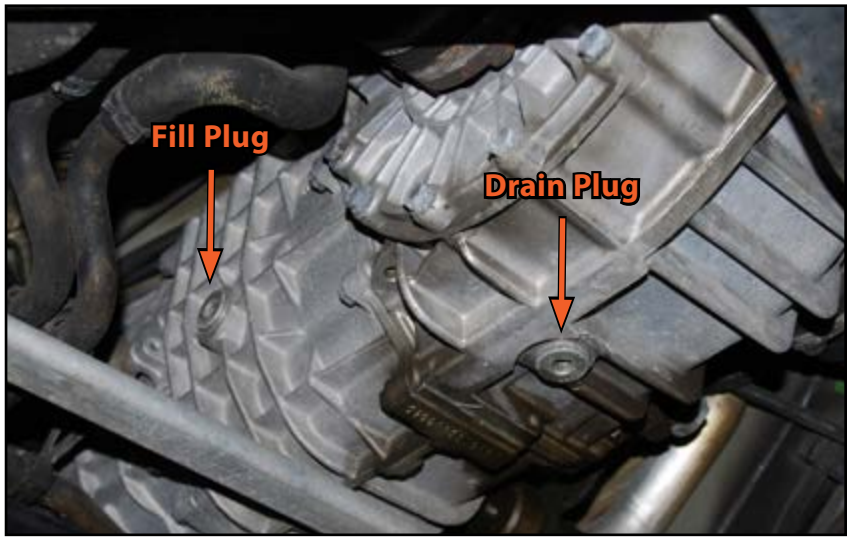
The standard service procedure for a differential is to drain the old fluid, then refill with new. It's really that simple, however some differentials do not have drain plugs, such as the example on the right.



For differentials without drain plugs, in some cases, you can remove the differential cover to drain the fluid, then reinstall it using a new gasket or sealant. On many of these vehicles though, the cover also has a differential mount cast into it making removal more difficult. This is the ideal time to use a fluid extractor to make short work of the job.

Many gear oil containers have a pointed spout, and you can attach a hose to the spout and squeeze the fluid in. The drawback to this method is that it is messy and usually very wasteful.

The transaxle on the lower right, with the differential housed in the case, has both a drain and fill plug.



Refer to the manufacturers info for the correct fluid fill level. In some cases it is level with the fill plug, in others it may be a few mm below the opening for the fill plug.

TECH TIP

When the fill level is below the opening for the fill plug, bend a piece of mechanics wire slightly longer than the fill level and use it as a dipstick

Table of Contents

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