

NAME _____
CLUB _____
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YEARS IN PROJECT _____
YEARS IN 4-H _____

2

MAINTENANCE AND OPERATION



4-H

AUTOMOTIVE PROJECT
CARE AND SAFETY

UNIT 2
MAINTENANCE AND OPERATION
4-H
AUTOMOTIVE PROJECT IN CARE AND SAFETY

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OUTLINE OF UNITS

You are invited to participate in the 4-H Automotive Program which has been developed especially for older Club members. Its purpose is to help you achieve and enjoy the fullest opportunities as a safe and efficient automobile driver, upon acquiring a license. The impact of the automobile age on our lives makes it important that we have more educational opportunities to learn the safe care and operation of automobiles.

Even though you have not started to drive as yet, the 4-H Automotive Project offers you an opportunity to share with others in your age group the advantage of learning more about the automobile, how it should be handled on the road, and the cost involved.

Following is an outline of the contents of the three Units, this manual being Unit II.

UNIT 1: The Car and the Highway

- Section I. You and the Automobile
- Section II. Highway Safety.
- Section III. Group Activity—Highway Hazard Hunt.
- Section IV. What Makes a Car Go! and Stop!
- Section V. The Engine in General—Simple Principles of Internal Combustion.
- Section VI. Carkeeping.
- Section VII. Car Costs and Record Keeping.
- Section VIII. Traffic Code and Your Future Responsibilities.
- Section IX. Car Inspection—Safety Checking a Car.

UNIT 2: Maintenance and Operation

- Section I. The Engine as a Power Unit.
- Section II. The Engine Needs Clean Air.
- Section III. How the Fuel System Works.
- Section IV. Igniting the Air-Fuel Mixture.
- Section V. Career Opportunities.
- Section VI. Group Activities—Safety Lane and Braking Demonstration.
- Section VII. How Engine Temperature is Controlled.
- Section VIII. General Lubrication.
- Section IX. Tires and Their Care.
- Section X. Handling a Car Safely on the Road.

UNIT 3: Operating the Car Efficiently

- Section I. What Does It Cost to Own and Operate a Car?
- Section II. How Power is Transmitted by the Engine.
- Section III. What Makes for a Smooth, Safe Ride.
- Section IV. Selecting Lubricants.
- Section V. The Electrical System.
- Section VI. What to Look For in Buying a Used Car.
- Section VII. Operating Your Car Efficiently.
- Section VIII. How to Make Your Community a Safer Place to Drive.
- Section IX. Group Activities—Economy Run and Driving Skill.

UNIT 2, SECTION I



The engine is the heart of an automobile. The strength of an engine is measured in terms of Horsepower (HP). The goal of this section of the 4-H Automotive Care and Safety Project is to help you understand horsepower and its meaning to you as you become a driver, and to provide you with an opportunity to know the engine parts and their functions. This knowledge will aid you in taking care of the most important part of an automobile — the Power Unit.

From the birth of the automobile industry the term horsepower has been used to indicate the ability of an engine to propel a car with the performance expected of it by the purchaser.

The scientist knows that power is the rate of doing work. Almost 200 years ago a man named James Watt wanted to rate a steam engine in terms of power. He observed that the average horse traveled at the rate of 2½ miles per hour (M.P.H.), or 220 feet per minute, and could exert a force of 150 pounds. As work is force times distance, 150 lbs. x 220 ft. = 33,000 ft. lbs., and since this work was done in one minute, it was a time rate of doing work. James Watt called this amount of work "one horsepower." The term has been used since his day.

The advertised horsepower of an automobile is the Maximum or Gross Horsepower, which is obtained from a stripped engine on a test block. This method of rating the horsepower, automobile manufacturers agree, is not a very good overall measurement of the car's ability, but it is the best method that has been devised so far. All manufacturers use the same method.

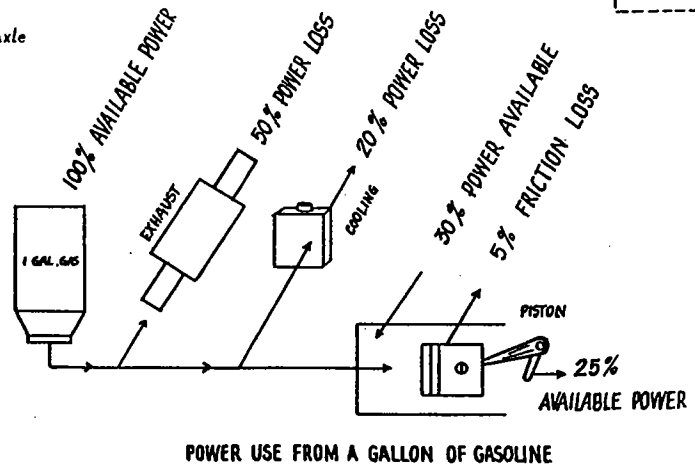
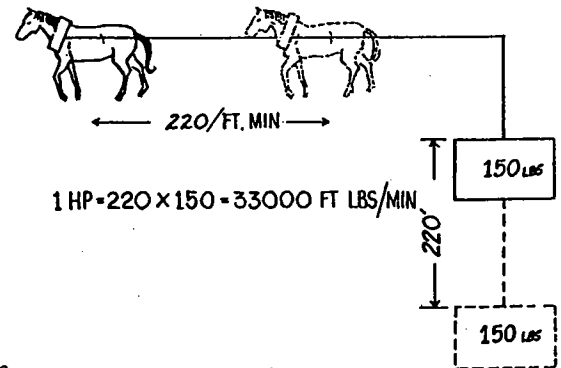
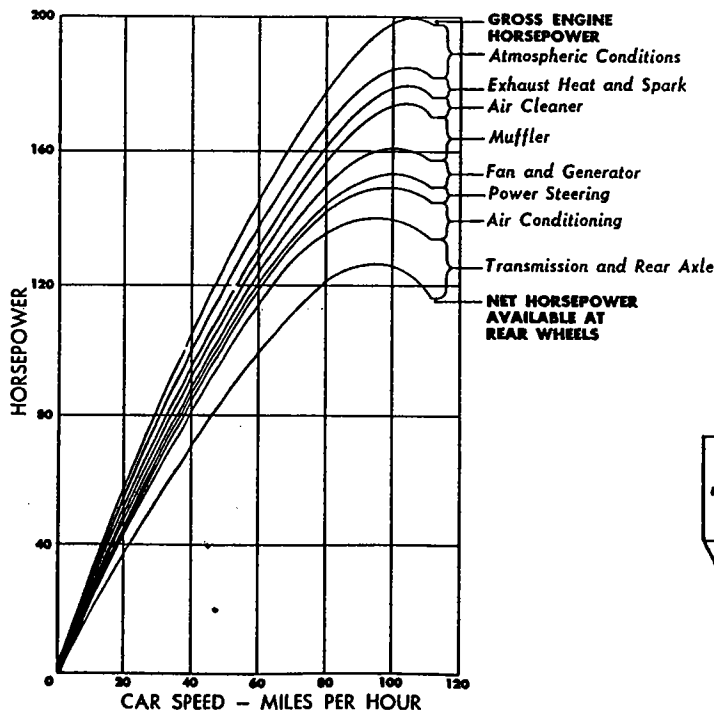
To obtain the Gross Horsepower rating the air filters, fan, generator, and muffler are removed from the engine before it is placed on the test

block. The engine is operated with a manually adjusted spark and without exhaust heat being applied to the intake manifold. The gross horsepower which occurs at a fairly high engine speed, is measured on a machine called a dynamometer, then corrected to a standard atmosphere according to the code of the Society of Automotive Engineers (SAE).

The reason the gross horsepower is used to rate an engine is because different models of cars, all with the same engine, may carry different power-absorbing equipment and accessories so that the power delivered to the rear wheels may not be the same from model to model.

When the engine is installed in a car, the manifold heat, the automatic spark, the generator, fan, muffler, and air filters all reduce the gross horsepower. Accessories such as power steering and air conditioning reduce it still further. Thus in a 200 gross horsepower car, equipped as described, about 135 horsepower actually is delivered to the flywheel. Additional power is lost through the transmission, drive line and rear axle so that the net power delivered to the rear wheels amounts to about 125 horsepower, or about 5/8ths of the rated gross horsepower of the engine.

More power is required to overcome air, tire and road resistance and chassis friction, with the result that the horsepower of the engine when the car is moving at any constant speed on a smooth, level, paved road would be something less than 120. This is further reduced when the car is operating at high altitudes or in conditions of extreme heat and humidity.





What's in the Power Unit?

For a power unit to deliver horsepower to the wheels over a long period of years, the materials used in building the engine must be carefully selected for the work each part will perform. These parts are machine ground and polished to a precision fit, one with the other, so as to give a powerful, smooth-running engine.

The cylinder block, crankcase and cylinder head form the foundation and main stationary body of the automobile engine and serve as support and enclosure for moving parts.

The **CYLINDER BLOCK** contains: (1) the smooth, round cylinders in which the pistons slide up and down; (2) the openings for the valves or push rods, and (3) the passages for the flow of cooling water. The cylinder surfaces are given a precision mirror finish by an accurate grinding and honing process. In nearly all modern day automobile engines the cylinders are cast in a single block, although removable liners of special hardened steel sometimes serve as cylinder walls.

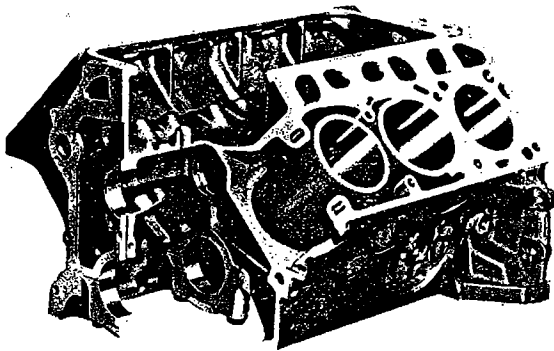
The **CRANKCASE** acts as the base of the engine. It supports the crankshaft and camshaft in suitable bearings and provides arms or brackets for supporting the engine on the frame. Although the cylinder block and the crankcase must be considered as separate parts from a functional standpoint, physically the cylinder block and the upper half of the crankcase usually are cast as a single

unit. The combined cylinder block and crankcase casting usually extends a short distance below the center line of the crankshaft. This casting normally is made of a ferrous alloy or semi-steel to provide a stronger, harder casting which will give greater wear resistance than the gray iron casting commonly used for many years. Although it is more difficult to machine than gray iron, the stronger, tougher material permits thinner casting walls, thus saving weight and improving cooling.

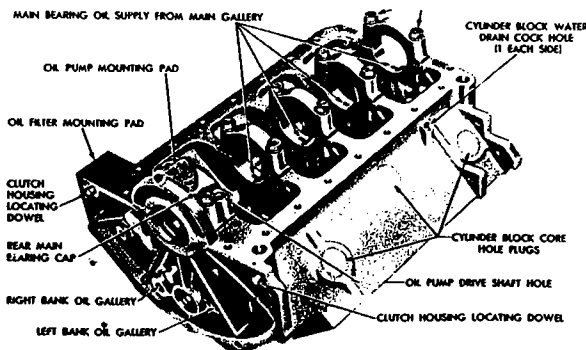
The lower part of the crankcase is called the oil pan. It provides a reservoir for the storage, cooling and ventilation of engine lubricating oil. It also encloses the lower part of the crankcase. The oil pan is bolted or screwed to the lower flange of the main casting and usually is made of pressed steel or aluminum.

The **CYLINDER HEAD** is a separate casting bolted to the top of the cylinder block and contains the combustion chamber. In this cylinder head are mounted the spark plugs and, in most instances today, the valves. To carry the flow of cooling water, the cylinder head contains passages which meet those of the cylinder block. The cylinder head usually is made of gray iron or aluminum alloy. It is cast separately from the block to make possible removal for cleaning carbon and grinding valves. To retain compression in the cylinders, a gasket (constructed of a flat piece of copper asbestos or of steel and asbestos) is placed between the cylinder head and the cylinder block sealing the joint.

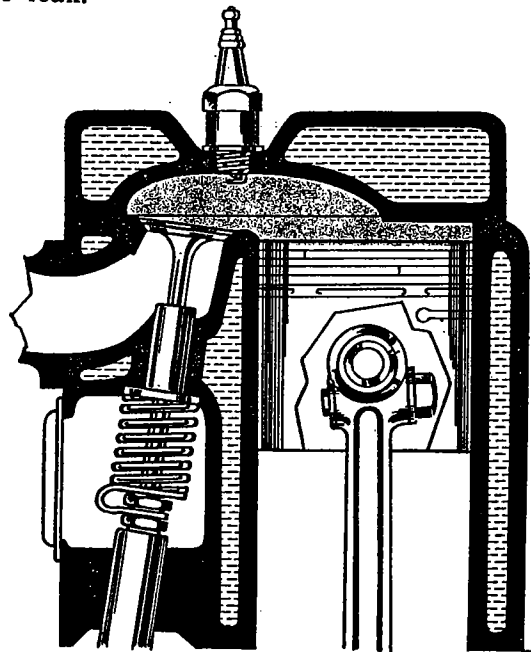
All cylinder heads, whether cast iron or aluminum, should be tightened down with a special tool, called a torque wrench, to the manufacturers' specifications. Uneven tightening causes distortion of the cylinder block, which in turn prevents the valves from seating squarely, eventually warping them and resulting in loss of compression. It is also possible that the cylinder head gasket will blow out or leak.



The cylinder block of a V-type engine cut-away to show construction.



Engine block turned upside down to show crankcase area and main bearings.



Cut-away sketch of an L-head showing the combustion chamber and the cooling area.

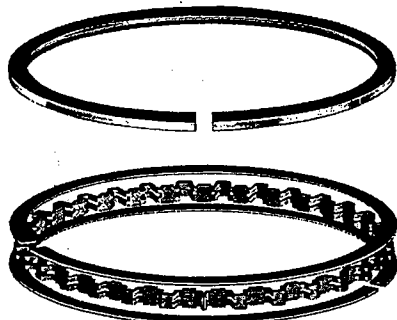


Pistons are slightly smaller in diameter than the bore of the cylinder. The space between the piston and cylinder wall is called the "piston clearance." This clearance is necessary for two reasons: (1) the pistons reach a higher temperature than the cylinder walls, which are cooled by the water surrounding them; and (2) it is necessary to provide space for a film of lubricant between the piston and the cylinder wall. Pistons are made of aluminum alloys, cast steel, cast iron, or chrome nickel. In today's automobiles surfaces of pistons are "anodized," that is, treated with a coating of tin or zinc oxide. Aluminum alloy pistons usually are lighter than other types and are excellent conductors of heat, but they expand more and consequently require some means of compensation for this characteristic, such as vertical slots.

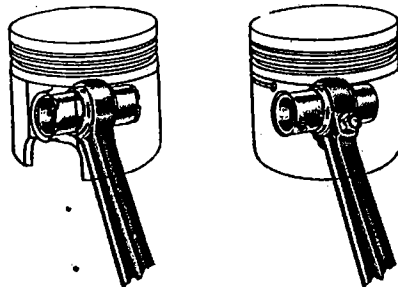
The top of the piston is called the head, and the part below the ring grooves is called the skirt. In some piston designs the cross section of the piston skirt is oval. As the piston expands the oval skirt tends to become round. The portion of the piston that separates the grooves is called the lands.

PISTON RINGS fit into the ring grooves and seal, with the help of oil, the compressed and expanding gases above the piston. At the same time the rings prevent the oil from entering the combustion space and causing carbon deposits on the cylinder head and the top of the piston. A third purpose of the rings is to transmit heat from the pistons to the cylinder walls.

The top two rings are called compression rings, and are designed to maintain cylinder pressure. The bottom one or two rings are called oil-regulating rings. They scoop the excess oil from the cylinder walls and return it through horizontal slots to the piston ring grooves. From there it passes through the oil drain holes inside the piston.



A compression ring (top) and oil control ring (bottom).

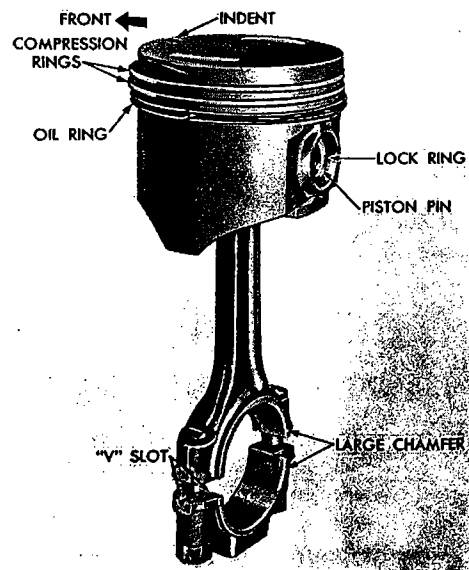


Two methods of securing piston pins: (left) floating piston pin held by retainer; (right) piston pin fastened in connecting rod.

Practically all piston rings are of the concentric type, that is, they are uniform in size around their entire perimeter. Piston rings have joints allowing them to be expanded and slipped over the piston into their grooves, and to compensate for expansion and wear. Rings usually are made of cast iron. Those used today are commonly plated with chromium, cadmium or tin, or given a surface treatment to reduce wear and eliminate scuffing.

The PISTON PIN, or wrist pin, links the piston to the connecting rod. Usually it is hollow and made of case hardened steel. There are three commonly-used methods of making the connection: (1) the pin is fastened to the piston by set screws through reinforced sections, called the piston bosses; (2) the pin is fastened to the connecting rod with a clamp screw; or (3) a floating pin is used. The latter is free in both the connecting rod and the piston, but is prevented from coming in contact with the cylinder wall by two lock rings which fit in grooves in the outer end of the piston bosses.

The CONNECTING ROD is the connection between the piston and the crankshaft. It joins the wrist pin with the crank of the crankshaft. The lighter the connecting rod and the piston, the greater the resulting power and the less the vibration, because the reciprocating weight is less. Connecting rods in American automobiles are made of steel forgings, although aluminum alloys have been used both in this country and in Europe. Rods are matched carefully in sets of uniform weight to maintain engine balance. The rod usually has an I-beam cross section. The lower part of the rod is split to permit clamping around the crankshaft. The split usually incorporates bearings lined with steel-backed copper-lead, or steel-backed cadmium-silver. The lining may be either in the form of a separate split shell, called a bearing insert, or it may be spun on the inside of the rod and cap during the manufacture of the connecting rod. Thin pieces of metal called shims, sometimes are used with spun bearings.



Connecting rod and associated parts.

