

4-H TRACTOR PROGRAM

2

SECOND YEAR



TRACTOR CARE AND SAFETY

Assuring Safe Efficient Operation

THE 4-H TRACTOR CARE AND SAFETY PROGRAM

FIRST YEAR — TRACTOR PROJECT

Units

1. Learning How to Be Safe
2. What Makes an Engine Run
3. Nuts, Bolts, Screws, and Rivets
4. The Instrument Panel
5. Controls for Your Tractor
6. Daily Maintenance and Safety Check
7. Starting and Stopping Your Tractor
8. Clean Air for Your Engine
9. Periodic Lubrication and Maintenance

THIRD YEAR — TRACTOR PROJECT

Units

1. Tractor Safety on the Highway
2. Engine Ignition Systems
3. Hitches, PTO, and Hydraulic Controls
4. Steering, Brakes, and Front Wheels
5. Valves and Valve Service
6. Power Transmissions
7. Winter Care and Trouble Shooting
8. Tractor Records and Ownership Costs

SECOND YEAR — TRACTOR PROJECT

Units

1. Tractor Safety on the Farm
2. Oil for the Engine
3. Mixing Fuel and Air
4. Battery Service and Spark Plugs
5. Cooling Systems for Engines
6. Care of Tires
7. General Lubrication
8. Tractor Records and Operating Costs

FOURTH AND ADVANCED YEARS — MACHINERY PROJECTS

Units

1. Safe Use of Farm Machinery
2. Transmitting Power
3. Tools For Breaking The Soil
4. Applicators For Chemicals
5. Servicing Seed Planters
6. Cutters for Crops
7. Seed Separation
8. Farm Machinery Management

This educational material has been prepared for 4-H Club use by the National 4-H Tractor Program Development Committee, composed of representatives of the State and Federal Extension Services, the National 4-H Service Committee, and the National 4-H Tractor Program Donors. The 4-H Tractor Program is conducted by the Extension Services of the State Agricultural Colleges, with the United States Department of Agriculture cooperating. It is arranged and announced by the National 4-H Service Committee.

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Department of Agriculture Co-operating. Distributed in Futherance
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Director, California Agricultural Extension Service.”**

4-H TRACTOR PROGRAM

SECOND YEAR

TRACTOR CARE AND SAFETY

This is the second in a series of four project books in the 4-H Tractor Program. It is intended for your use after you have completed the First Year Project book. By doing the demonstrations and jobs outlined, you will learn more about tractor care and safety.

The purpose of our 4-H Tractor Program is to give you an opportunity to "learn by doing." You will learn that better tractor care results in longer tractor life, more power, and lower operating costs. Because you learn how to do many small but important tractor maintenance jobs, you will get better production from farm power units and you will cut down on costly breakdowns.

While you are learning how to care for your tractor you should also learn how to be a safe operator. Another important goal of this program is to help you form good safety habits so that you can think and act safely—at all times.

Equally important with learning tractor care and safety is the 4-H goal of helping you to become a sound-thinking citizen. The training you receive in your 4-H program will be very beneficial to you throughout your lifetime.

Take time to read carefully the informative material in each unit. Go through the work sheets slowly and carefully, and complete the demonstrations and jobs outlined. The greater the interest and effort you give to your 4-H project, the greater will be its reward to you.

Ask your leader about Unit 8 on record keeping and operating costs. He may want you to start on this unit right away.

DETAILS ABOUT WHAT YOU DO ARE ON THE FOLLOWING PAGES

Good Luck! _____



Note: In completing your 4-H Tractor Project at the close of the club year it is suggested that you submit only the following pages:

Member's Summary (page 3)

Completed Work Units (the yellow sheets)

Completed Check-Up Sheets (the blue sheets)

My Achievements and
Experiences (in back of book)

This is my 4-H Tractor Book

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4-H TRACTOR CARE AND SAFETY PROJECT SECOND YEAR



WHAT TO DO

Your 4-H Tractor Program has four parts. The First-Year Project lets you get acquainted with your tractor and learn about the importance of tractor safety. The Second and Third Year Projects cover tractor care and safety. The Fourth book covers machinery care and safety. It can be divided into two or more project years according to the machines you have on your farm. Safety is always important. That's why it is included in all four books.

For each year's project there is a booklet like this one. This booklet and your Operator's Manual will give you the answers to most of your questions. The white sheets in each unit give you correct general information and are illustrated with drawings to help you. Read each paragraph carefully. Study your Operator's Manual and put into practice what you learn by actually working with a tractor.

On the yellow work unit sheets, record the jobs that you finish. The more jobs you do, the more you will enjoy this work. There are also some questions for you to answer.

Be sure to answer all of the work unit questions that apply to your tractor. Some of the questions are about diesel and propane tractors. If you find the information in the white sheets, fill in the answers. If you are not working on a propane or diesel engine, and the answer isn't given in the white sheets, you don't need to answer the questions.

Be sure to answer the blue check-up sheets. All you have to do is put the letter for the correct answer at the right of the page. Be on your toes. Read each question carefully before giving your answer.

YOUR RECIPE FOR SUCCESS

Keep your records up to date as you complete each work unit. There are honors and awards for those who do the best work. You will want to do some of the following in addition to filling out the work units:

Give demonstrations and talks on tractor care and safety.

Take part in local and county tractor operators' contests.

Encourage other boys to enroll in the club.

Become a junior leader and help your leader to assist others or younger members.

Practice what you learn on your tractor at home. Remember, you should know the "why" as well as "how."

Submit only the Member's Summary, Work Units, Members' Check-Up Sheets, and story in this book to complete your project and club year. Do not submit the entire book.

Continue your tractor projects by enrolling for next year's work.

HONORS AND AWARDS

The top four winners in the 4-H Tractor Program in your county can receive gold medals. The state winner in your state receives an all-expense trip to the National 4-H Congress in Chicago. You may even win one of the \$500 scholarships that are awarded to national winners. In addition, you can receive honors and awards in tractor operators' contests or for demonstrations you give or exhibits you make.

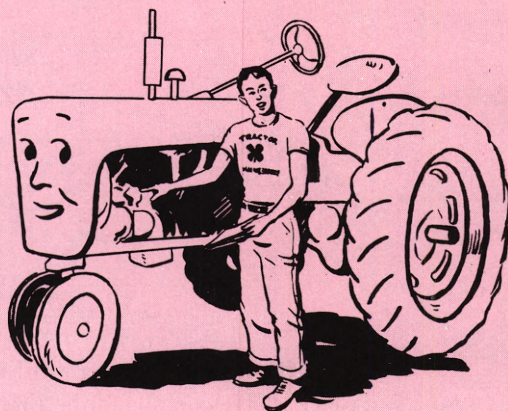


Fig. 1 Learning by demonstrating.

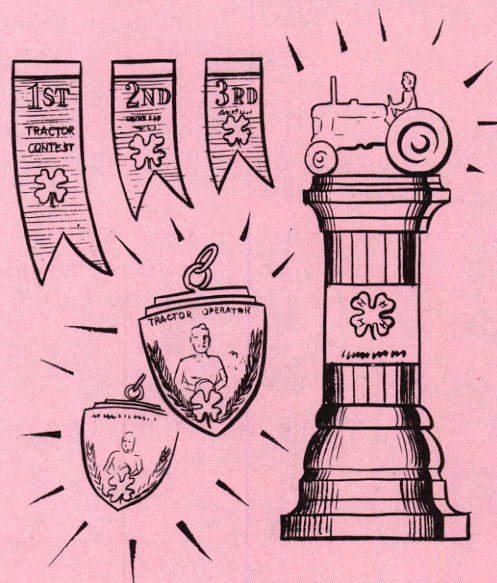


Fig. 2 Awards for 4-H achievements.

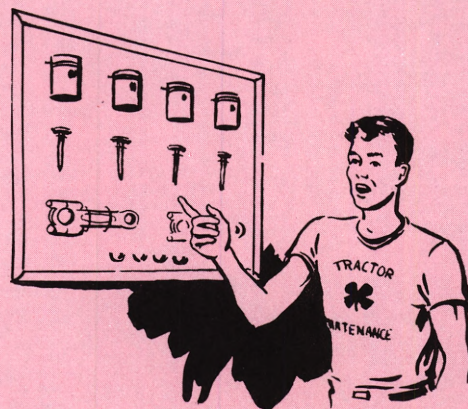


Fig. 3 Display of damaged parts.



MEMBER'S SUMMARY SECOND YEAR



TRACTOR CARE AND SAFETY

Name _____ Age _____ Years in 4-H _____

Address _____ County _____ State _____

Name of Club _____ Name of Leader _____

Date and Place of Meetings	1. Tractor Safety on the Farm.	2. Oil for the Engine and Hydraulic System.	3. Mixing Fuel and Air.	4. Battery Service and Spark Plug Care.	5. Cooling Systems for Engines.	6. Care of Tires.	7. General Lubrication.	8. Tractor Records and Operating Costs.
1. _____								
2. _____								
3. _____								
4. _____								
5. _____								
6. _____								
Date meeting held								
Did you attend?								
Date work unit completed								
Date check-up sheet completed								

DEMONSTRATIONS: Where? When? Topic? _____

TRACTOR OPERATING CONTESTS: Date? Where? Placing? _____

OTHER EVENTS: Exhibits, Tours, etc. _____



SECOND YEAR



4-H TRACTOR CARE AND SAFETY PROJECT

COMPLETED _____
(Date) (Signature of member)

COMMENTS OF CLUB LEADER

Date _____
(Signature)

COMMENTS OF COUNTY EXTENSION AGENT

Date _____
(Signature)

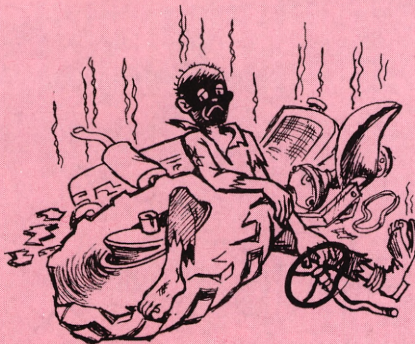


Fig. 1 "I was in a hurry."



Fig. 2 Plan ahead—Avoid accidents.

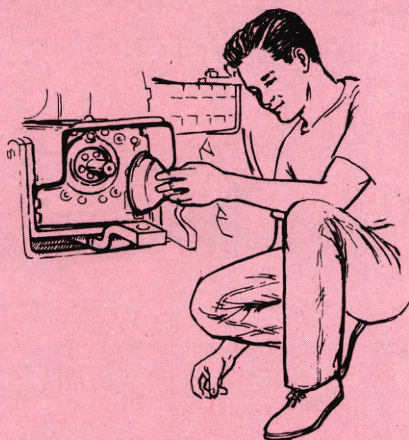


Fig. 3 Safe equipment and a safe operator can reduce accidents.

DEMONSTRATION!

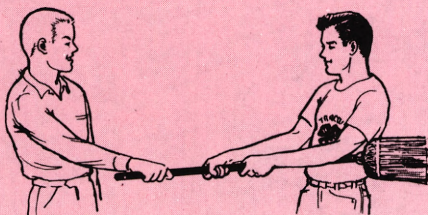


Fig. 4 You can't let go!

The tractor is involved in more fatal and non-fatal accidents than any other farm machine. In fact, an Ohio study tells us that 4 out of every 10 operators will have a serious accident with a tractor during the time they are actively engaged in farming. As a member of the 4-H Tractor Program you should do your part to help reduce tractor accidents.

PLAN AHEAD—AVOID ACCIDENTS

"I was in a hurry." "I just got careless." "I thought I could get out of the way in time." How many times have you heard these excuses from persons who have had an accident? We all know that carelessness and being in a hurry can cause accidents. But why do we hurry or get careless? The answer is simply that we are trying to do more in a given amount of time than can be done safely. Or we continue to work after we get tired. When we get behind with our work, we take too many chances, and that results in accidents.

You have the ability to think. That's something a machine doesn't have. That's also why it is better for you to plan your work so that you don't need to hurry or take chances. By thinking ahead you can learn to eliminate hazards before they cause an accident.

You can be a safe tractor operator by forming two important safety habits: (1) Be sure the equipment you operate is safe, and (2) Be sure you have the proper attitude—one that lets you think ahead so you can avoid getting into an accident situation.

REACTION TIME

Do you know how long it takes to make a simple reaction, such as putting your foot on both brakes to make a sudden stop? Or turning off the ignition? The minimum time needed to make these reactions is one-half of a second. It may take two or three times that long if you panic or make the wrong move first. A lot can happen in the fraction of a second it takes for you to make a simple move. The tractor could upset on you or you could be caught in the PTO shaft.

Your natural reaction in an accident situation is either to freeze and do nothing at all, or to make the wrong move. Here's an easy way to demonstrate this fact: You hold one end of a broomhandle and ask another 4-H'er to grip the other end tightly with one hand and pull. Tell him to let go when he feels you jerk on the broom. After a second or two give a quick jerk on the broom. Chances are, your friend only tightened his hold and could not let go. Your natural reaction is to tighten your grip and hold on. This is why people get caught when they try to unclog a machine while it is running. The machine suddenly unclogs itself and the operator can't let go, so his hand goes into the machine.

The simplest and easiest way to avoid accidents is to think ahead and avoid accident situations. When you are having trouble with a tractor or machine, always shut off the motor before leaving the seat to work on it.

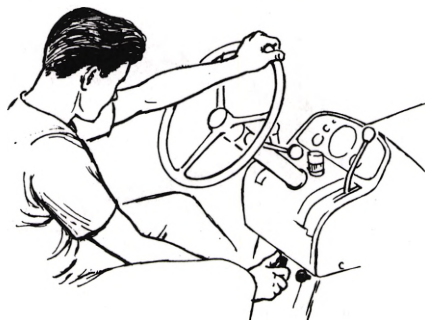


Fig. 5 Always shut off the tractor before leaving the seat.



START WITH SAFE EQUIPMENT

Every time you get ready to start your tractor, make sure it is mechanically safe to operate. That goes for all other machines too.

With a little practice, you can give your tractor a complete daily maintenance and safety check in less than five minutes. Use a method that lets you start at one place on the tractor, and move completely around it so that you don't miss anything. Include the seat, steering, brakes, clutch, platform, wheels, tires, hitch, and PTO in your check. You can add several other items to the list for your tractor.

SEAT

Seats on modern tractors have several adjustments. Adjust the seat to your size and weight. You need to be able to reach and operate all controls from a comfortable sitting position. Check all of the bolts and screws. If any are loose or missing, make repairs immediately.

BRAKES

Good brakes are important too. Keep them evenly adjusted whether they are the kind that can be locked together, or are both operated with one foot. Newer tractors having power or hydraulic brakes need special care. Check your Owner's Manual. If you usually turn in one direction more often than the other, brakes will not wear evenly. For this reason they must be checked frequently. Form the habit of stopping your tractor by slowing down the engine. Don't jam on the brakes to make a stop unless it is necessary to avoid an accident.

HITCHES

Any time you pull a load with your tractor, the load is trying to pull the tractor over backwards. The tractor tries to pivot around the point where the rear wheels touch the ground. You may have noticed how the front end of your tractor seems to be lighter when you are hitched to a very heavy load. The hitch on your tractor is designed to let you pull very heavy loads without fear that the tractor will upset backwards, provided you use the hitch properly. So always hitch to the drawbar, and keep the hitch low. When the point of hitch on the tractor is raised, the chance for a backward upset is greatly increased.

Always use a safety-hitch pin for fastening a pulled implement to the drawbar of a tractor. This pin will not bounce out and cause the implement to get loose and possibly cause an accident.

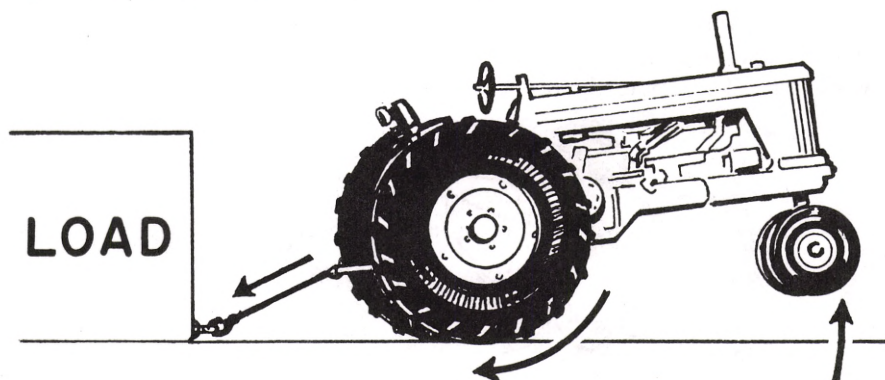


Fig. 10 The load tries to raise the front end of the tractor.

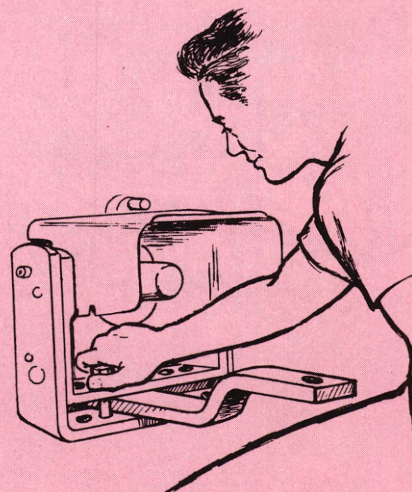


Fig. 6 Start each day with a safety check of your tractor.

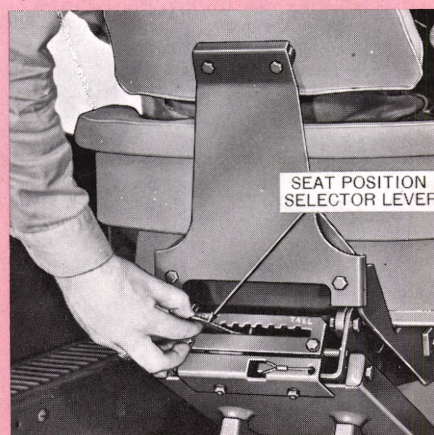


Fig. 7 Adjust the seat to your height and weight.

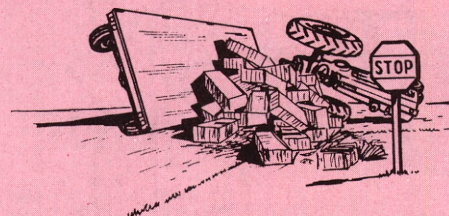


Fig. 8 Tractors can pull several times more weight than they can safely stop in an emergency. Slow down before applying brakes.

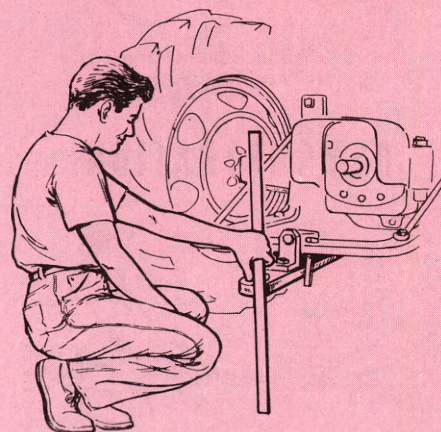


Fig. 9 Is your hitch the proper height?

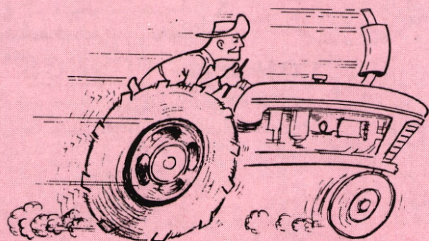


Fig. 11 Speed is the number one cause of tractor accidents.

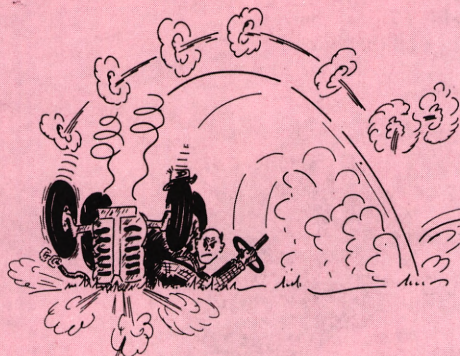


Fig. 12 Tractors upset quicker in a turn.

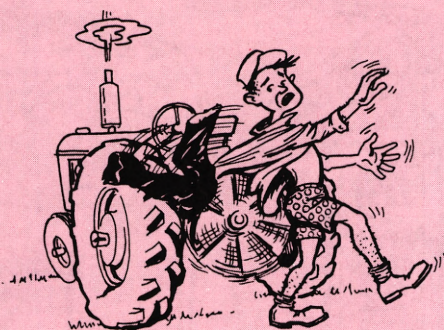


Fig. 13 Caught by an unguarded PTO shaft.

TRACTOR TIPPING

A tractor has the power to rotate around the rear axles should the rear wheels be held fast. In this situation, if the tractor is in a forward gear, the front end will come up, resulting in a backward upset. Such might be the case if you got stuck in a ditch and fastened a plank or something else to the wheels to get traction. Always back out, if you get stuck. Or get someone to pull you out with another tractor.

A tractor can tip over sideways at a speed of 8 miles an hour if the wheels drop into a hole or hit an obstruction. (Eight miles an hour is about twice as fast as you can walk.) It will tip at a much slower speed if you are turning. Slow down and be very careful to avoid obstructions or holes. The chances of upsetting are four times greater when speed is doubled.

If you have hilly or sloping fields, be especially careful to avoid conditions that may lead to an upset. The chance of a tractor upsetting backward increases if the front end is higher than the back end. This means that you should be very careful when driving or pulling a load up a hill. Let the clutch out very slowly when starting up a slope. Adjust the rear wheels to a wide position when working along the slope, to help protect from a sideways upset.

POWER-TAKE-OFF

Taking power from the power-take-off (PTO) shaft on the tractor is an easy way to drive some machines, such as combines, mowers, or forage choppers. The standard speed for a PTO shaft is either 540 or 1,000 revolutions per minute. An unguarded shaft is dangerous at any speed when it is turning. It can quickly grab your clothes should you touch it. Once caught, you are helpless against the power of your tractor, no matter how big you are. Never operate a machine unless the PTO is covered with a standard shield. One type of shield covers the top and sides of the shaft. Another type is a loose shield that is fastened to the PTO with anti-friction bearings. It will rotate slowly when the PTO is in use but will stop when it is touched. *Caution*—You can't always tell whether a PTO shaft is guarded by a loose shield while it is running. To be safe, treat it as an unguarded shaft and stay away from it. The PTO stub should be protected when the PTO is not in use. This can be done with a stub shield that completely covers the shaft. If you don't have one for your tractor, it is not too difficult to make one. A master shield covers the top of the stub shaft and is standard equipment to allow all tractors to be connected to any power-driven equipment. It should always be in place.

Some of the newer tractors also have a front PTO shaft under the tractor. It should be given the same protection with shields as a rear PTO.

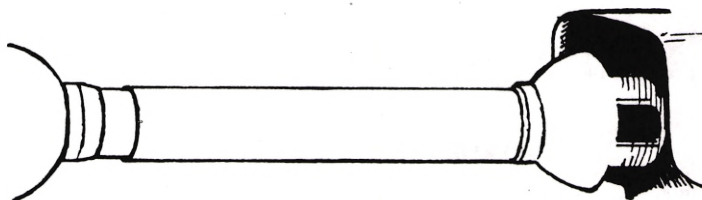


Fig. 14 A PTO guard that turns slowly with the shaft. You can't always tell if a shaft is covered. To be safe, stay away from all moving shafts.



TRACTOR SAFETY ON THE FARM

SAFE HANDLING AND STORING OF FUELS

If not handled and stored properly, petroleum products can cause fires and explosions. The explosive force of 1 gallon of gasoline, vaporized and mixed with air, is equal to 87 pounds of dynamite.

Liquid fuel cannot burn. It must be vaporized and mixed with air. You can demonstrate this with a candle. Light the candle and watch it burn for a few seconds. Notice how the paraffin first melts from a solid to a liquid and then is vaporized by the heat from the flame. When the candle is snuffed, the vapors that continue for a few seconds can be re-lighted some distance from the wick.

An underground tank provides the safest storage for petroleum fuels, other than liquified petroleum gas (LPG). Where underground storage is not feasible, safe fuel storage may be provided by a good aboveground tank. Locate it as far as practical from buildings. (Forty feet is considered a minimum.) You can get specific suggestions for safe fuel storage from your fuel supplier. A shutoff valve between the hose and the tank is a must. It should be the kind that will stop flow of fuel in case of fire. Keep the area around the storage tanks clean of weeds and trash.

If flammable liquids must be used indoors, always keep them in a safety can with a spring-closed cover to prevent the escape of vapors.

Do not use gasoline for cleaning purposes. Gasoline gives off flammable vapors at temperatures down to 45 degrees below zero. Use a solvent for cleaning. It is much safer and will clean as well as, or better than gasoline. Never refuel a tractor while it is running or even while the engine is hot. Fuel vapors are heavier than air and may collect around the engine where they may be easily ignited by a hot manifold or a spark. If you spill fuel while refueling, wait a few minutes before starting the engine. Keep the tractor clean and watch for fuel leaks. Examine all fuel connections, the sediment bulb, and the carburetor. Fix all leaks immediately.

FIRE EXTINGUISHERS

Do you have a fire extinguisher on your tractor? Do you also have one in the shed where the tractor is stored? You need to have fire extinguishers in these areas and know how to use them if you have to, when a fire starts. Use only extinguishers that carry a stamp of approval by a recognized testing laboratory. They should be approved for use on petroleum fires.

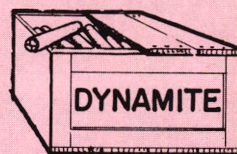
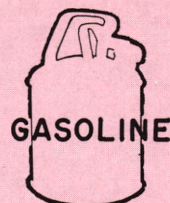
Carbon dioxide (CO_2) and dry chemical extinguishers are two examples of approved extinguishers. Carbon tetrachloride extinguishers are no longer recommended for any kind of fire, because they produce a gas that is poison when breathed.

SAFETY AND YOUR RADIATOR

If the radiator has a pressure cooling system, let it cool for awhile before removing the radiator cap. The water in a pressure cooling system quickly turns to steam when the pressure is suddenly released. Always remove the cap slowly and place a cloth over it first as added precaution against being burned by the steam.

EXHAUST GASES CAN KILL

Exhaust gases contain carbon monoxide (CO), which is a deadly poison. You can't smell it or see it so you have no way of knowing when a deadly amount is present. If you must run an engine inside, keep the doors open.



1 GALLON = 87 POUNDS

Fig. 15 1 gallon of gasoline has the same explosive force as 87 pounds of dynamite.

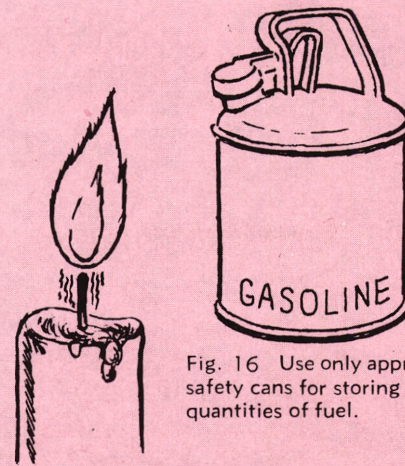


Fig. 16 Use only approved safety cans for storing small quantities of fuel.

Fig. 17 It is the vapor of fuel that burns.

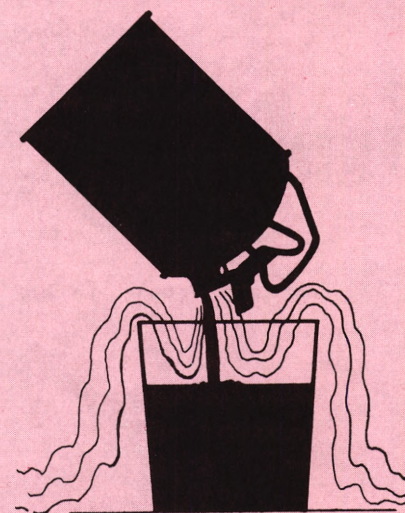


Fig. 18 Fuel vapors are heavier than air.

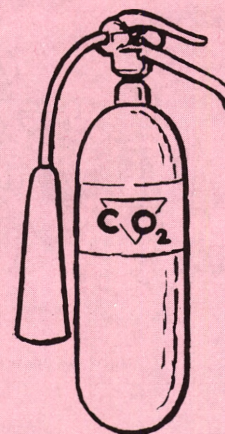


Fig. 19 Two examples of extinguishers that are approved for use on petroleum fires.



Think Safety--Act Safety

LET'S DISCUSS SOME ACCIDENT SITUATIONS

To help you learn how to avoid accident situations, let's start with a discussion of some accidents that have actually happened. Read the stories of the accidents. Discuss them with other members and your leader. Then use the blanks to tell how the accident could have been prevented. Be on your toes; the answer may not be as simple as you think.

Situation 1— Farmer A was pulling a large drag harrow in a field crossed by a small ditch. Due to constant plugging of trash under the harrow, Farmer A took the stay bars off the hydraulic hitch of the tractor and raised the hitch as high as it would go. This stopped the plugging, but the harrow caught on an old stump as he crossed the ditch. The tractor tipped over backward. Gasoline spilled from the tank and started a fire. Farmer A was pinned under the tractor and suffered a broken leg and severe burns before being rescued by a neighbor. The tractor was a total loss.

How could this accident have been prevented? _____

Situation 2— A new tractor had just been delivered by the local dealer to Farmer B, whose son was 10 years old. A few days after the tractor was delivered, the boy was showing off the new tractor to his 9-year-old friend. He had watched his father start the tractor, so he decided to start it too. It started right away, but the PTO was engaged. The 9-year-old became curious and grabbed the turning PTO stub with his gloved hand. The stub was not shielded. The glove was quickly caught in the PTO, twisting off the boy's arm at the shoulder.

How could this accident have been prevented? _____

Situation 3— Farmer C tried to start a tractor but found the starter locked. In order to loosen the locked starter, he put the tractor in gear and hooked on with a second tractor to give it a little pull. In his haste, he had forgotten to shut off the switch. The first tractor started and crawled up the rear tires of the second tractor. Farmer C was knocked off the seat and suffered severe bruises.

How could this accident have been prevented? _____

Situation 4— A 7-year-old boy was sent by his mother to take a jug of water to his father's baling crew in a nearby field. On the way back to the house he got tired and lay down in a windrow to take a rest. He went to sleep and didn't hear the baler coming. No one in the baler crew saw him and he was run through the baler and instantly killed.

How could this accident have been prevented? _____

LET'S GO TO WORK

The best way to prevent an accident is to eliminate hazards that might cause an accident. Ask Dad to give you a hand. Use this work sheet to list hazards you can find on your farm and tell what you did to eliminate them.

1. *Roadways, farmstead, and lanes.* Look for obstructions and holes that might cause an upset.

Hazards found	How they were eliminated
1. _____	_____
2. _____	_____
3. _____	_____
4. _____	_____

2. *Tractor.* Give your tractor a complete safety inspection. Look for low tires, fuel leaks, loose seat, missing shields, etc.

Hazards found	How they were eliminated
1. _____	_____
2. _____	_____
3. _____	_____
4. _____	_____

3. *Fuel storage.* Check location of tanks from nearest building. Check for shutoff valves, safety cans, relief valves for LPG tanks, etc.

Hazards found	How they were eliminated
1. _____	_____
2. _____	_____
3. _____	_____
4. _____	_____

4. *Shop area and storage shed.* Are flammable petroleum products stored where they might cause a fire? Are there fire extinguishers? Are the tools where they belong? There may be other hazards.

Hazards found	How they were eliminated
1. _____	_____
2. _____	_____
3. _____	_____
4. _____	_____

Note: Fill out this work unit, using your own tractor at home. Be ready to discuss your experiences with the other 4-H members at your next club meeting.

MEMBERS'



CHECK-UP SHEET

SECOND YEAR UNIT 1

TRACTOR SAFETY ON THE FARM

Place the letter for the correct answer at the right of the page.

1. PTO shields (A-can) (B-cannot) be used when the tractor is a different make than the attached equipment. _____
2. When pulling a heavy load up a slope, keep the hitch (A-as low as possible) (B-as high as possible). _____
3. Vapor from fuel is (A-lighter) (B-heavier) than air. _____
4. It is better to (A-back out) (B-drive out) of a ditch when the rear wheels start to spin. _____
5. Raising the hitch on the tractor (A-decreases) (B-increases) traction and (A-increases) (B-decreases) the possibility of tipping backward when hitched to a heavy load. _____
6. A tractor is about (A-5) (B-500) (C-5,000) times more powerful than you are. _____
7. It is the (A-carbon monoxide) (B-carbon dioxide) in exhaust gases that can kill you. _____
8. Raising the hitch on the tractor (A-decreases) (B-increases) the chance for a backward upset. _____
9. When speed is doubled the chance for an upset is (A-doubled) (B-quadrupled) (C-the same). _____
10. List three rules that you believe should be followed by every tractor operator.
 1. _____
 2. _____
 3. _____

Note: This Check-Up Sheet is intended to test what you have learned and to stimulate discussion with the other members. The more you discuss these questions with your leader and the other members the more you learn.

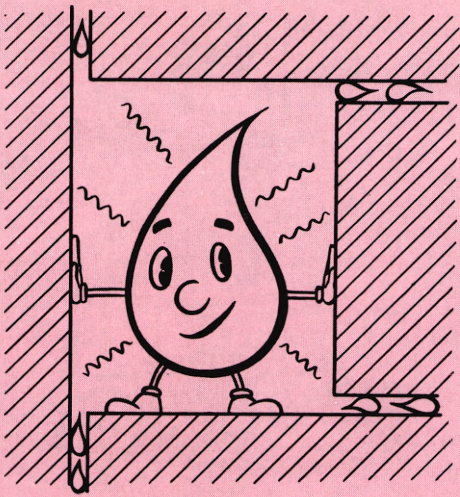


Fig. 1 Oil has many jobs.

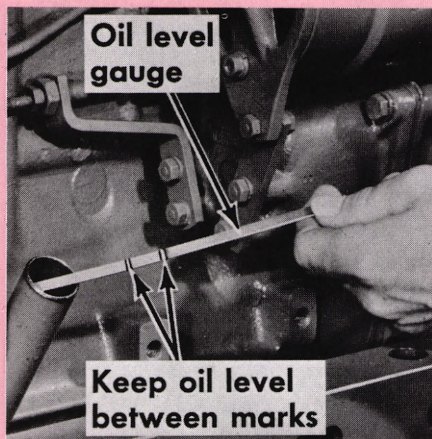


Fig. 2 Check the crankcase oil level every time you use the tractor.

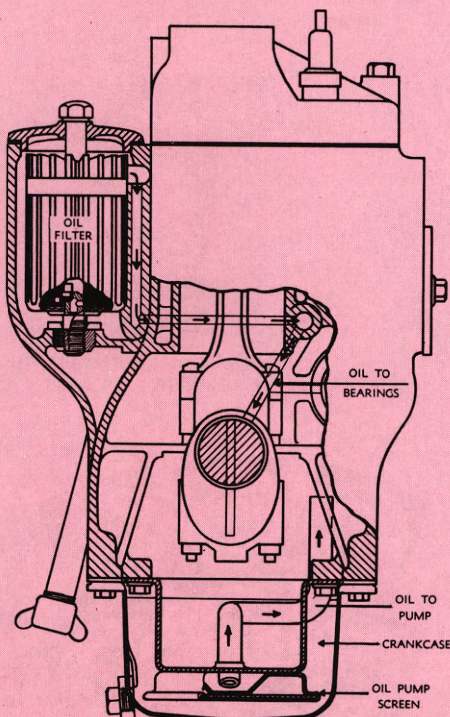


Fig. 3 Tractor engine showing oil flow and oil filter.

Oil in an engine must do several jobs. It must clean, reduce friction, reduce wear, absorb shocks, cushion loads, and help seal the pistons. It must also help cool some parts of the engine, while it distributes heat to others.

Because oil has so many jobs to do, you can readily see why you must check the oil level frequently in order to keep the right amount of oil in the crankcase. If you let the oil get low you make a small amount do all the work. The right amount of oil must always be in the crankcase to carry away the heat of the engine.

HYDRAULIC OILS

When used in a hydraulic system, oil has the added job of transmitting power. It is not subject to as much heat then as when used in an engine. Therefore, such oil is normally used for a longer period of time before it becomes contaminated and needs to be drained. You should always follow the tractor manufacturer's instructions for time to change oil in the hydraulic system.

HOW TO SELECT AN OIL

A good motor oil will help give longer engine life. To obtain a high quality oil, follow the advice given in your Operator's Manual. Purchase it from a reliable company.

Appearance tells you very little about an oil. It can be green, yellow, or purple. After it has been in an engine a short time, it can turn dirty gray or black quickly and still do a good job. In fact, most modern motor oil contains added substances called detergents (additives) which act much like soap in water. The additives keep the fine fuel soot, moisture, varnish, etc. suspended in the oil. Thus the engine is kept clean. Then, when the oil is drained, the suspended materials drain out with the oil. You can see, therefore, why oils with additives in them may change color quickly. Just as a cleaning solution becomes discolored when you clean something dirty, so do oils with additives become discolored as they clean an engine. The condition of your engine and how you operate it will determine how quickly the oil will become discolored. There are other additives which improve motor oils in other ways.

HOW AND WHEN TO CHANGE OIL

In use, the additives in motor oil become depleted as the oil becomes contaminated with moisture, fuel soot, dilution, acids, dirt and many other undesirable materials. To keep oil as free of contaminants as possible, and to make sure it has the necessary additives, the oil should be changed at regular recommended intervals.

On most tractors, a filter is used to remove the larger dirt particles. Service the filter as recommended. Your instruction book will tell you how often the oil should be changed and the filter serviced. It will also tell you what weight of oil to use for different operating temperatures.

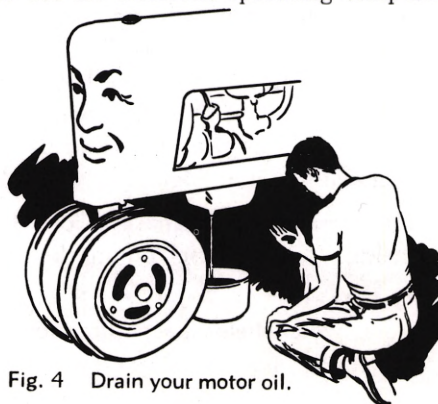


Fig. 4 Drain your motor oil.

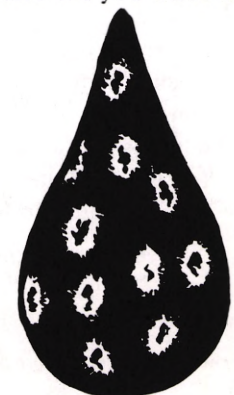


Fig. 5 Oil holds dirt.



OIL FOR THE ENGINE AND HYDRAULIC SYSTEM

SAE OIL GRADES

After motor oils are made, they are given many tests—for fire, flash, gravity, pour, color, viscosity, and other qualities. Such tests do not tell the buyer much, but they do tell the manufacturer whether he is making a uniform product.

Of the above-named tests, viscosity is the most important to the user. Viscosity tells how well the oil flows at different temperatures. The Society of Automotive Engineers (SAE) has set specifications for the different grades of motor oils, based on viscosity. The motor oil grades are SAE 5W, 10W, 20W, 20, 30, 40, and 50. The W means that the viscosity of the oil must meet the SAE specifications at 0° F. The viscosity for the grades 20 to 50 is taken at 210° F.

Oils that contain additives to provide good low-temperature properties and prevent too rapid thinning when heated are classed as multi-graded oils. Such oils are listed as 5W-20, 10W-30, or 20W-40. These oils are well suited to start-and-stop operation and one grade may be used year around where extreme temperatures are not encountered.

The SAE grade of oil you should use in your engine depends on crankcase temperature and engine design. Check your Operator's Manual for the grade to use in your tractor.

API OIL CLASSIFICATION

Engine tests reveal how well a motor oil will protect an engine. In fact, because of what oil companies have learned from many thousands of engine tests, motor oils are now made to protect the engine fully under severe conditions, more additives are often used.

Engine design, kind of fuel, and how the engine is used determine its oil requirements. No longer are motor oils classified as regular, premium, and heavy duty, because such descriptions do not help anyone pick the right oil. Today's classifications make it easy to select the right oil to meet requirements of an engine or of a particular job. The API (American Petroleum Institute) has set up a method for classifying oil. There are three service classes of oil for spark ignition engines and three classes for diesel engines.

The three classes for spark ignition engines are: ML - light service; MM - medium service; and MS - severe service.

The classes for diesel engines are: DG - diesel general service, DM - diesel severe service, and DS - diesel extremely severe service.

All oil containers are marked so that you may learn at a glance the type of service for which the oil is to be used. You will find on a can or container such markings as ML, MM, or MS. Some containers may show all three markings. When a container is marked only MS, the letters indicate that the oil is suitable for lighter service as well. Some containers may be marked MS-DG, indicating that the oil can be used for all spark ignition engine services and also for general service in diesel engines.

The sulfur content of diesel fuel plays an important part in diesel engine lubrication. If high sulfur fuel is being used, a diesel oil marked DM or DS may be required.

Such oils have a high additive content, which helps keep the engine clean.

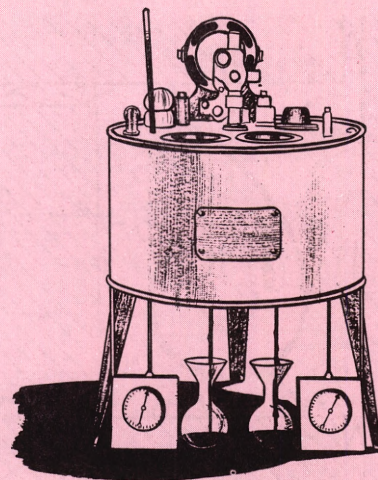


Fig. 6 A viscosity tester.

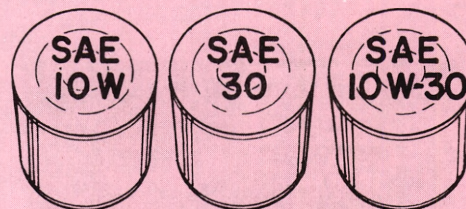


Fig. 7 Use the correct SAE grade of oil for the season as recommended in your Operator's Manual.

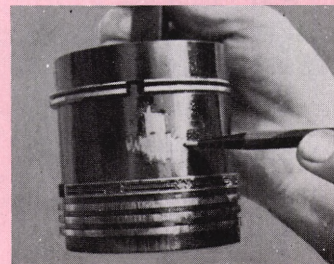


Fig. 8 Test piston shows varnish - non-additive motor oil.

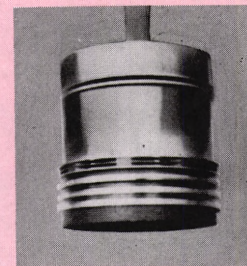


Fig. 9 Clean test piston - additive motor oil.

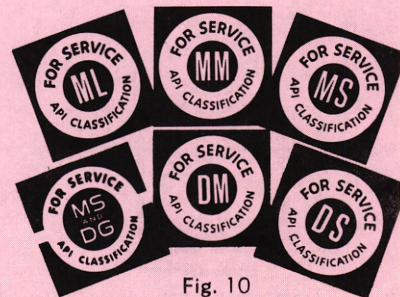


Fig. 10
API classifications.



Fig. 11 Read your Operator's Manual.

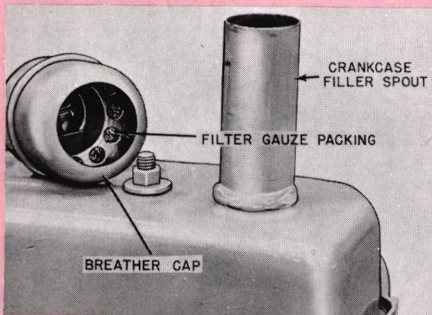


Fig. 12 Don't forget to clean the crankcase breather.

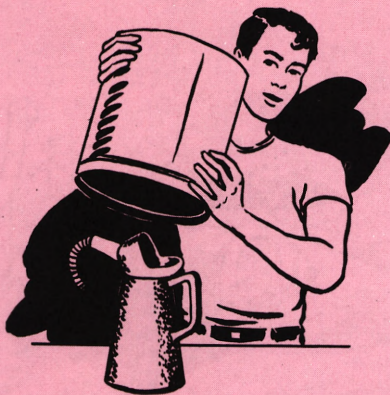


Fig. 13 Keeping oil can clean.

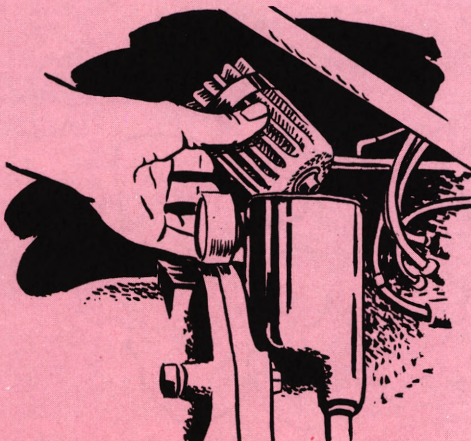


Fig. 14 Replacing oil filter element.

The idea of using markings on oil cans is, of course, to help you pick the right oil for your engine. Refer to your Operator's Manual to see what class of oil the manufacturer of the engine recommends. Then, when you purchase an oil, ask for one which meets the service classification.

STORE OILS WITH CARE

Use care in storing and handling oil and greases. Cover containers tightly to keep out water and dirt. Store oil drums inside a building and place them on their sides. Don't leave drums standing on end or in the open. Water from rain or snow collecting on the top of the barrels may seep inside. If a drum is not under cover, lay it down or tilt it so that water will not accumulate around the bungs.

Always clean the dirt from around the filler pipe of the engine before putting in new oil.

Be sure to use a clean container. If there is sand or dirt in the measuring can, it will be washed into the engine with the oil. A simple way to keep the oil can clean is to place it in a covered box, or set it on a bench and turn a pail over it. If you are using canned oil, wipe off the lid before you open the can. Use a clean pouring spout. Keep it protected from dirt when you store it.

HOW TO DRAIN THE CRANKCASE AND SERVICE THE OIL FILTER

While in use, motor oil becomes dirty, picking up products of combustion, soot, fuel, water, organic acids, and other products of oil oxidation. Oil filters help remove some of these undesirables. Sometimes filters fail to give good service because operators do not change the element as recommended. There seems to be a feeling of false security among many operators that an engine with an oil filter has magic protection and can go without oil changes. That isn't so.

Service the oil filter as recommended. If a new element is needed, put one in. If there is a drain in the filter base, drain the base before removing the element. After servicing the oil filter, you should run the engine and check it for oil leaks. Always drain the oil when the engine is hot, for then the oil will be stirred up and any dirt present will be drained out.

On some engines, only a small part of the oil in the engine is filtered. We call this a by-pass oil filter. It is usually a can of filtering material. The can is replaced when it fills up. A simple way to check this filter to find out if oil is still flowing through it is to feel the can. Note if it appears to be as warm as the crankcase.

Don't forget the crankcase breather. It should be serviced every time you change the crankcase oil.

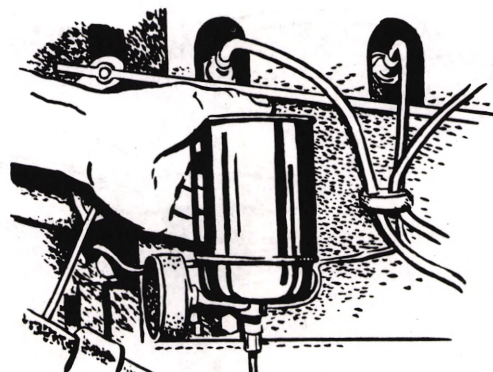


Fig. 15 Feel your oil filter to check oil flow.



OIL FOR THE ENGINE AND HYDRAULIC SYSTEM

CAUSE OF DEPOSITS IN CRANKCASE

One of the reasons the crankcase on some engines becomes dirty is that the engine is often allowed to stand for weeks or months with dirty, used oil in it. The dirt settles out and packs into the bottom of the pan. If the top cock on the oil pan is opened after the engine has been standing idle for some time, only clean oil will run out. This is a poor test, as most of the dirt and water will remain on the bottom of the pan. If the bottom plug is removed, you probably will see dirt and water run out.

When deposits collect in the bottom of the pan of an engine, they harden and some begin to break loose. Then the loose deposits are often drawn into the oil inlet screen, shutting off the oil flow and causing bearings to burn out.

On many engines a removable oil pump intake screen is used. This should be cleaned regularly. When an engine is particularly dirty, it should be flushed with a flushing oil. However, flushing is not necessary if oil is changed properly and regularly.

The newly developed oils which clean the engine also help to keep the crankcase clean.

WATER SLUDGING IN COLD WEATHER

Every time a gallon of fuel is burned, a gallon of water is formed. The water normally passes from the exhaust as vapor; but when the engine is cold the exhaust gases coming into contact with cold metal of the engine condense, and then water finds its way into the crankcase.

Tractor engines and other power units have a greater exposed metal surface inside the crankcase than automobile engines. Therefore, they collect more water and care must be taken to keep them warm so that the water will be driven out.

A common winter operation problem is that of water sludging. To guard against it, always cover the radiator to warm up the engine rapidly. Never shut an engine off until it has run for 10 minutes or more. It takes at least 10 minutes to dry out the engine after starting.

A motor oil intended for service MS may be more resistant to water sludging. But even this kind of oil must be drained regularly to avoid trouble. During winter operation, draining should be more frequent, and the filters should be serviced more often.

Water in the motor oil may cause the oil to look "milky." Applying heat to the oil will drive the water out and cause the color to return to normal.

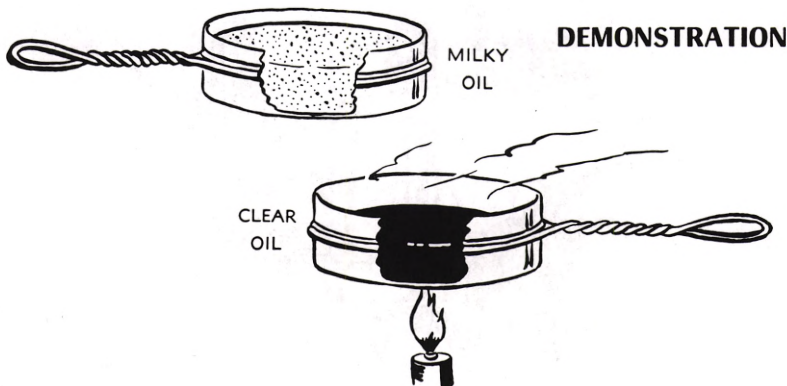


Fig. 20 Heating milky oil drives off water and makes the oil clear

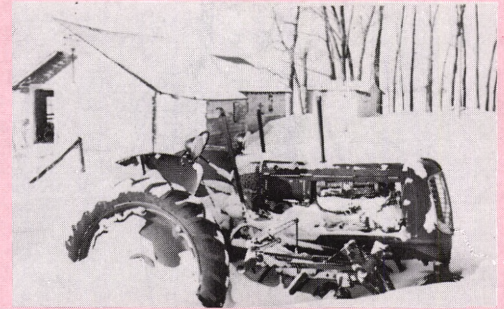


Fig. 16 After your tractor has been standing idle — look for water and dirt settling in crankcase.

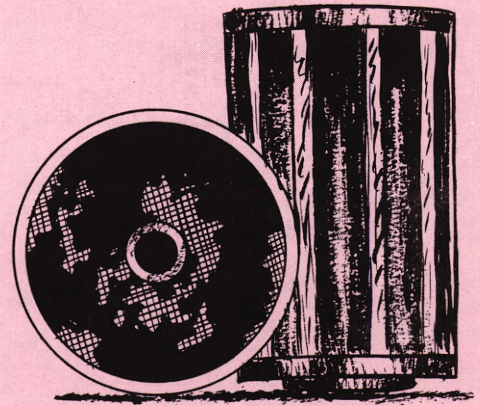


Fig. 17 Plugged filter and screen.

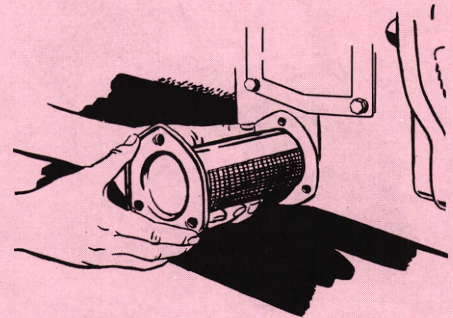


Fig. 18 Removing oil pump intake screen for cleaning.

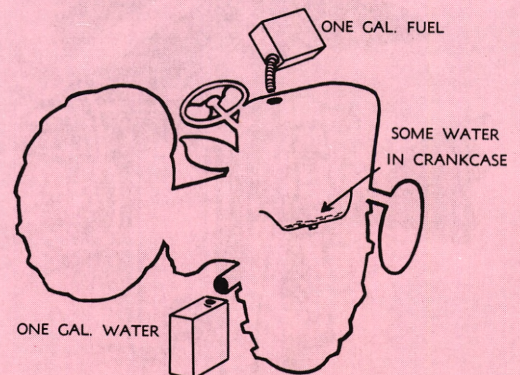


Fig. 19 For every gallon of fuel, one gallon of water is formed.



HOW THE OIL CIRCULATES

All engines use an oil pump to circulate the oil. The pump is usually a small set of gears which puts the oil under pressure. It picks the oil up from the bottom of the oil pan. A screen on the suction side of the pump takes out large particles that might otherwise damage it. Much more oil is pumped than needed and the surplus flows through a by-pass valve or pressure regulating valve, back to the crankcase. Thus, by letting the oil flow back to the crankcase at a given pressure, maximum pressure is regulated. On some systems the oil pressure can be regulated with an adjustment.

An oil gauge indicates whether the pump is putting the oil under pressure in the line. In fact, some of the lines could be plugged and you would not know the difference by looking at the gauge. It would merely show pressure. The excess oil that couldn't get through the line would flow back to the crankcase through the by-pass valve.

Some engines have small pipes and holes in the crankshaft which lead to all the bearings. Such an arrangement is called a full force feed system. With this system, if the bearings become loosened, the oil pressure may drop. Lowered pressure is most likely to be noticed if the engine is operated at slow speed. Loose bearings will let more oil escape; then the oil will be thrown up on the pistons. Such a condition is a common cause of high oil consumption. Another oiling system popular on older tractor engines is the circulating splash system. Here oil is pumped to a dip trough or squirted through holes in an oil line to the rod bearings. With this system, loose bearings will not cause a low oil pressure. The same amount of oil is thrown from the connecting rods to the pistons, regardless of the condition of the bearings.

If you know the type of lubricating system in your engine you will better understand your troubles when you have low pressure or high oil consumption.

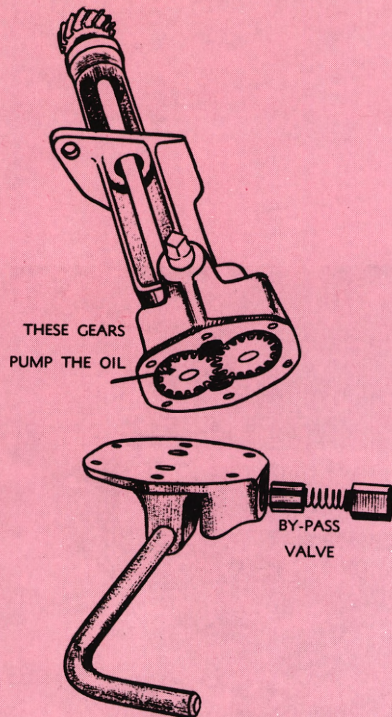


Fig. 21 A gear pump.



Fig. 22 An oil gauge.

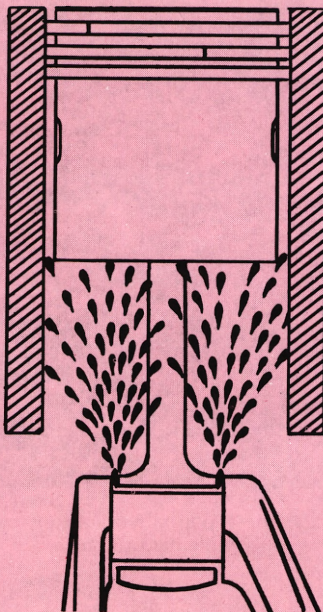


Fig. 23 Oil leaks out of a loose bearing.

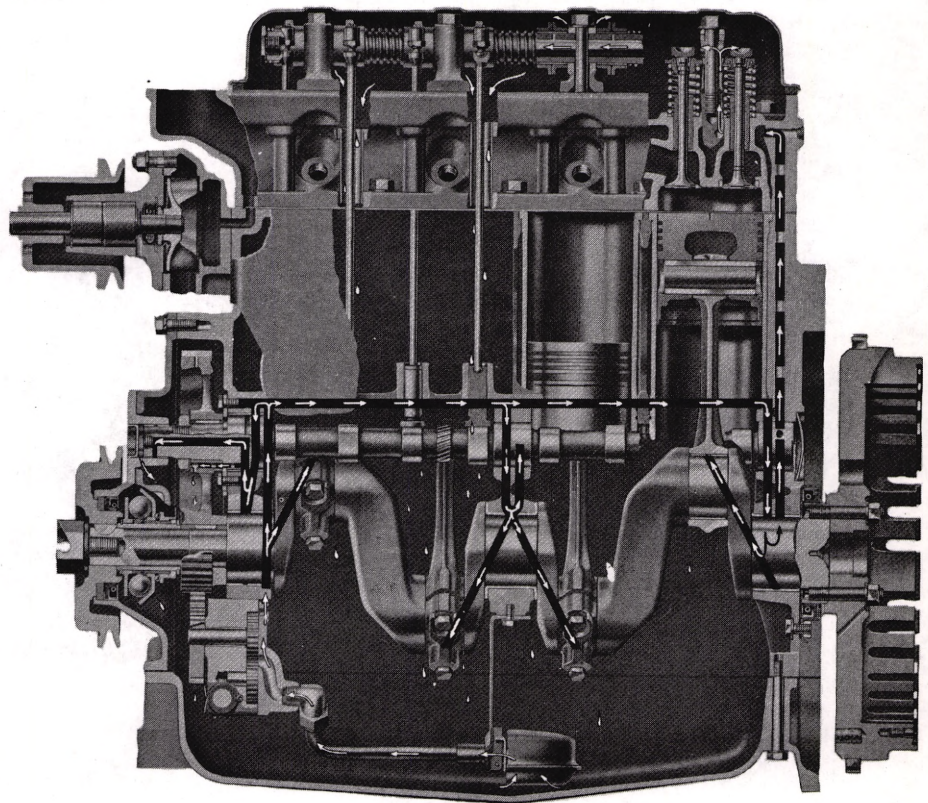


Fig. 24 How oil is circulated in a modern engine.



OIL FOR THE ENGINE AND HYDRAULIC SYSTEM

HYDRAULIC SYSTEM

Most farm tractors have a power lift or hydraulic system. The power lift and hydraulic system uses a pump and oil for transmitting power from the tractor to the implement. The power lift is used for lifting implements. The hydraulic control usually controls both lifting and lowering of the implement.

Most hydraulic systems use motor oil. In some systems the manufacturer specifies a special oil. A special oil may be needed to protect the pump. In some cases a special oil is recommended for protection of the sealing rings. To protect the hydraulic pump you must be sure the system is filled with oil. Some systems can be thrown out of gear when not in use. To stop the hydraulic pump, it may be necessary to disconnect the pump drive.

USE CLEAN OIL IN HYDRAULIC SYSTEM

One of the most important things for you to do is to keep the dirt out of the system. Use clean oil and be sure oil containers are clean. Be sure to cap the connections whenever the hoses are disconnected. In units which have a breather on the supply system, be sure the breather is open. If clogged, it needs cleaning. Some tractors use an oil filter to help clean the oil in the hydraulic system.

Hydraulic systems usually have a safety valve so the oil pressure will not go beyond a recommended point. It is not advisable to change such an adjustment. When the pump becomes worn the controls may work slowly. Have the pump repaired. If you change the pressure you will not make the lift operate properly and you could have an accident if a connection breaks due to excessive pressure.

Power lifts, hydraulic systems and farm implements are covered in more detail in the Third and Fourth Year books. Ask your 4-H Club Leader when your club will start these projects.

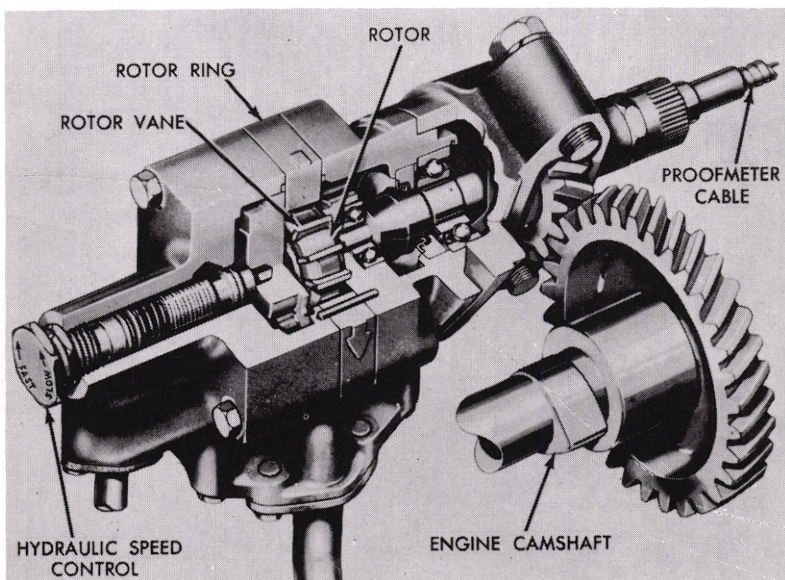


Fig. 27 Hydraulic pump cut apart to show construction.

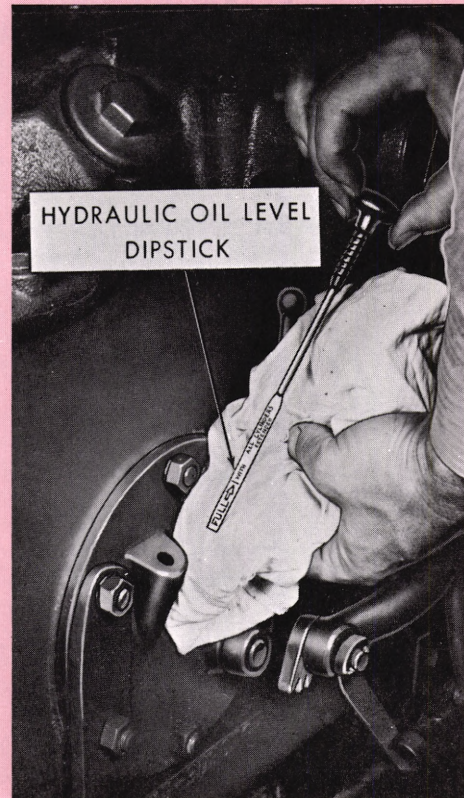


Fig. 25 Maintain the hydraulic system oil level.

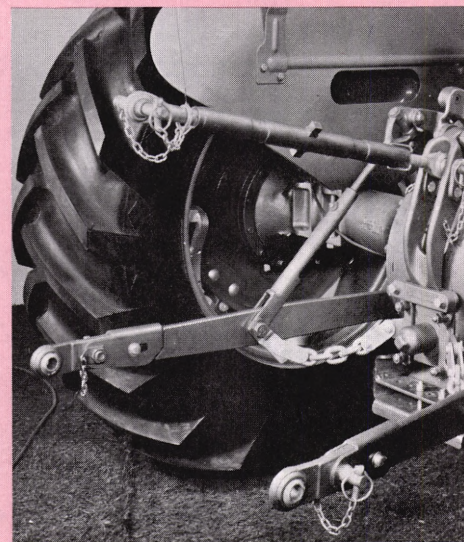


Fig. 26 A three-point, hydraulically controlled implement hitch.



Let's service the crankcase and hydraulic system for the experience of learning by doing.

1. Check the oil level in the engine and hydraulic system.
How much oil is needed: in the engine? _____
In the hydraulic system? _____
2. What was the color of the oil in the crankcase? _____
3. How often should the engine oil be drained? _____
4. What SAE grade of oil is recommended for your engine in summer? _____
in winter? _____
5. What API service classification is recommended for your engine oil? _____
6. How should you store your motor oil to keep it clean? _____

7. How should you store measuring cans? _____
8. Completely service the crankcase of your engine and the crankcase breather.
Answer the following questions.

Was the engine warm when you drained the oil? _____

Did you flush the engine? _____ If so, what with? _____

Did you service the filter? _____ If so, how? _____

Did you drain the base of the filter before removing the element? _____

How did you service the crankcase breather? _____
9. Does your engine have an oil pressure gauge? _____

Does the gauge show pressure when the motor is idling? _____
10. Is the hydraulic system equipped with an oil filter? _____

How often should the hydraulic system oil be changed? _____

Use the space on the back of this page to tell us of any other work you have done on engine lubrication which you think should be reported.

Note: Fill out this work unit, using your own tractor at home. Be ready to discuss your experiences with the other 4-H members at your next club meeting.

ADDITIONAL NOTES _____

MEMBERS'



CHECK-UP

SECOND YEAR UNIT 2

OIL FOR THE ENGINE AND HYDRAULIC SYSTEM

Place the letter for the correct answer at the right of the page.

1. Thinning of oil in the crankcase is caused by (A - oil breaking down) (B - fuel and products of combustion getting into the crankcase due to cold operation) (C - condensation due to temperature change). _____
2. Sludge is formed by (A - a poor grade of oil) (B - water, dirt, and products of combustion that blow past the pistons). _____
3. If the oil-pump screen is plugged, oil (A - will) (B - will not) flow to the bearings. _____
4. In a pressure lubrication system the pressure shown on the gauge (A - is not) (B - is) a true indication of the amount of oil that is reaching the parts to be lubricated. _____
5. A multi-grade oil (A - thickens) (B - gets thinner) as it warms up. _____
6. Paper oil-filter cartridges (A - may) (B - should never) be cleaned and reused. _____
7. Crankcases must be drained oftener in winter than in summer because (A - water sludge forms faster and condensation is a serious problem) (B - the tractor works harder). _____
8. A gasoline engine would use a (A - MS) (B - DS) API-classification crankcase oil for severe service. _____
9. Oil-filter bases should be drained (A - before) (B - after) removing the filter element. _____
10. Oil for the hydraulic system must be (A - kept clean) (B - stored where it will not freeze). _____

Note: This Check-Up Sheet is intended to test what you have learned and to stimulate discussion with the other members. The more you discuss these questions with your leader and the other members the more you learn.



MIXING FUEL AND AIR

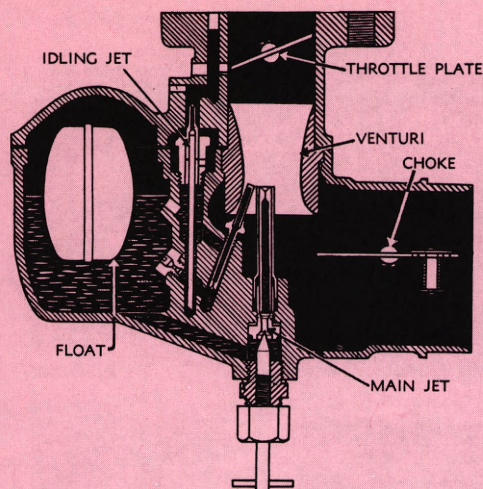


Fig. 1 Important parts of a carburetor.

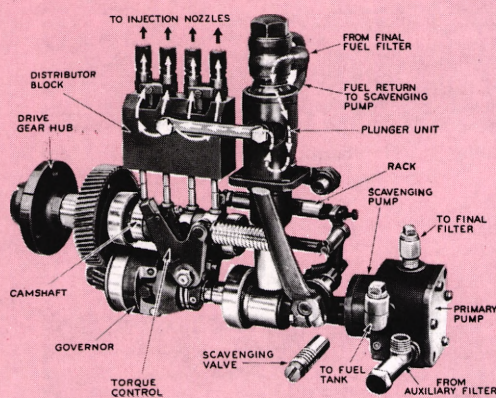


Fig. 2 A diesel engine fuel system.

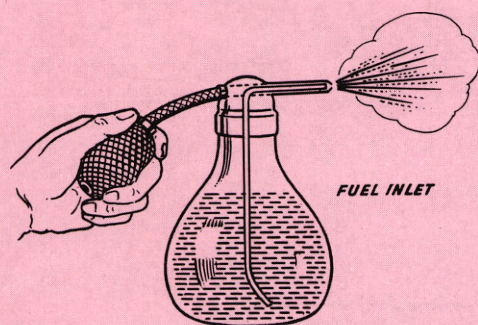


Fig. 3 A carburetor works like an atomizer.

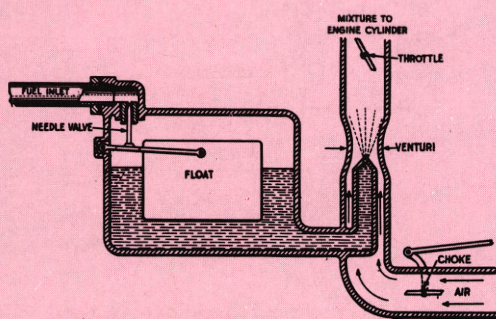


Fig. 4 Here is how a carburetor works.

CARBURETION – FUEL INJECTION

Liquid fuel will not burn in an engine. To make it burn it must be broken up and mixed with the right amount of air. In engines which burn gasoline and fuels heavier than gasoline, we use a device called a carburetor. The carburetor mixes the fuel and air in the right proportion.

A diesel engine uses a fuel injection pump. The pump shoots a fine mist of fuel directly into the combustion or pre-combustion chamber. The chamber is filled with air under high pressure. Highly compressed air becomes hot. When the fuel mist is injected into the hot air, it burns instantly.

CARBURETOR

It is important to have just the right amount of air and fuel mixed by the carburetor. In gasoline engines about $13\frac{1}{2}$ pounds of air are required to burn 1 pound of fuel. This is the best mixture for a full-load operation. It takes a lot of air to make a pound. It takes more than 8,000 gallons of air to burn 1 gallon of gasoline. The carburetor has the job of mixing all this air with a small amount of fuel. If too little fuel is supplied, we call it a lean mixture.

A lean mixture burns slowly and does not give full power. The exhaust gas temperature of a lean mixture due to slow burning, is so hot that it can cause valve trouble. On the other hand, if too much fuel is allowed to enter the engine, a rich mixture results. This wastes fuel, and fouls the spark plugs and other engine parts.

The carburetor works much the same way as a bug spraygun. When you pump a spraygun, air passes over a little tube that comes up from the can. The speed of the air over the tube creates a vacuum and fuel comes up from the can. The force of the air then breaks the liquid fuel into a fine mist, thus vaporizing it.

In an engine, the piston intake stroke creates a vacuum in the cylinder. Air rushes in. The incoming air goes through the air cleaner and through the carburetor. To make the air flow at higher speed through the carburetor we reduce the size of the tube. We call the reduced opening a venturi. Air going through a venturi must speed up in order to get through. Where the tube flares out again, there is always suction. Locating the outlet of the main carburetor jet at this point causes fuel to be discharged into the speeding air. The rush of air through the venturi picks up and vaporizes the fuel for the engine. The amount of fuel and air entering the engine is controlled by a throttle valve.

FUEL LEVEL

In order to obtain the right mixture it is necessary to control the amount of fuel that enters the air stream. First, we use a device called a carburetor fuel bowl. A float in the bowl is connected to a shut-off valve. The purpose of the float is to keep the fuel level at the right height. The fuel level should be slightly lower than the tip of the jet, which sticks up in the air stream. If the fuel level is too low the mixture may run lean. If it is too high, the mixture may run rich.



MIXING FUEL AND AIR

HEAT FOR THE MIXTURE

Heat helps the fuel vaporize. It helps keep the fuel from dropping out of the air after it vaporizes. When fuel vaporizes, it takes up heat from the air. To replace the heat, exhaust gases are often circulated around the intake manifold. Take a close look at your engine. There may be a heat regulator on the exhaust manifold. The regulator can be set for either cold- or warm-weather operation. On trucks and cars this adjustment is usually automatic.

Heat for the fuel mixture is seldom needed in the summer. In fact, heating the intake mixture when it does not need it reduces the power output of the engine. Engines burning heavier fuels require more heat on the intake manifold than do engines burning gasoline. If you have a tractor that burns heavy fuel, you may even have a shield which should be used to keep the intake manifold at uniform temperature. Your Operator's Manual will tell you when to use the shield. Check your Manual for proper manifold adjustments.

HOW TO GET A GOOD STARTING MIXTURE

A choke valve which cuts air intake is necessary for starting a cold engine. When the choke valve cuts off the air, more fuel and less air is pulled into the engine. When the intake manifold begins to heat up, the choke should be turned off. Excessive choking causes many troubles. Raw gasoline washes the oil from the pistons and cylinder walls. Fuel dilutes the oil in the crankcase. The over-rich mixture does not burn clean. The engine puffs out black smoke. If it is necessary to choke the engine after it warms up, the carburetor needs to be adjusted.

CARBURETOR ADJUSTMENT

If your carburetor is properly adjusted, you seldom need to change it. Make adjustments only when weather conditions vary or when changing from light to heavy loads. On some small gasoline engines, there is no load adjustment. However, there usually are adjustments to change for the idling mixture and to control the idling speed.

If you have a propane or butane burning tractor, you should have the carburetor adjusted by your dealer. He will use a special gas analyzer and make an accurate adjustment. It is difficult to adjust propane burning tractors by the sound of the engine.

Before adjusting a carburetor, have the engine warmed up to proper operating temperature. Refer to your Operator's Manual for making proper adjustment. The adjustment setting given in your Operator's Manual is quite accurate. Your final setting should be close to that given in the Operator's Manual.

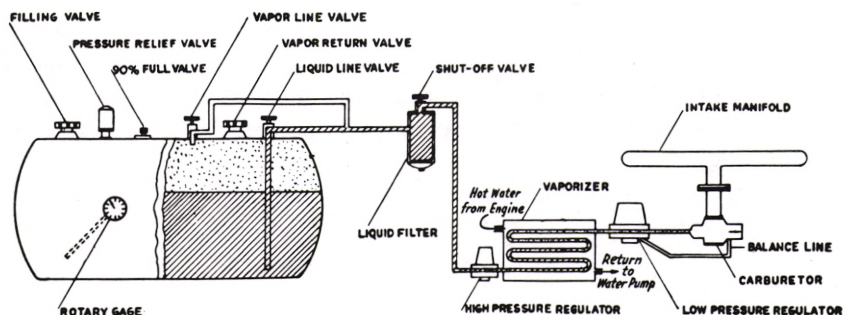


Fig. 8 Parts of an LPG (propane or butane) fuel system.

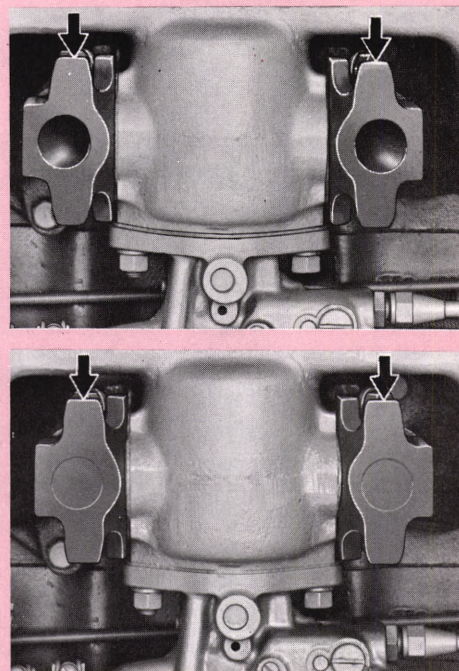


Fig. 5 The manifold heat control opened for warm weather (top) and closed for cold weather (bottom).

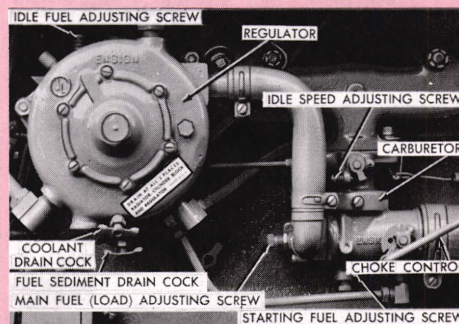


Fig. 6 LPG carburetor.

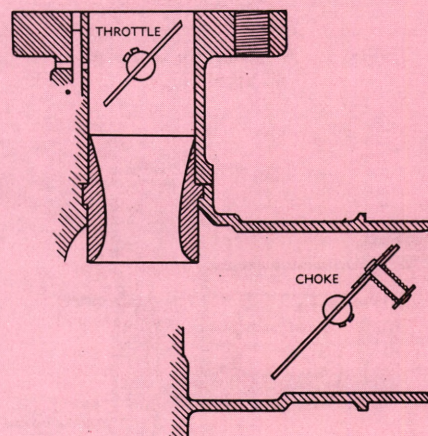


Fig. 7 The choke cuts air intake when starting a cold engine.

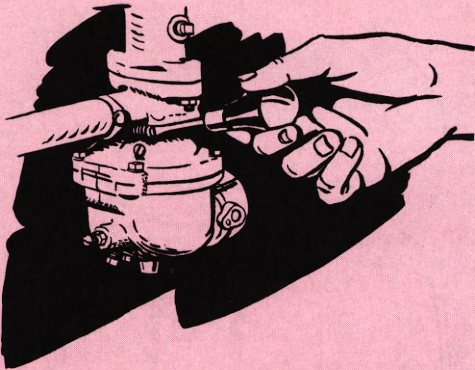


Fig. 9 Adjusting the idling speed.

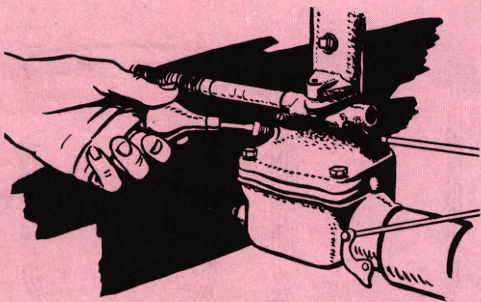


Fig. 10 Adjusting idling mixture.

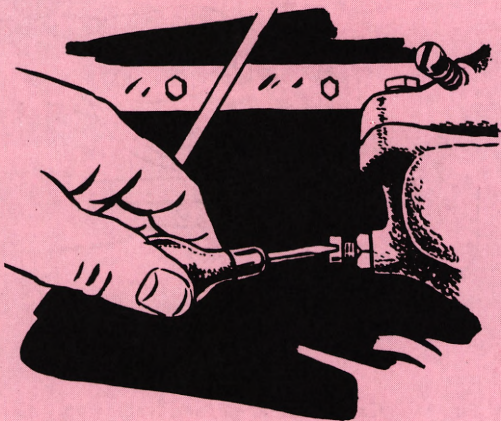


Fig. 11 Adjusting load valve.

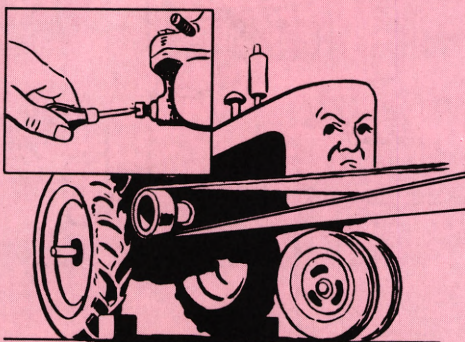


Fig. 12 Adjust the load valve when doing belt work.

ADJUSTING IDLING SPEED

To adjust the idling speed there is a little stop screw that keeps the throttle shaft from closing completely. It is usually best to adjust this screw first. If you are burning gasoline, set the engine to idle at a speed of 400 to 500 r.p.m. When using heavier fuels, set the engine to idle faster. A faster speed is desirable to provide more heat on the manifold. In service, the idle stop screw wears and may need to be turned to keep the engine from dying when idling. You need to make the same adjustment on small engines and on trucks and passenger cars.

ADJUSTING IDLING MIXTURE

The idling mixture adjusting screw may either let in more air or more fuel when you open it. Better refer to your Operator's Manual to find out how to adjust it. If the needle valve controls fuel instead of air, and the engine puffs a little smoke when a load is suddenly applied, better check the idling adjustment to make sure it is right. On some tractor engines this adjustment should be set at fast idling speed, so be sure to follow the instructions given in the Operator's Manual.

ADJUSTING LOAD VALVE

On carburetors having a load adjustment, a needle valve lets in more fuel when opened. To make this adjustment, warm up the engine. Then, when the engine is running at full speed, screw the valve in until the engine begins to lose speed. Now, open it until the engine runs smoothly. Next, try to pull the load. If the engine starts to stall, stop and open the needle valve about $\frac{1}{8}$ th turn or two notches. Try pulling the load again. As soon as the engine will pull the load without stalling, you have a good carburetor adjustment.

If you are grinding feed or doing other belt work, it is a simple matter to adjust the load needle valve. Turn the needle valve down until the engine loses power, then back the valve up until the engine runs smoothly.

Your Operator's Manual tells you how much the valve should be opened. If you don't have a faulty needle valve, your adjustment should be very close to that given in the book.

It is not safe to adjust the carburetor while you are driving through a field. You may slip and fall under the tractor.

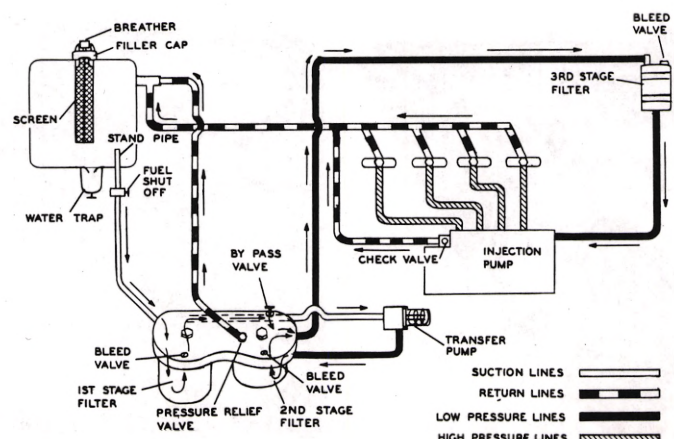


Fig. 13 Parts of a diesel fuel system.



MIXING FUEL AND AIR

Carburetors used on power units and tractors do not have an accelerating pump like those used on trucks and cars. Therefore, you should not expect these engines to accelerate as rapidly as those in passenger cars and trucks. If you are pulling a power-take-off machine, such as a combine or pick-up baler you may want to run with a slightly richer mixture. A richer mixture may be needed to give a more even speed for variable loads.

CLEAN FUEL

Clean fuel is important to a well running engine. Your carburetor is protected by a sediment bowl and screen. You will find the sediment bowl between the fuel tank and carburetor. It is up to you to keep the sediment bowl clean. When removing it, first shut off the fuel. Loosen the clamp that holds the bowl in place. Twist the bowl when removing it, to prevent tearing the gasket. The fine mesh screen may remain at the top of the housing. Take a look. If it is clean you need not disturb it.

Water is heavier than fuel, and you will find water in the bottom of the bowl. In winter, it will freeze. You may also find some dirt and flakes of metal worn from tanks and barrels. Wipe the bowl with a clean cloth. Before replacing the sediment bowl open the valve and make sure that the fuel flows freely. Be sure there is no fire near spilled gasoline.

Now examine the fuel line where it enters the carburetor. You may have a screen at the end of the line. Occasionally this screen needs to be cleaned. Some carburetors have both a screen and water trap. If your carburetor has a water trap, remove the plug and drain it.

If the tractor is to be used with equipment where there is danger of fire, the glass sediment bowl should be replaced with a metal bowl that will not break. Much damage can be done if even a small fire should crack the bowl. The fuel would drain out of the tank and might cause a serious fire.

DIESEL FUEL

The most important thing for you to do if you have a diesel engine is to keep the fuel clean. It takes a close-fitting pump to measure the fuel accurately. Dirt in the fuel will soon cut out the pump. Here are some things to watch: Make sure you know how to service the fuel filters. Before filling your storage tank, fill the tractor tank. Thus you give the fuel in the storage tank a chance to settle before you need more. Your diesel has several dirt traps. Read your Operator's Manual for guidance in cleaning them.

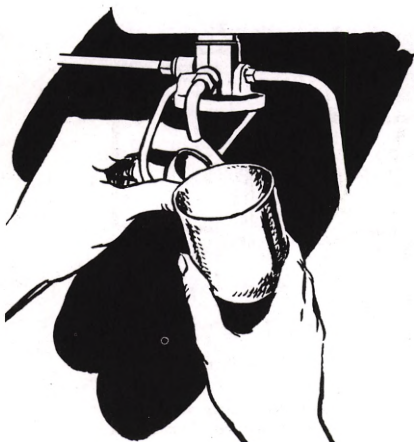


Fig. 19 Use a metal bowl where there is danger of fire.

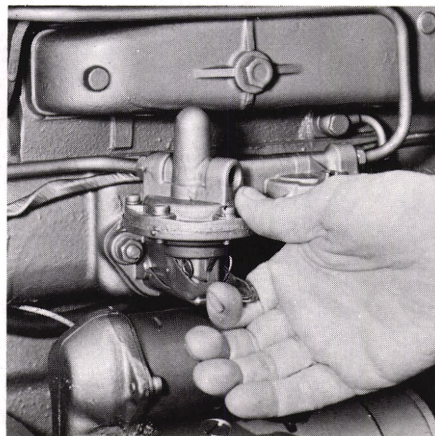


Fig. 18 Priming a diesel fuel system to bleed out the air.

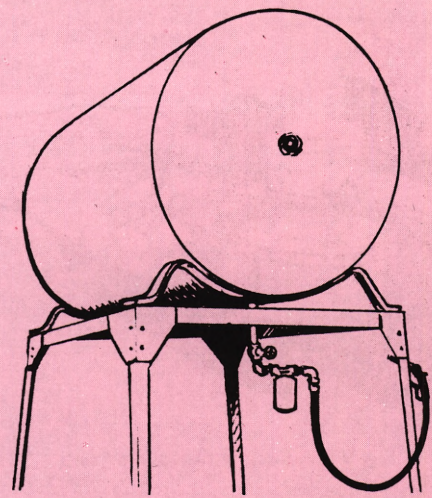


Fig. 14 Fuel storage tank with filter and water trap.

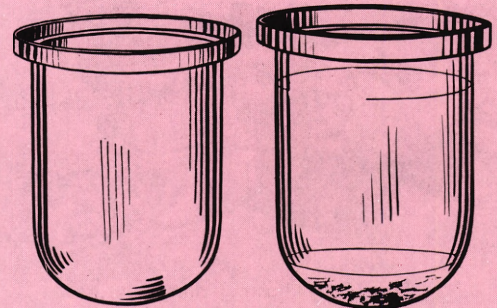


Fig. 15 Sediment bowl collects dirt and water.

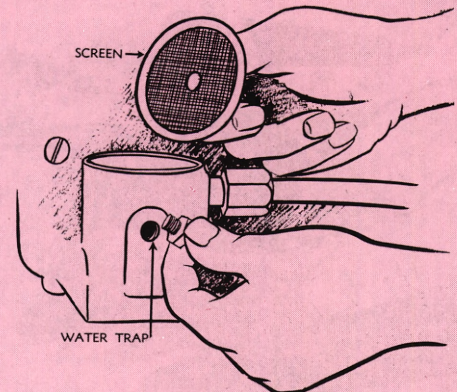


Fig. 16 Carburetor screen and water trap.

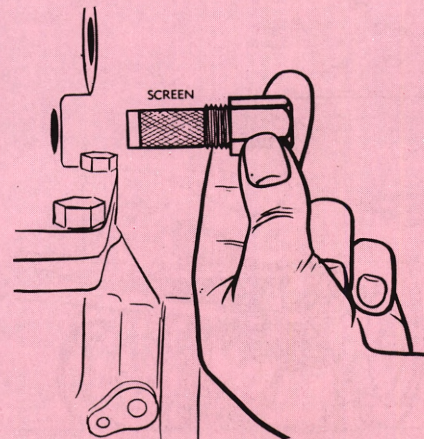


Fig. 17 Another type of carburetor screen.



MIXING FUEL AND AIR

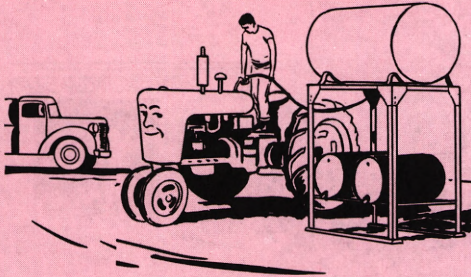


Fig. 20 Filling your tractor.

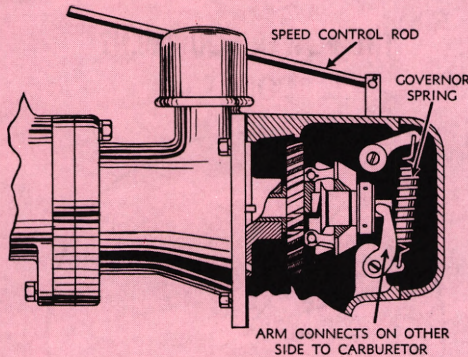


Fig. 21 Governor on a gasoline engine.

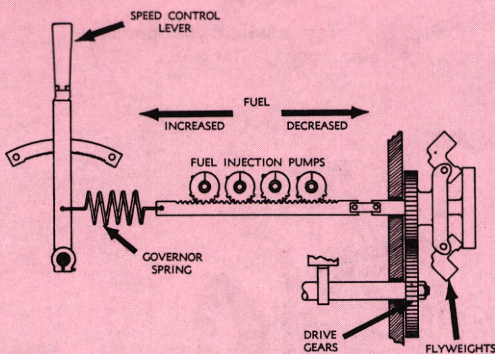


Fig. 22 Governor on a diesel engine.

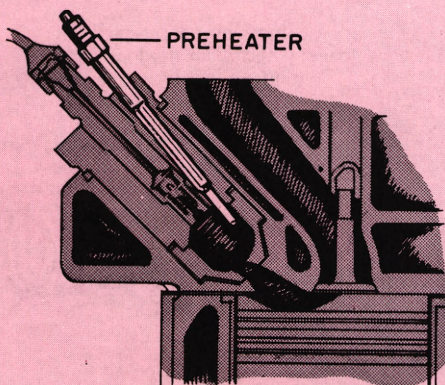


Fig. 23 Some diesels use a glow plug in the pre-combustion chamber for quicker starting.

KEEP WATER OUT OF FUEL

How does water get into the fuel? When the fuel tank is not filled at the end of the day, the tank cools at night and water condenses out of the air in the tank. Many diesel tractors have a water trap at the bottom of the fuel tank. Drain it as recommended. Keep the fuel clean.

If the storage tank isn't kept filled, it too will condense water from the air. Most storage tanks have a water trap at the bottom or a drain-off pipe located above the bottom. A fuel filter on the tank outlet helps to keep out dirt and water. Also, carelessness in handling of cans used for filling the tractor is a cause of water in fuel. Barrels left out in the open will also collect water and dirt. If the barrels are left outdoors, be sure the bungs are tight. Tip the barrel slightly so that water will not collect on top of the drum.

GOVERNOR

The throttle lever runs to the governor. When you change the lever adjustment you change the pull on a spring in the governor. From the governor a rod runs to the throttle valve in the carburetor. This is how the governor works: The engine rotates weights on the governor. When the weights rotate, they have a tendency to fly out. To keep them from flying out too far, we use a spring. Changing the throttle setting changes the tension on the spring that holds the governor weights. When the governor weights fly out, they close the throttle shaft in the carburetor. If the spring is pulled tightly, the engine must run faster to throw the weights out the same distance. Increasing the spring tension makes the engine run faster. By balancing the pull of the weights against the spring, the engine is kept running at whatever speed it is set to run.

GOVERNOR ON A DIESEL

On a diesel engine the governor is built into the injection pump. The amount of fuel injected regulates engine speed. To increase the fuel when a load is applied the governor changes the effective length of plunger delivery. This is done by rotating the plunger so it must travel farther before the slotted cut-off hole reduces pressure. Another method is to control the amount of fuel pumped to the opposed piston cavity. More fuel forces the pistons farther apart and increases delivery when pistons are returned by the cam.

STARTING A DIESEL

A diesel engine does not have a choke. The problem in starting a diesel engine is to turn the engine over fast enough so that air in the combustion chamber does not cool before the fuel is injected. On some diesel engines, a special device is used for heating the intake air. When starting in cold weather, the heating device is turned on. If a diesel engine has a starting engine, you can obtain heat for it by operating the starting engine for a greater length of time before trying to start the diesel. Some diesels have a small gasoline engine used for starting and some have an electric starting motor.

One of the most important things to do in starting a diesel, or a tractor burning propane in cold weather, is to make sure that the battery is in good condition. Keep the battery well charged so that the starting motor will turn the engine over rapidly.



MIXING FUEL AND AIR

SAVING PETROLEUM FUELS

The fuels delivered to your farm furnish the power for your engines. Petroleum fuels are the most convenient and economical source of energy for your engines. It is up to you to make sure that you get full power from fuel and that it is not wasted.

To get full power from petroleum fuels you must first make sure that your engine is in good condition. An overhaul by an authorized service mechanic every one to three years, depending on how much it is used, is necessary to keep it in tiptop shape. Even when an engine is in perfect condition mechanically, you must operate it properly and keep it well adjusted to assure economical and efficient results. Such operation calls for good engine care. Don't neglect your engine! Read your Operator's Manual and follow it carefully. Later on we will show you how to keep a cost and service record for your tractor.

The cost of fuel for a farm tractor amounts to about 40 percent of the total operating costs. This is a large item, one where real savings can be made. Field surveys and tests on gasoline-burning farm tractors show that the average operator wastes about 10 percent of his fuel each year. These studies also show that the main reason for waste of fuel results from having the carburetor set too rich.

FIELD TESTS FOR SAVING FUEL AT LIGHT LOADS

Surveys show that the average cultivating tractors are used about 70 percent of the time at light load. When a tractor is to be operated at light load for a fairly long period, it may be advisable to set the load mixture leaner. Some carburetors automatically give leaner mixtures for part loads, although most do not. In any event the mixture should not be set too lean for light loads, because an extremely lean mixture gives poor engine performance and may actually increase fuel consumption.

An engine gets most work from its fuel when it develops full compression pressure. Full compression is obtained when the throttle is nearly wide open. At lighter loads the throttle is only partly opened. Therefore, the final compression is much lower. This condition, of course, does not apply to diesels. Diesels take in a full cylinder of air at all times. The amount of fuel injected is automatically changed to suit the load. For this reason a diesel engine is efficient at light loads.

To save fuel, you can increase your load by adding more implements; or in some cases you can increase the load by shifting to a higher gear and slowing the speed of the engine down to the desired travel speed. Doing so will decrease the number of fuel charges taken into the engine and increase the efficiency of each charge. With a typical three-plow tractor it may be possible to save as much as four gallons of fuel a day. When an engine is operated below normal speed, there is some danger of its overheating and not receiving sufficient lubrication for safe protection. It is always advisable to check with your tractor dealer to determine if your tractor is built to run at the slower speed before you try to operate it in this manner.

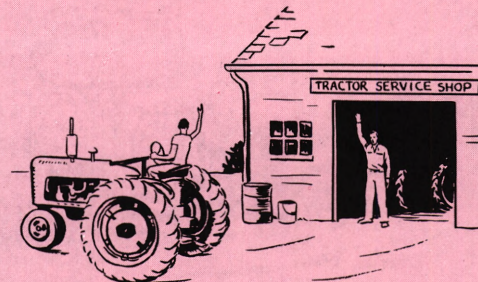


Fig. 24 Have your tractor serviced regularly by a qualified mechanic.

THE POWER EQUIPMENT DOLLAR

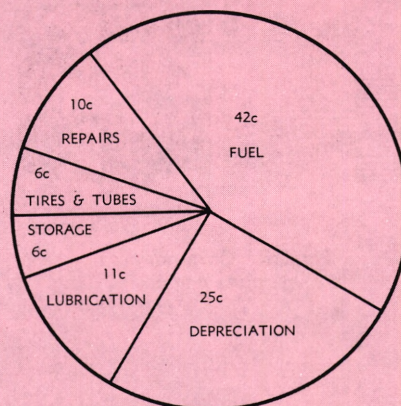


Fig. 25 Here is where your power equipment dollar goes.

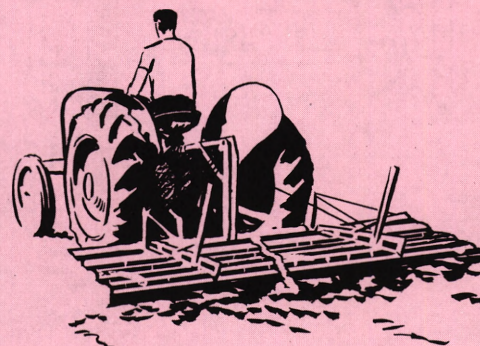


Fig. 26 When you operate at light loads, you can set the load mixture leaner.

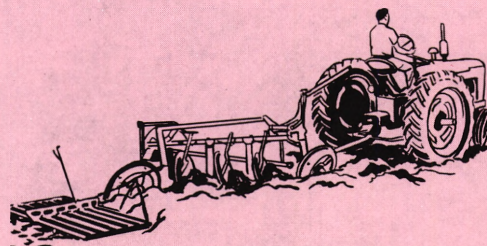


Fig. 27 Heavy loads increase the efficiency of gasoline tractor engines.



It's time to service the carburetor or injection equipment and show what was learned by reading the white sheets and the Operator's Manual.

1. What is the make? _____ model number? _____ of the carburetor on your tractor or the engine you have chosen. _____
2. (For those who are servicing a diesel engine.) What is the make of the fuel pump? _____
Model number? _____
3. Start the engine and note if the mixture appears to be properly adjusted. Examine the exhaust stack and note if it looks sooty or clean on the inside. How did it look? _____
4. Locate the throttle valve in the carburetor or on the diesel fuel pump. To what does the throttle valve connect? _____
5. Does your engine have a heat regulator on the manifold? _____
What is the purpose of a heat regulator? _____
How can you get more heat in a diesel engine? _____
For LPG tractors: Does the tractor have a heat exchanger? _____
Can the heat exchanger be regulated? _____
6. Does the engine have a shield over the manifold? _____
What is a shield used for? _____
7. Where is the choke located? _____
How long will you let the engine run before you quit choking it: About how many minutes? _____
Diesel and LPG engines: Tell how you start them. _____
8. How many fuel adjustments are there on the engine that you are servicing? _____ Tell us what each one is for? _____
9. Use your Operator's Manual and locate idling speed adjustments. Set idling speed. Did you find it necessary to change it? _____
Why should the idling speed be increased for winter operation? _____
10. Locate the idling mixture adjustment. Does the adjustment control the fuel or the air? _____
Does your setting look the same as that given in the Operator's Manual? _____

(Over)

11. Does your engine have a load adjustment? _____ If so, how far should the needle valve be opened? _____ Do you change this setting when pulling heavy and light loads? _____
12. Is the fuel system protected by a sediment bowl or fuel filters? _____ If you have a diesel or LPG tractor, how many fuel filters do you have? _____
13. How often should you clean the sediment bowl? _____
- Diesel owners: Caring for the fuel system is one of the most important jobs you have. Tell us how you do it. _____
14. Does your engine have a fuel screen or dirt trap where the fuel line enters the carburetor? _____
- If so, service it. _____
15. When should a metal sediment bowl be used? _____
16. Diesel and LPG owners: How many fuel filters are there on your engine? _____
17. Do you fill the fuel tank before having the storage tank filled? _____
18. Where does the water come from that gets into the fuel system? _____
- How can you help keep it out? _____
19. Can you adjust the governor on your engine? _____ How can you tell if the engine is running at the correct speed? _____
- What is the correct speed of your engine? _____
- You can count the revolutions of the rear wheels and time how many revolutions they would make in a minute with a watch. If you knew how many revolutions the engine turned when the wheels made a revolution you could figure the speed. This makes a good demonstration. Ask your leader to help you work this out.
20. Diesel owners: Do you have a special starting device for cold weather? _____ How do you start a cold engine? _____
21. List some ways to save fuel with your tractor. _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____

Note: Fill out this work unit, using your own tractor at home. Be ready to discuss your experiences with the other 4-H members at your next club meeting.



SECOND YEAR UNIT 3

MIXING FUEL AND AIR

Place the letter for the correct answer at the right of the page.

For Gasoline Tractors

1. The throttle stop-screw adjustment (A - changes richness of the mixture) (B - keeps throttle valve open) (C - regulates air). _____
2. When the idle adjustment is made, the throttle valve should be (A - open) (B - closed) (C - nearly closed). _____
3. Closing the adjustment of the high-speed, or load needle valve (A - reduces (B - increases) the richness of the mixture. _____
4. When using gasoline, the manifold can be (A - hotter) (B - cooler) than when using a tractor or heavy fuels. _____
5. A common indication of an over-rich operating mixture is (A - white) (B - blue) (C - black) vapor or smoke from exhaust. _____
6. An extremely lean mixture will cause (A - loss of power and burned out valves) (B - greater economy of operation). _____
7. Idling speeds should be set somewhat (A - higher) (B - lower) when using tractor fuels heavier than gasoline. _____
8. Engine should be at (A - correct operating temperature) (B - 140° F.) and under load, when making the final adjustment of the load valve. _____
9. It is best to use a metal sediment bowl when using (A - hay buck or corn picker) (B - 3-bottom plow). _____
10. The gas lever changes (A - carburetor throttle) (B - governor spring adjustment). _____

For LP Gas Tractors

1. Fuel reaches the carburetor in the form of (A - gas) (B - liquid). _____
2. The vaporizer is (A - cooled) (B - heated) by water from the engine circulating system. _____

(Over)

3. LP gas is pumped into the tractor fuel tank as (A – gas) (B – liquid) under pressure. _____
4. LP gas tanks should be filled (A – completely) (B – 80 or 90 percent) full. _____
5. When starting the LP gas tractor in cold weather, it is advisable to start the engine on (A – vapor) (B – liquid). _____
6. If frost appears on any part of the fuel regulator with the engine running it is a sign of (A – engine running too hot) (B – not enough water circulating). _____
7. If frost appears in any part of the fuel system with the engine not running, it is a sign of (A – fuel leakage) (B – engine running too cold). _____
8. The fuel regulator should be drained every (A – 10) (B – 120) (C – 500) hours of operation to remove any substances that will not vaporize. _____
9. LP gas engines generally operate at (A – lower) (B – higher) compression than gasoline engines. _____
10. When LP gas fuel changes to a gas in the vaporizer, it (A – heats) (B – cools) the vaporizer. _____

For Diesel Tractors

1. Fuel and air are mixed (A – before they enter the cylinder) (B – in the cylinder). _____
2. The fuel is ignited by (A – the heat of compression) (B – a spark plug) (C – the pressure in the cylinder). _____
3. The amount of fuel injected depends on engine (A – speed) (B – load) (C – load and speed). _____
4. Movement of the throttle controls the speed of the engine by (A – directly moving the injection pumps) (B – changing the position of throttle in intake manifold). _____
5. Injection pumps and injectors (A – can) (B – should not) be disassembled in the field. _____
6. The exhaust from a diesel engine (A – is always smoky and dirty) (B – should be clean) (C – is usually smoky and dirty). _____
7. The parts of a diesel engine fuel system fit together (A – very closely) (B – fairly closely) (C – loosely). _____

Note: This Check-Up Sheet is intended to test what you have learned and to stimulate discussion with the other members. The more you discuss these questions with your leader and the other members the more you learn.

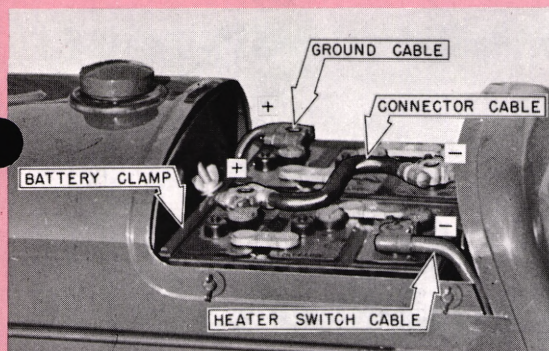


Fig. 1 Two 6-volt batteries in series to give 12 volts.

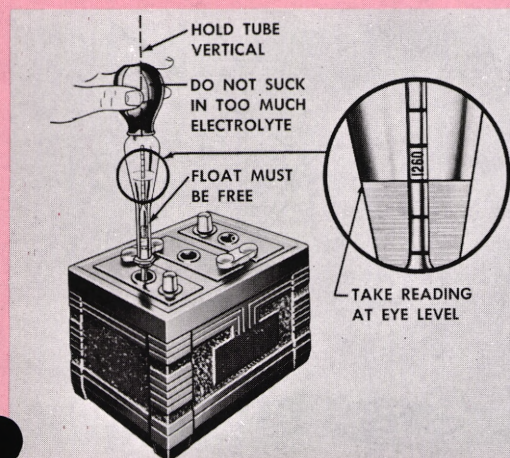


Fig. 2 Measuring the charge of your battery with a hydrometer.

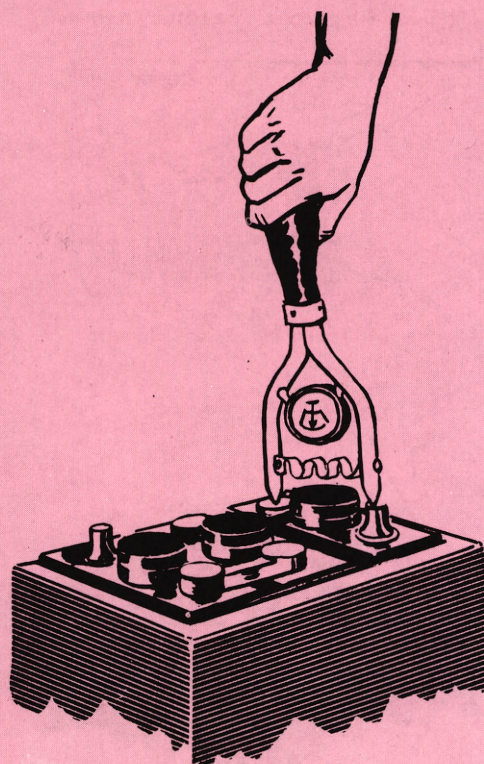


Fig. 3 Checking your battery with a voltmeter.

"BUGS" IN YOUR BATTERY

Electrical "bugs" begin in your battery. They may also show up in your spark plugs and wiring. You need to know how to keep them out. By "bugs" we mean troubles that most people don't understand.

A battery has a number of positive and negative plates, held apart by thin strips called separators. Each group of plates is called a cell. The cells are connected and held together in a hard rubber box. Each cell produces a little more than 2 volts. A 6-cell battery has a little over 12 volts. Connecting two 6-volt batteries in series also gives 12 volts. Some large tractors even have two 12-volt batteries in series to provide 24-volts for the starter motor.

A HYDROMETER FOR CHECKING THE BATTERY

When you draw on the battery, as you do when you turn on lights or step on the starter, the sulfuric acid starts a chemical action which produces an electrical current. The acid is heavier than water. Therefore, as current is drawn from the battery, the acid solution becomes weaker. We can measure the charge of the battery by using a hydrometer.

A hydrometer is a float with a weight in it. It shows how heavy the solution is compared to water, that is, its specific gravity. If a battery has a specific gravity of 1.280, for example, it is fully charged. Some batteries, however, are made with a weaker solution of acid and are fully charged with a reading of 1.250. Therefore, when you check your battery with a hydrometer, if it never reads more than 1.250, you will know that you probably have a low-gravity battery. If the gravity reads lower than it should, have the battery checked with a voltmeter. This will tell you its condition. This test will show you which cell might be weak. A weak cell may be noticed when the generator appears to charge at a high rate all the time. This only applies where the generator has a voltage regulator which controls the output of current.

The following is a high-gravity battery table. It shows gravity, percent charged, and freezing point.

SPECIFIC GRAVITY	% CHARGED	FREEZING POINT °F
1.280	100	— 90
1.250	75	— 62
1.220	50	— 16
1.190	25	— 4
1.160	About discharged	+ 5
1.130	Discharged	+ 19

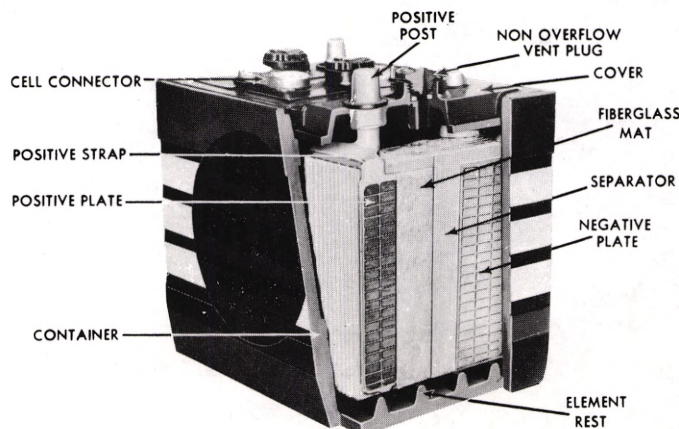


Fig. 4 Showing parts of a battery.



BATTERY SERVICE AND SPARK PLUG CARE

BATTERIES NEED WATER

A battery must have water. In hot weather when the tractor is in heavy use, water evaporates rapidly. Therefore, you need to pay special attention to the water level in the battery. Battery water should be free of salts and minerals. Rainwater is the best to use. If rainwater is not available, it is better to put in clean drinking water rather than let the battery go dry.

CLEAN BATTERIES

The battery cable connections should be kept clean. Clean connections will help provide good contact with the battery posts. Here is an easy way to clean the battery connections. Sprinkle a little soda on the corroded area. Mix with a small amount of water (just enough to make a paste). Stir the mixture around until the fizzing stops. Then flush it off with water. Don't get any soda inside the battery cells. It is well to cover the terminal cable with a little grease to help prevent more corrosion. Another way to keep the connections clean is to wash off the top of the battery with plain water about every two weeks.

CAUTION: If spilled, battery acid can eat holes in clothing and burn your eyes and skin. Therefore, you must protect yourself when working on a battery. If you spill acid on your clothes or your skin, apply baking soda immediately. Keep baking soda nearby when working on a battery.

Battery connections must be kept tight. If the heavy cables or connections are badly corroded and broken, replace them. On tractors which use a magneto, it is possible to operate the tractor even though the cables are loose or broken. But if you do so, you are apt to burn out the generator. If you must run the tractor without the battery, keep the generator from burning out by removing the field wire and taping it.

See that the battery is clamped firmly in its carrier frame. Don't fasten the bolts too tightly; you may crack the battery case.

CHARGING THE BATTERY

To recharge a battery you need a direct current, which the generator supplies. When the engine turns the generator at full speed, a direct current is fed to the battery. The flow of direct current back through the plates restores the sulfuric acid solution.

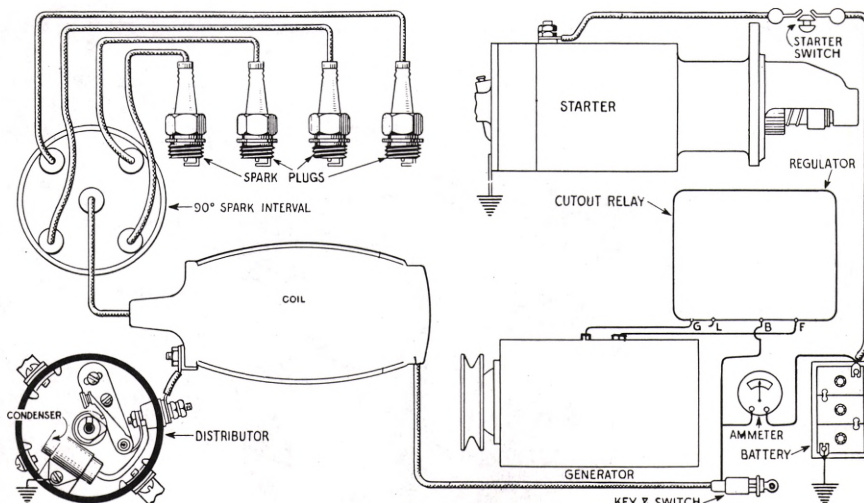


Fig. 9 The electrical system of your tractor.



Fig. 5 Filling the battery.

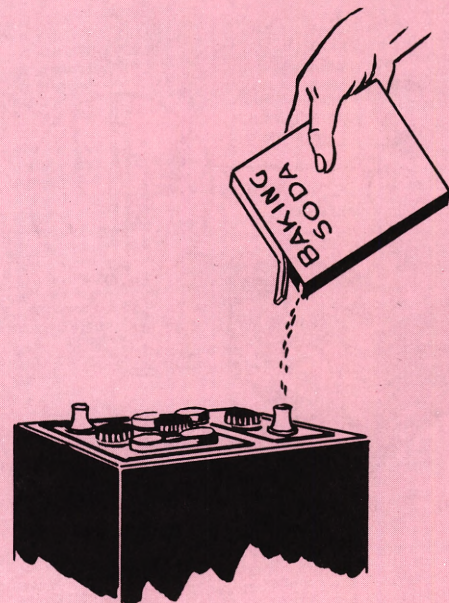


Fig. 6 Baking soda cleans battery terminals.

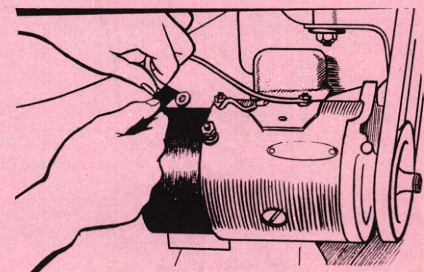


Fig. 7 Taping generator field wire.

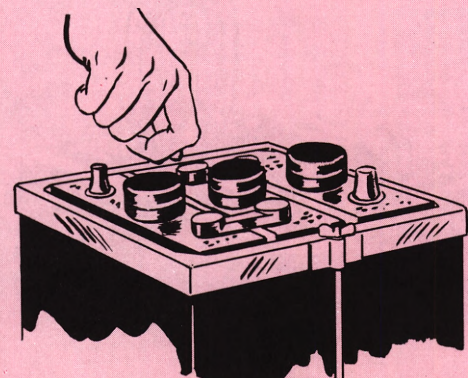


Fig. 8 Tightening the battery.

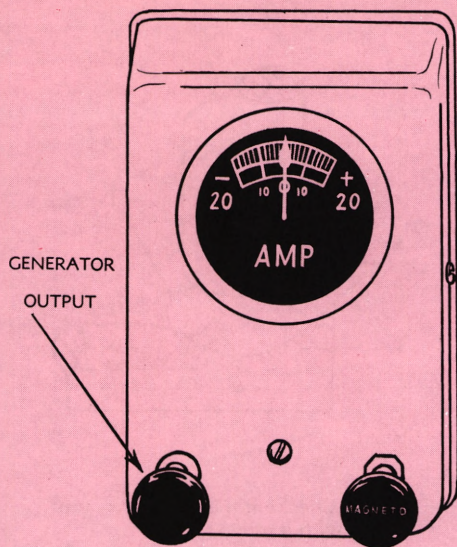


Fig. 10 Hand switch for generator output.

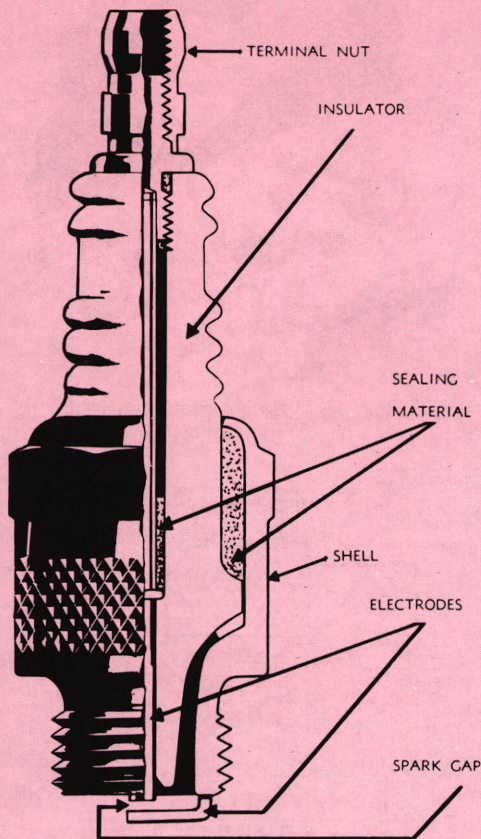


Fig. 11 Showing the parts of a spark plug.

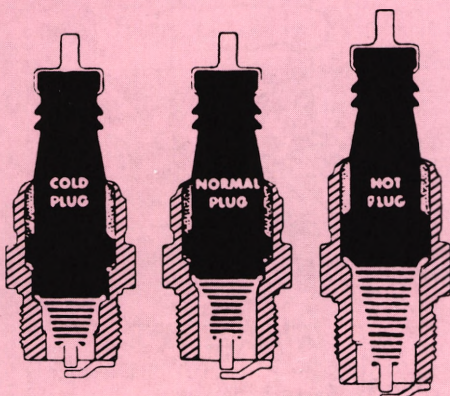


Fig. 12 Cold plug and hot plug.

CAUTION: When you charge and discharge a battery, hydrogen gas is present. If you bring a flame near the battery, it may explode.

The amount of current which a generator will supply to a battery is controlled either by a voltage regulator or a switch. Some of the first tractors used a hand switch control. Always guard against overcharging. Many batteries, due to overcharging, have a shortened life. During winter, keep the battery fully charged or you will not have enough power to crank the engine. There is also danger that a low battery may freeze.

Comparison of Cranking Power Available from a Fully Charged Battery at Three Different Temperatures:

80°F.	—	100%
32°F.	—	65%
0°F.	—	40%

SELECTING SPARK PLUGS

Spark plugs are made in many heat ranges. When replacing the plugs in your tractor, get the plugs recommended for the engine. The heat range of a spark plug is determined by the distance the heat must travel from the lower tip of the center electrode to the spark plug gasket and to the engine. The longer the distance the heat must travel, the hotter the plug will run. A cool plug has a short distance for the heat to travel.

Hot plugs are used for burning heavier types of tractor fuel. They are also used in engines that run cool or are being operated with light loads. If you are having trouble with a spark plug or if your engine fouls out, it may be that you need hotter plugs. Your dealer or plug supplier can suggest the plug you need to correct your engine troubles.

When selecting a spark plug for an older engine, refer to a spark plug chart. New plugs with different numbers are often recommended. Spark plugs are made in many thread sizes. Be sure to buy those with the correct thread size.

CLEANING SPARK PLUGS

One-piece plugs are used in gasoline-burning tractors or tractors that use propane. If you clean a one-piece plug, use a sand blast machine.

Some plugs are made so that they can be taken apart for cleaning. They should not be cleaned with a sand blasting machine. The bottom part of the porcelain is glazed to keep carbon from sticking to the porcelain. These plugs are recommended when you burn a heavy tractor fuel.

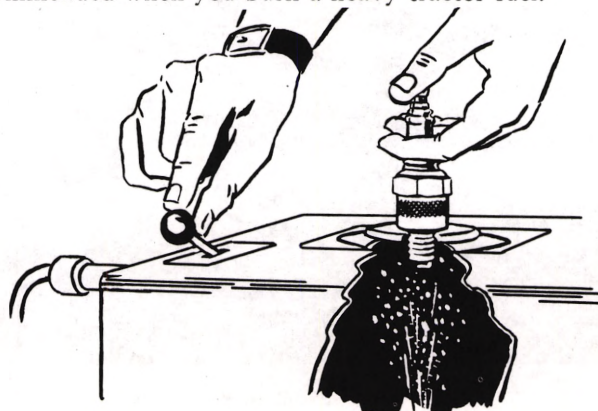


Fig. 13 Sand blasting a spark plug.



BATTERY SERVICE AND SPARK PLUG CARE

When checking the gap of a used plug, a round gauge is used. A round gauge will fit the burned points which are no longer flat. Although a flat gauge can be used, you must make sure the points have a flat surface so you can get a true measure. When adjusting the spark plug gap, bend the electrode *attached to the shell* of the plug. Never bend the center electrode. If you do so, you may cause the porcelain to crack. Setting the gap too close may cause poor idling. A gap too wide may cause missing under full load. When you take out the plugs be sure to use a socket wrench; one that will fit the plugs. Then there is less danger that the wrench will slip and crack the porcelain of the plug.

Spark plugs are made with copper or steel gaskets that seal them—to make them gas tight. When replacing plugs, it is important to use new gaskets. Always tighten the spark plug enough to crush the gasket somewhat. Before trying to tighten the spark plugs, make sure that the threads of the plug are clean. Use a wire brush to clean the spark plug threads. Also, cut a few notches across the threads of an old plug and screw into the engine block so that the threads will be cleaned out. If you don't have a special wrench which shows you how much you are pulling (we call this a torque wrench), tighten the cleaned plug snugly until you can feel it draw against the gasket. Then give it about another half-turn. Some plugs do not use a gasket, but are sealed with a tapered fit.

KEEPING WIRES CLEAN

The wires leading from the distributor to the spark plugs carry high voltage. Therefore, they are heavily insulated. If the insulation cracks, the spark may arc across to the engine and fail to ignite the fuel. Wipe these wires and keep oil and dirt away from them. Keep dirt away from the spark plugs. Wipe the coil and distributor. Dirt around the high voltage wires or spark plugs may collect moisture and "short out" the spark. Moisture on a dirty engine is a common cause of hard starting.

There's more about tractor ignition in the Third Year of your 4-H Tractor Program. Ask your leader about Club plans for next year's work.

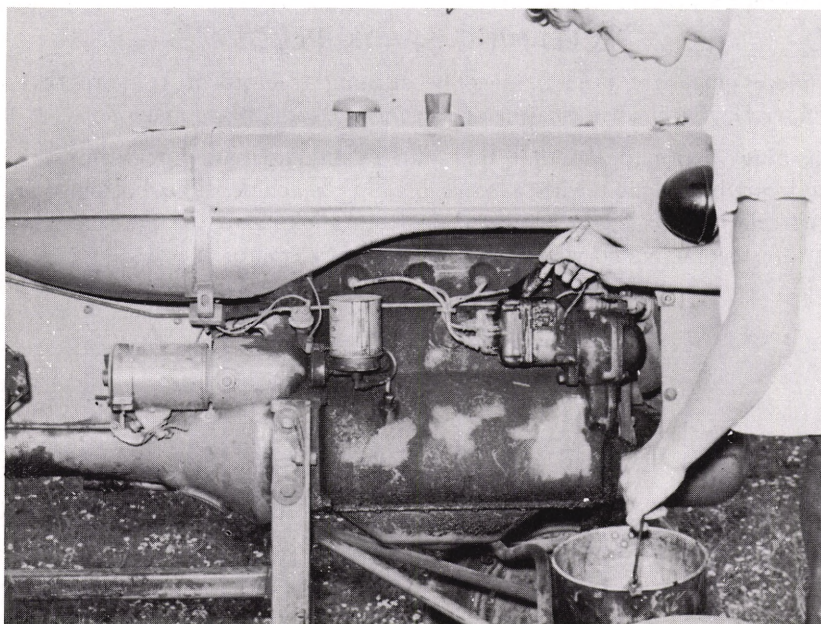


Fig. 17 Cleaning up ignition parts.

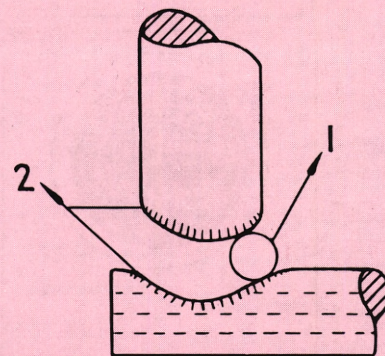


Fig. 14 Checking the spark plug gap with a round gauge.



Fig. 15 Use a socket wrench on spark plugs.

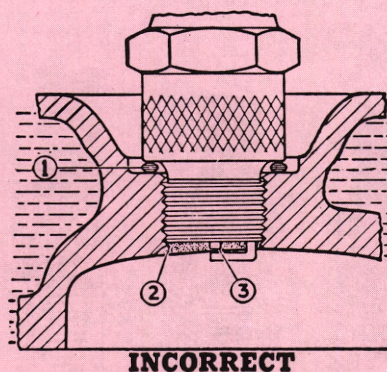
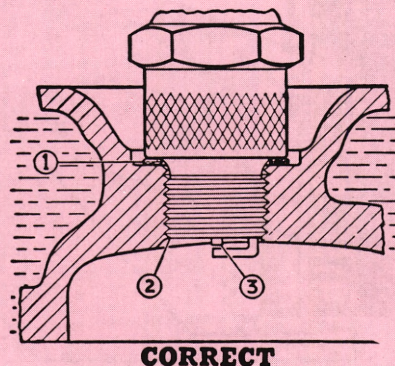


Fig. 16 Tighten the spark plug enough to crush the gasket.



1. Check the battery with a hydrometer. (Borrow one from a service station or garage.) List the reading for each cell. Use an electric voltage tester also, if you have one.

Do you have more than one battery in your tractor? _____

If so, what is the voltage of the system? _____

2. Is the water level OK in the battery? _____ Did you add water? _____

If so, what kind of water did you use? _____

3. Do the electrical connections on the battery need cleaning? _____

How did you clean them? _____

What should you do after cleaning them? _____

4. Replace worn battery cables. Be sure all terminals are tight. See that the battery is secure in the battery box or holder. Check to see that vent holes in filler caps are open. What did you find that needed repairing, adjusting, or replacing? _____

5. Is the generator charging too high? _____ Too low? _____

Can the charge rate be varied? _____ How? _____

How often should you lubricate the generator and starter? (See Operator's Manual.) _____

What lubricant is recommended? _____

6. What plug is recommended in your Operator's Manual for your engine? _____

Is this considered a hot or cold plug? _____

Do you have a spare set of plugs? _____

(It is a good idea to have a spare set so that one set can be taken to town and cleaned without laying up the tractor.)

7. Blow out the dirt from around each plug. Remove the plugs and check the plug gap. List the gap as found in each.

Cyl. No.	Make of Plug	No. of Plugs	Thread Size	Condition (Dirty, cracked, blistered, burnt electrodes)
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

How did you clean the spark plugs? _____

(Over)

8. What is the recommended spark plug gap for your engine? _____

What kind of a gauge did you use for checking the gap? _____

Which electrode did you bend? _____

9. Did you put in new gaskets when replacing spark plugs? _____

How tight did you tighten the plugs? _____

Was there any sign of leak around the gaskets when you took the plugs out? _____

10. Examine the spark plug wires to make sure the insulation is not cracked. What did you find?

Clean all the dirt from around the plugs and high voltage system.

Wipe the wiring with a dry cloth.

11. Using your Operator's Manual as a guide, check the wiring system in your tractor. Be sure all terminals are clean and securely fastened.

What did you find? _____

ADDITIONAL NOTES _____

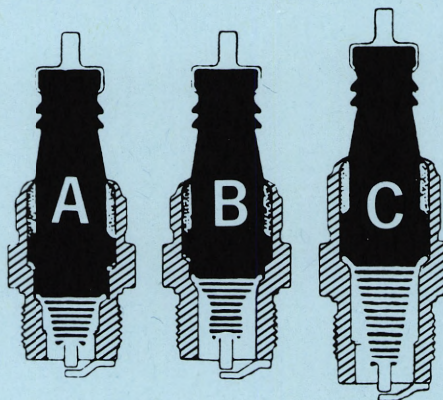
Note: Fill out this work unit, using your own tractor at home. Be ready to discuss your experiences with the other 4-H members at your next club meeting.



SECOND YEAR UNIT 4

BATTERY SERVICE AND SPARK PLUG CARE

- I. Label correctly, in the spaces on the right, the heat range of the three plugs shown.



Hot

Normal

Cold

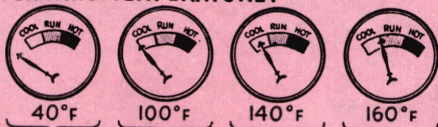
- II. Place the letter for the correct answer at the right of the page.

1. A wire brush is used to clean: (A - electrodes) (B - porcelain) (C - threads) of spark plugs. _____
2. In gauging the spark gap of used plugs (A - a flat gauge) (B - a round wire gauge) is more accurate. _____
3. Setting spark gaps closer together than recommended causes: (A - poor idling) (B - better idling) (C - easier starting). _____
4. The main difference between a HOT and COLD plug is (A - the gap setting) (B - length of the insulator below the gasket shoulder). _____
5. A fully charged battery will deliver 65% of its cranking power at (A - 32° F.) (B - 60° F.) (C - 0° F.) _____
6. On a tractor that has a magneto, the battery can be removed and the tractor operated without danger if the generator (A - is) (B - is not) grounded. _____
7. If a battery is low, the battery is (A - more apt) (B - less apt) to freeze. _____
8. Keeping a battery fully charged all the time (A - is good for it) (B - burns it out sooner than necessary). _____
9. Poor or worn insulation on spark plug wires (A - doesn't) (B - does) affect starting efficiency. _____
10. The voltage regulator controls: (A - how fast the generator charges the battery) (B - how much voltage the battery puts out). _____

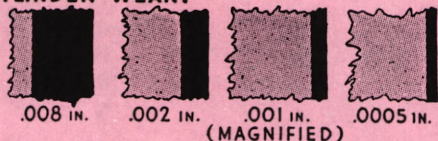
Note: This Check-Up Sheet is intended to test what you have learned and to stimulate discussion with the other members. The more you discuss these questions with your leader and the other members the more you learn.



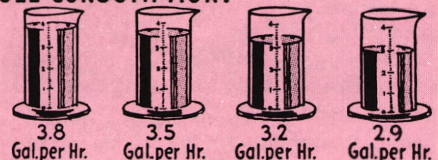
OPERATING TEMPERATURE:



CYLINDER WEAR:



FUEL CONSUMPTION:



POWER:

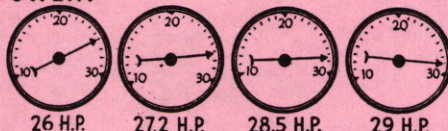


Fig. 1 Here's what happens when you operate your engine too cool.



Fig. 2 A cooling system temperature gauge.

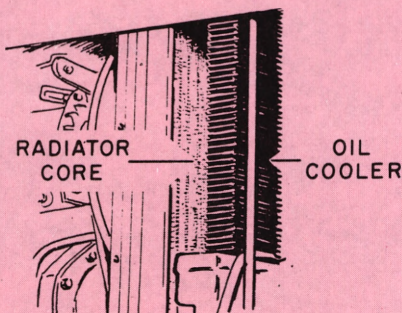


Fig. 3 On some tractors, the hydraulic system oil is cooled by air drawn through the radiator.

Do you know what would happen if you put a fire under an empty pan? The heat would soon burn a hole in the pan. If you put a little water into the pan, the water will pick up the heat.

Another way to cool the pan is to blow cool air over it. To do so requires a fan. We cool some engines with a fan and air. We call these "air-cooled" engines. We cool others with water and call them "water-cooled."

RADIATORS

In a water-cooled engine, water would soon boil away if the heat were not removed. To remove the heat we pass the water through a radiator. A radiator has a tank on top. Attached to the tank are a number of copper or steel tubes. These tubes carry the water to a lower tank in the radiator. Around the tubes are many thin pieces of metal called fins, which pick up heat from the water. Air passes around the fins and tubes, picks up the excess heat and carries it away. A fan keeps a large amount of air moving through the radiator. So you see, in a water-cooled engine, both water and air are used for cooling.

WHAT THE COOLING SYSTEM HAS TO DO

The cooling system of an engine has two jobs to do. It must keep the engine from overheating and it must also keep a uniform temperature in the engine. Up to one-third of the fuel heat released in an engine must be removed by the cooling system. Engines can be damaged from overheating; and much damage can also be caused by operating them too cool. Operating an engine too cool causes a high rate of wear. It may also cause spark plug fouling and a waste of fuel.

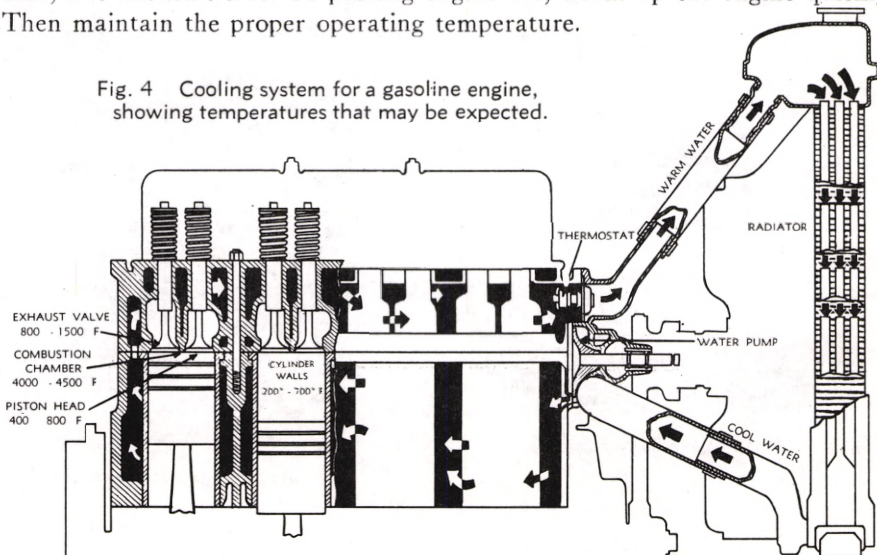
On some engines, hydraulic system oil is circulated through a coil in front of the radiator. This helps to cool the oil when the engine is running.

DIESELS

A diesel engine fires by injecting fuel into hot, highly compressed air. Therefore, the engine must be kept warm to prevent overcooling the air. Running a diesel engine cold fouls the injectors and causes excessive wear. Remember, always bring an engine up to proper operating temperature before you apply a heavy load.

Tractor engines and power units are built with great cooling capacity—enough to keep them from overheating when pulling a heavy load on a hot day. For this reason some operators believe that a tractor should run cool; but this isn't true. To prolong engine life, warm up the engine quickly. Then maintain the proper operating temperature.

Fig. 4 Cooling system for a gasoline engine, showing temperatures that may be expected.





PUMP AND THERMOSTAT SYSTEM

Whenever a water pump is used on a cooling system, a device is needed to prevent the water from circulating until the engine becomes warm. A thermostat is such a device. It is an automatic water valve that opens with heat.

A bellows-type thermostat outwardly looks like a solid coil spring; but inwardly it is filled with a high-boiling alcohol or a similar solution. Whenever the thermostat reaches a particular temperature, the sealed-in solution boils. The pressure opens a valve and allows water to circulate through the radiator. Thermostats are available for varying temperatures.

Another type of thermostat often used is made up of two metal strips wrapped in a coil. One strip expands faster than the other when heated. When the thermostat heats, it opens a valve, just like the bellows type of thermostat.

When hard water is used, thermostats become covered with lime scale. If they open and close often, they can break, just as a piece of wire is broken from frequent bending. Be sure you have a thermostat in your cooling system that works properly.

CHECK THE THERMOSTAT

An easy way to check a thermostat on many engines is to start with a cold engine. Crank it up and, while it is running at about three-fourths speed, remove the radiator cap. Then look in to see whether the water is circulating in the system. The thermostat should be closed; but, if it is open, you will see water circulating rapidly in the system. On some engines a baffle obstructs the view into the radiator. If you have such a tractor engine, put a thermometer into the top of the radiator. If the thermostat is closed, as it should be, you will have to run the engine a while before the thermometer records much change in temperature. When a thermostat begins to open, the temperature of the water at the top of the radiator will rise rapidly.

Here's how to check a new thermostat or one that you have removed from your tractor. Use a string and pencil to suspend the thermostat in a can of water, along with an oven or deep-fat thermometer. Place the can of water on the stove or hot plate. As the water heats up you can watch the thermostat to see if it opens at the correct temperature. If the thermostat is working properly, it will open at the same temperature as indicated by a stamping on the thermostat.

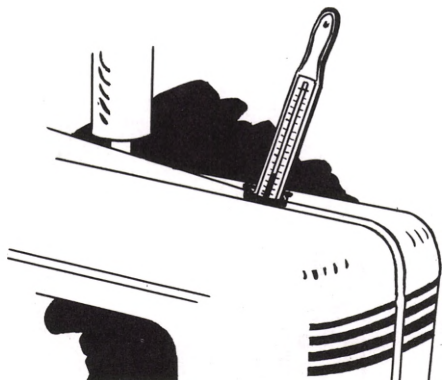


Fig. 9 Measuring radiator temperature.



Fig. 8 Checking a new thermostat.

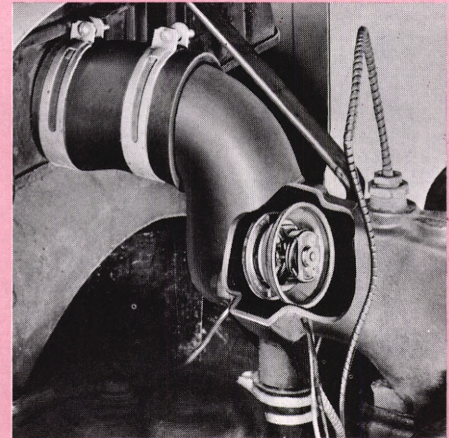


Fig. 5 The thermostat acts as a valve to control flow of liquid in the cooling system.



Fig. 6 A metal strip thermostat that has been ruined by scale.

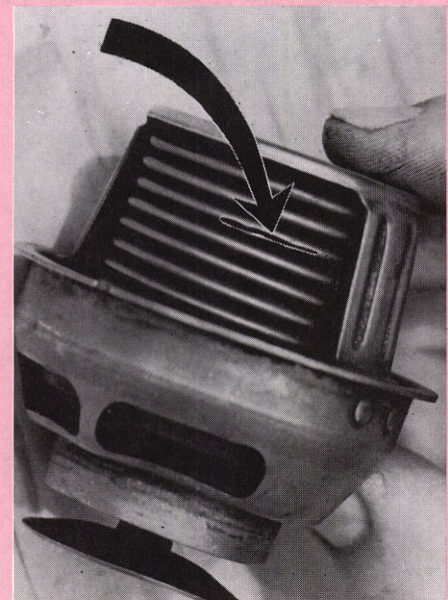


Fig. 7 A cracked bellows-type thermostat won't close.

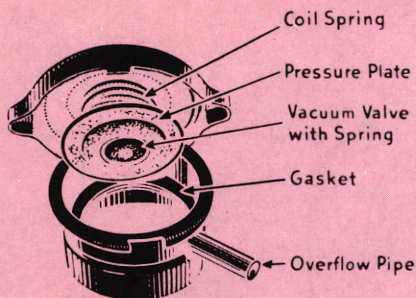


Fig. 10 Radiator cap of a pressure system.

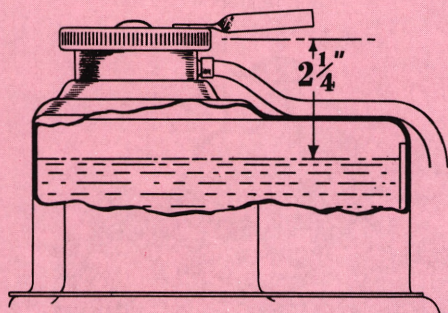


Fig. 11 Don't over-fill.



Fig. 12 Lime deposits in the cylinder head from hard water.

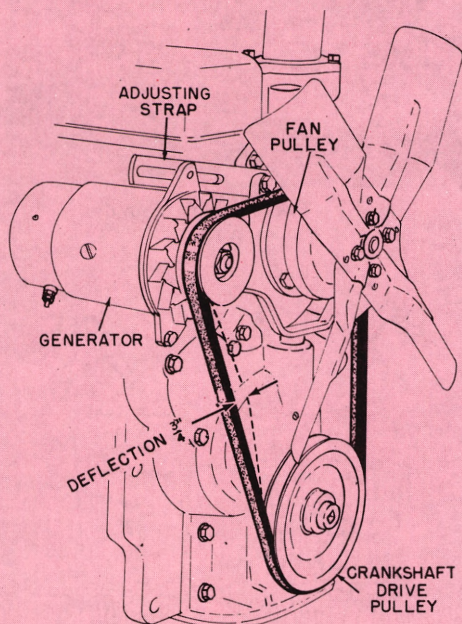


Fig. 13 Keep the fan belt properly adjusted.

PRESSURE SYSTEM

On most engines the radiator cap is sealed. It contains one valve that admits air to keep the radiator tubes from collapsing and another that lets water escape at a pressure of 6 or 7 pounds. We call this a pressure cooling system.

If your engine has such a cooling system, you should make sure that the gasket used to seal the radiator cap fits tightly and that it doesn't leak. *You must also be sure the engine has cooled before you remove the radiator cap. If you remove the cap when the engine is hot, you are likely to be burned, because water in a pressure cooling system runs at a temperature much higher than in other systems.* In fact, the boiling point for a pressure cooling system is about 228°F.

It is important that you do not over-fill the radiator of your engine. Some space must be left for water expansion. If you put in too much water, the excess will run off in the overflow pipe. Some people have been led to believe that the engine was overheating when they have seen water running out of the overflow pipe. Be sure to use clean, soft water when filling the radiator. Rainwater is good to use. If you use rainwater, it is a good idea to put a rust-proofing solution in the radiator.

The use of hard water can cause lime deposits to build up on the inside of the cylinder head. Such deposits interfere with cooling. In older engines lime deposits in the cooling system around the valves is a common cause of shortened valve life. It is difficult to remove these deposits unless a special cleaning solution is used. Your leader or your tractor dealer can tell you what to use to remove lime deposits.

FANS AND BELTS

Most engines are equipped with a V fan belt, which should be adjusted so that there is about $\frac{3}{4}$ -inch to 1-inch slack measured halfway between the pulleys.

If the groove in the fan's pulley is adjustable, make sure that the belt runs in the proper position. If the belt runs at the bottom of the groove, you will soon damage the belt. However, if the belt runs too high in the groove, the pulley may run too slowly to give proper cooling. You may change the pulley groove, as well as tighten the belt, by moving the generator.

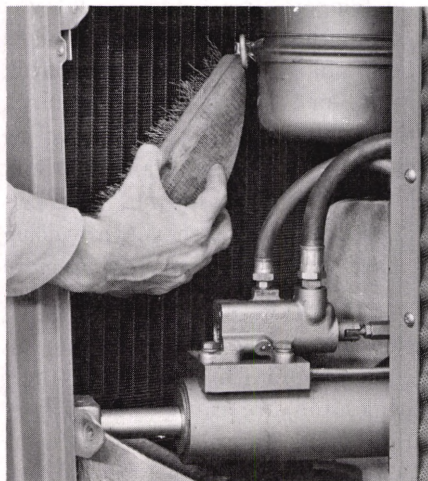


Fig. 14 Use a brush to remove trash from the front of the radiator grill.

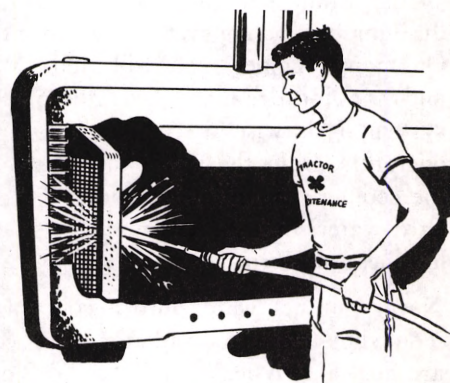


Fig. 15 Washing out the radiator.



ALLOW ENGINE TO COOL BEFORE STOPPING

An engine may be so hot after pulling a hard load that it will keep on running after you turn off the switch. This happens when red-hot carbon in the combustion space ignites the fuel. The best way to prevent it is to allow the engine to idle for about 5 minutes at one-half to three-fourths speed until it cools. Then, when you turn off the switch, the engine will stop. Turning off a hot engine without first allowing it to cool off is a common cause of stuck valves.

One of the most common causes of overheating an engine is low speed and overloading. The engine is overloaded and the speed of the fan is reduced. This gives less cooling when a larger amount of fuel is used. Overheating is also caused by allowing leaves and dirt to collect in front of the radiator and on the radiator fins.

KEEP AIR-COOLED ENGINES CLEAN

Air-cooled engines are used in small tractors. They are also used as power units on many machines. The air-cooled engine is often operated in dusty areas, where you must be especially careful to keep the air inlet screen clean. The engine must have air. On air-cooled engines you will find a metal shroud to direct the flow of air. The metal keeps the air close to the engine. Be sure dirt does not collect in the bends and between the fins around the cylinder. This can cause burned pistons or valves. Some engines have a section of the shroud which can be removed for cleaning. Keep the engine air path clean to prevent over-heating and thereby to help lengthen engine life.

WINTER PROTECTION OF THE COOLING SYSTEM

Water will freeze at 32° F. If water freezes in the cooling system, it will crack the block or head of the engine. Use an anti-freeze solution in the radiator to prevent freezing. One most commonly used has a high boiling point. It is known as the permanent type of anti-freeze. Another is alcohol which has a much lower boiling point and must be renewed occasionally. Keep in mind that an anti-freeze solution will not carry the heat away from the engine parts as rapidly as clear water; alcohol and water mixture is 75% as efficient, permanent type and water mixture is 87% as efficient as water. When warm weather comes, you should drain out the anti-freeze and replace it with water.

If you use water rather than anti-freeze in temperatures below 32°F., you should drain out the water each time after the engine is used. When draining the cooling system, be sure to drain the block as well as the radiator. On many engines, you will find two drains—one for draining the block and one for draining the radiator. If the engine has a pressure-cooling system, it is wise to remove the cap when the engine is drained. Many operators drain the water into clean pails so that it can be put back into the cooling system later. This is a good idea, especially when you are using hard water, because every time you add hard water you are adding more hardness to form scale.

Never put hot water into a cold engine or cold water into a hot engine. You should inspect radiator hose connections often to make sure there are no leaks. A leaky radiator hose or a leaky radiator causes you to keep adding water. If you add hard water, you add scale. Stop leaks.

Check the inside of the radiator hose also. Rubber wears off with age and it can be carried to the top of the radiator, where it may plug up the small tubes in the radiator.

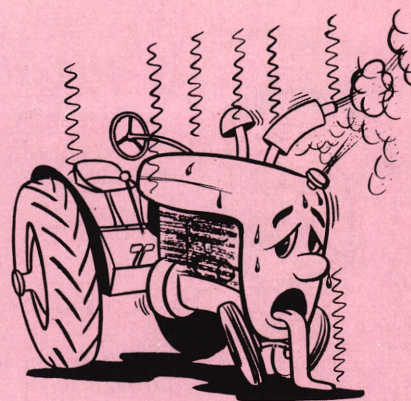


Fig. 16 Let your engine cool off before stopping.

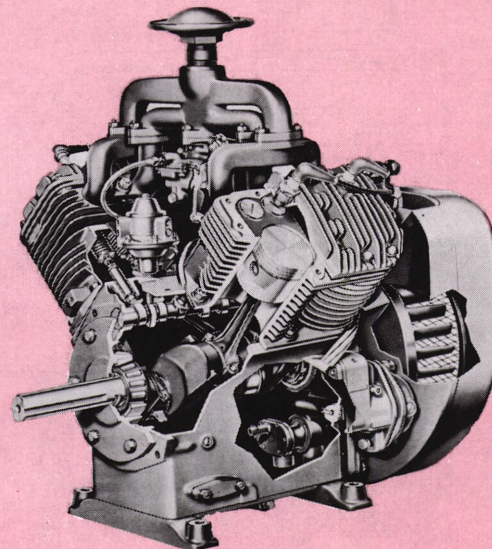


Fig. 17 An air-cooled engine.

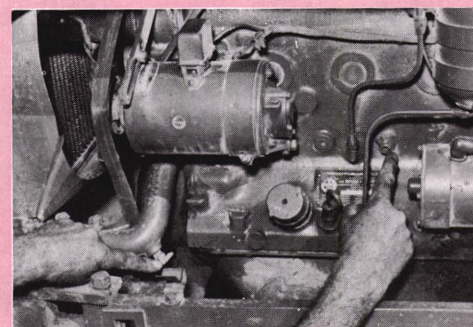


Fig. 18 Two places to drain the cooling system.

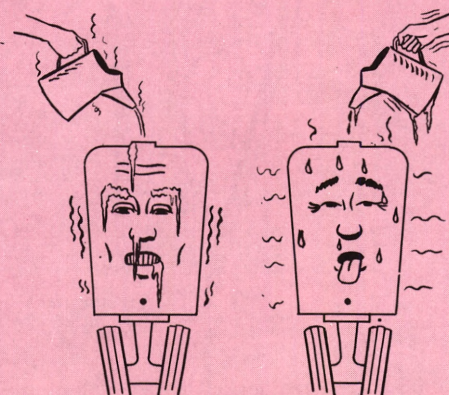


Fig. 19 Never put hot water in a cold engine or cold water in a hot engine.



Let's check the cooling system. Answer the questions when you have done the job.

1. Check the condition of radiator hose connections. Did you find any that were leaky, rotten, or pinched together? _____ Tighten clamps or replace hoses where needed.
2. Remove grill or work behind it and clean away trash from front of radiator core.
What dirt or trash did you find? _____
How much of the core was plugged up? _____
3. Clean dirt from between radiator fins by using an air or water hose. Wash from back and side to front. Be careful not to punch tubes or bend cooling fins. Did you get out much dirt by doing this? _____
4. Inspect and adjust your fan belt. Was replacement necessary? _____
Which pulley moves to adjust the belt tension? _____
How much play did you leave in the belt? _____
5. Inspect the water pump for leaks. Adjust, if necessary. Lubricate according to directions in the Operator's Manual. Was your pump OK, or leaking? _____
What adjustment did you make, if any? _____

6. How many places are there for draining the cooling system? _____
7. Fill the radiator with clean, soft water. Rainwater is best. Where did you get the water you used?

8. Have you noticed any lime deposits inside the radiator, on the thermostat, or in the water jacket?
_____ These are usually caused by "hard" water. Clean rainwater will prevent such deposits.
9. Check to see that the overflow pipe is clear. If you have a pressure-cooled tractor, inspect the steam pressure release in the radiator cap and be sure a good gasket is used. Is it in working condition? _____
_____ Is the gasket air tight? _____

(Over)



SECOND YEAR UNIT 5

COOLING SYSTEMS FOR ENGINES

Place the letter for the correct answer at the right of the page.

1. Burning fuel temperatures range between 3,000 and 4,000 degrees Fahrenheit. Approximately (A - one-third) (B - all) (C - one-tenth) of this heat is carried off by the cooling system. _____
2. Temperatures are highest around the (A - cylinder head and exhaust valves) (B - piston and walls of cylinder). _____
3. When burning gasoline, temperature of the cooling water should be (A - as low as possible) (B - between 165° and 185°) (C - 190° to 210°) for best performance. _____
4. Extremely high temperatures caused by operating without water in the cooling system (A - will) (B - will not) cause pistons to stick. _____
5. It is best to use (A - cold wellwater) (B - rainwater) in your radiator. _____
6. If excess grease enters the cooling system it (A - will) (B - will not) interfere with cooling efficiency. _____
7. What precautions would you take to keep your tractor from freezing up when standing idle? (A - Use an anti-freeze or drain) (B - Put a light under the engine). _____
8. Tractor engines that run too cool (A - are best for hot days) (B - waste fuel). _____
9. Pressure cooling systems (A - are sealed and have a pump to force the water through the engine) (B - lower the boiling point of the coolant). _____
10. To remove all the water when draining most tractors which have a water pump, drain at (A - radiator and block) (B - radiator only). _____

Note: This Check-Up Sheet is intended to test what you have learned and to stimulate discussion with the other members. The more you discuss these questions with your leader and the other members the more you learn.

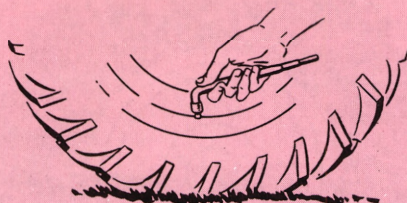


Fig. 1 Checking air pressure.

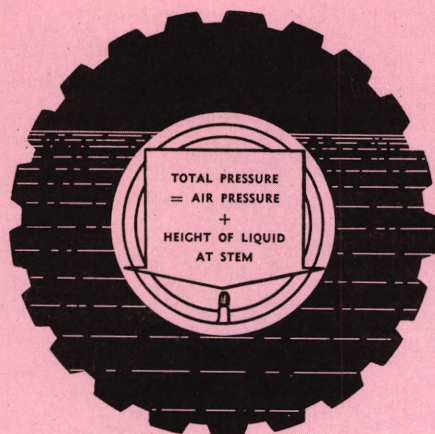


Fig. 2 Valve stem should be at the bottom when testing pressure of liquid-filled tire.



Fig. 3 Under-inflation is tough on tire sidewalls.



Fig. 4 Over-inflation can cause rapid tire wear.



Fig. 5 Shows correct inflation pressure in a tire.

Repair and replacement of tractor tires makes up about 30 percent of the total repair cost on a tractor during its life. You can reduce repair costs, and tires will last longer if you follow these simple rules:

1. Check air pressures regularly.
2. Use wheel weights to reduce slippage.
3. Drive carefully.
4. Keep tires repaired.

CHECK AIR PRESSURE FREQUENTLY

Check air pressure every two or three weeks. Do not allow it to drop below the minimum recommended for a particular tire. Remember that air pressures change somewhat with the temperature of the outside air. You should use a low-pressure gauge with one-pound markings in order to get accurate readings. Check the gauge occasionally for accuracy.

If you put calcium chloride in the tires, use a special gauge which can be cleaned and lubricated after the tires are checked. Have the valve stem at the bottom to get an accurate reading of tire pressure. Pressure taken at this point represents the air pressure plus the height of liquid at the stem. The difference is two or more pounds in large tires. If the tire contains liquid, prove to yourself that you get different pressure readings with the valve up and down. If you have only air in the tire, the pressure will read the same for all positions of the valve.

PROPER INFLATION

Proper inflation is important to tire life. For example, operating tires 5 pounds under-inflated will cut the tread life one-third. Under-inflation is the most common cause of shortened tire life. Under-inflation will damage the cord body of the tire and cause a series of breaks in the cord fabric of the sidewall. Such breaks usually occur first on the inner sidewall of the furrow wheel tire. Under-inflation results in repeated buckling on the sidewall. The constant buckling breaks the tire cords. Under-inflation may also allow the tire to slip on the rim and tear off the valve stem.

Over-inflation should be avoided, too. It reduces traction and results in excessive slippage and rapid tread wear.

Keep valve caps in place. Test the valves for leakage when you check tire pressure. The rubber washer in the cap gives an added air seal to the valve. The cap will keep out water and dirt that could mean trouble to you later.

GENERAL TIRE INFLATION DATA

In 1956, farm equipment and tire manufacturers adopted a new, extra-wide-base standard for sizing rear tractor tires. Minimum gauge pressures for both the old and new tire sizes are listed below:

Old tire size	New tire size	Minimum pressure
4-ply and 6-ply		
10, 11	11.2, 12.4	12 pounds
12	13.6, 13.9	14 pounds
6-ply		
13	14.9, 15.5	14 pounds
14, 15	16.9, 18.4	16 pounds

The minimum tire inflation pressure for all front tires is 20 pounds.



CARE OF TIRES

ADDED WEIGHT FOR BETTER TRACTION

The pulling power of a tractor depends on the weight it carries. The greater the weight, the greater pull it will have without too much slipping. However, the average tractor will require extra weight only when pulling heavy loads where the traction is poor. Additional weight is not needed for light loads or for running on the highway.

You can add weight by putting a mixture of calcium chloride and water in the rear tires, by using mounted equipment, or, where possible, by adjusting the hitch of the drawn implement so it will pull down on the drawbar of the tractor. When adding calcium chloride and water to tires, special equipment is needed. Your tire dealer has a special pump for putting liquids into tires.

The ability of a tractor tire to pull depends on the surface over which it is operating as well as on the weight on the tire. The following table shows the increased pull for each 100 pounds added to the rear tires (50 pounds per tire) operating over different surfaces:

INCREASED PULL OF TRACTOR

Type of Surface	Average Increased Pull in Pounds for 50 lbs. additional wt. per wheel
Concrete road	66
Dry clay	55
Sandy loam	50
Dry sand	36
Green alfalfa	36

Rear tires will usually slip when pulling a load; this is normal. However, the amount of slippage should not exceed 16 percent for most efficient field operation and 5 percent on pavement. We'll tell you how to check slippage later on in this lesson.

Where additional drawbar pull is needed, more weight can be added; but do not exceed the maximum carrying capacity of the tires. Whenever weight is added to the tires, the air pressure should be adjusted. See your Operator's Manual or ask your dealer to obtain information about the correct inflation pressure when weights are used.

FRONT-END WEIGHTS

When operating a tractor with rear-mounted implements or on hilly ground, it is important to add weight on the front end of the tractor. The added weight will give better draft control, improve steering, and help prevent backward tipping. Front-end weights cannot always maintain stability if the tractor is driven too fast over rough ground with heavy rear-mounted equipment in the raised position. Play safe and drive slowly under these conditions.

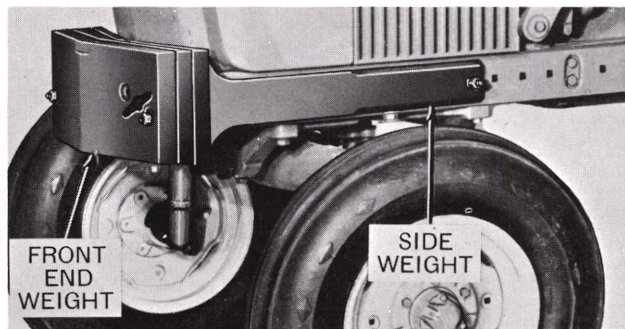


Fig. 10 Use front-end weights when operating the tractor with rear-mounted implements.

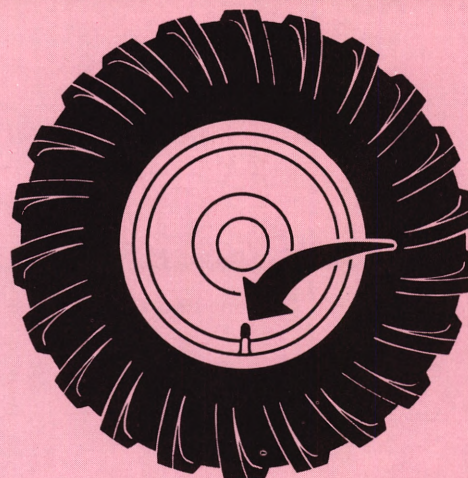


Fig. 6 Keep your valve caps on.



Fig. 7 Excessive slippage causes tread wear.

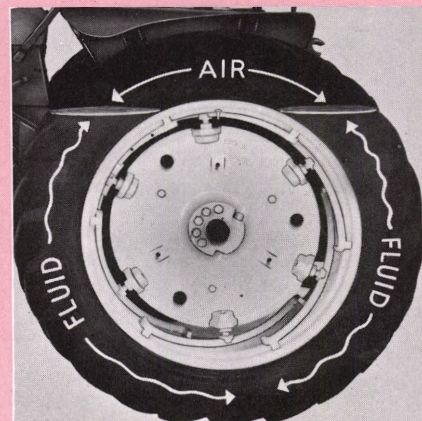


Fig. 8 Add calcium chloride and water to rear tires for additional weight.



Fig. 9 Wheel weights can also be used to add weight to the rear wheels.



Fig. 11 Check slippage by tying a cloth to a spoke and counting off 30 revolutions.

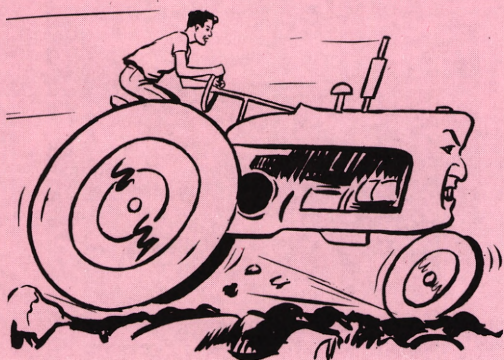


Fig. 12 Excessive speed is dangerous and shortens tire life.

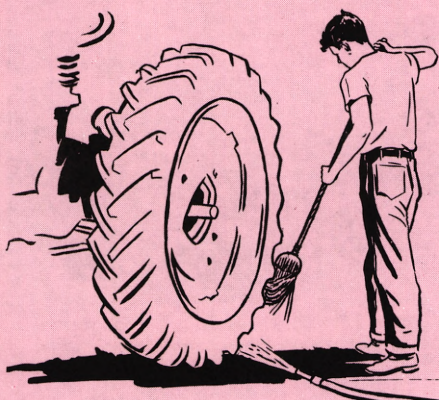


Fig. 13 Cleaning tires.

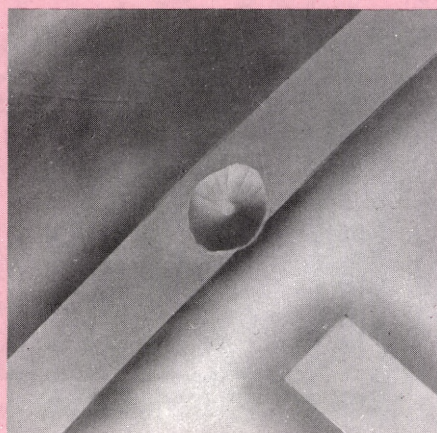


Fig. 14 A cut that has been repaired to prevent further damage.

CHECKING TIRE SLIPPAGE

Slippage is a common source of tractor tire wear. It may be caused by over-inflation or by trying to pull too heavy a load. To prevent excessive slippage in the field, add weight to the tires or decrease the load. In field service, it is easy to note excessive slippage by looking at the tread track. If the tread track is broken due to the spinning of the tire on the surface of the soil, you have too much slippage.

To check the amount of slippage accurately, tie a cloth on the spoke of the rear wheel and drive the tractor unloaded until the wheel makes 30 revolutions. Mark the distance the tractor traveled with a stake. Then pull a load over the same distance, counting the number of revolutions made by the rear wheel. Subtract 30 (the number of revolutions the tractor made without load) from the number under load. Then divide the difference by the number of revolutions made under load and multiply by 100. The answer will be the percentage of slippage.

Example: The tractor under load made 34 revolutions over the same distance it took to make 30 revolutions when not pulling a load. Solution:

$$34 - 30 = 4 \quad \frac{4 \times 100}{34} = 11.8 \text{ (percent slippage)}$$

This makes a good demonstration.

CLEAN TIRES LAST LONGER

Rubber can be damaged by grease and oil. Therefore, keep these materials away from tires. Also, after using your spray rig, always clean the excess spray off tires.

When tractors are left outdoors, tires may become weather-checked. In order to prevent such checking, it is wise to paint the tires with a protective coating which can be obtained from your tire dealer.

Protect tires from sun when you store the tractor. Jack up the wheels to take weight off tires when your tractor is likely to be stored for a long period.

If you have tires with self-cleaning tread bars, be sure they are mounted with the "V's" pointing forward.

SPEED CUTS TIRE LIFE

Excessive speed causes rapid tire wear. Avoid driving at high speed. This advice applies to trucks and passenger cars as well as tractors. High speed is harmful to tires—and dangerous for you.

REPAIR TIRE DAMAGES PROMPTLY

When minor damages to tires occur, give them prompt attention and repair. You will prevent more serious damage, expense, and field delays.

If a cut or snag in the tire tread does not expose the cords, clean it out with an awl or similar tool to remove any stones or other foreign objects. Then remove any loose rubber with a narrow-bladed knife, and bevel the cut by trimming a cone-shaped cavity to the bottom of the injury. Make sure the sides of the cavity are beveled enough to prevent it from picking up stones. Tires with cuts treated in this manner may be used without danger of the cut getting larger.

Deep cuts, which expose the cord body, should be repaired by your local dealer.



CARE OF TIRES

PROBABLE CAUSES OF UNEQUAL TIRE WEAR

Wear on trailing edge of tread bar:

Under-inflation. Probably such wear is due to operating on a highway with pressure too low; can be corrected by increasing pressure.

Wear on sides of tire tread:

Under-inflation. Check instructions for pressure.

Wear on center of tire tread:

Over-inflation. Tires will not give nor roll easily over obstructions. Slipping in wet, muddy spots may cause cuts.

Wear on leading edge of tread bars:

Over-inflation. Tire is digging instead of rolling.

Many tire cuts and bruises:

Over-inflation. Tires will not give and roll easily over obstructions. Slipping in wet, muddy spots may cause cuts.

Inside wear on wall of furrow tire:

Bad hitch. Tire running too close to furrow wall.

Expect these troubles from wrong inflation pressures on tires:

Over-inflation

Excessive slippage
Rapid tread wear
High fuel consumption
Damaged tires
More punctures

Under-inflation

Broken side walls
Rim bruises
Torn valves from slipping
of tire on rim

DOING BELT WORK

When a rubber-tired tractor is doing belt work, static electricity and sparks may be developed if the tractor is not grounded. Ground the tractor by connecting a chain or rod to the metal framework and running it to the ground. On four-wheel wide-tread tractors there is sometimes danger that the belt may cut the front tires. Such cutting can be prevented by placing a piece of sheet iron over the front tire to act as a shield.

RULES FOR PROLONGING TRACTOR TIRE LIFE

1. Keep all oil and grease off tires.
2. Inspect tires frequently for cuts and bruises and repair them properly and promptly.
3. Check tire inflation at least once every two weeks, preferably oftener.
4. Remove foreign particles from tractor tires.
5. Operate the tractor with a minimum of tire slippage.
6. Own and use a good tire pump.
7. Keep the tractor jacked up when not in service for a long period of time.
8. Keep the tires protected from sunlight as much as possible.
9. Use care when driving on highways. Don't tow the tractor at high speeds.
10. Occasionally rotate tires between wheels to distribute wear more evenly.
11. Ground the tractor when doing belt work to avoid injury and fires from static electricity.
12. On four-wheel tractors put a shield over the front wheel to prevent the belt from rubbing the tire.
13. Keep wheel lug bolts tight.



Fig. 15 Irregular wear caused by operating the tire at low pressure on a hard road surface.

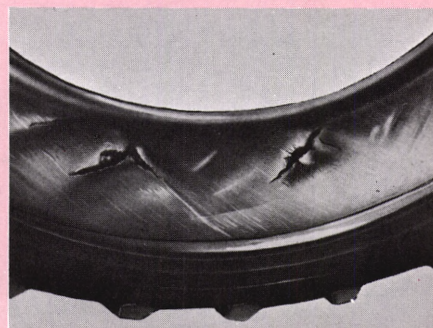


Fig. 16 Sidewall buckling due to constant use at too low a pressure.

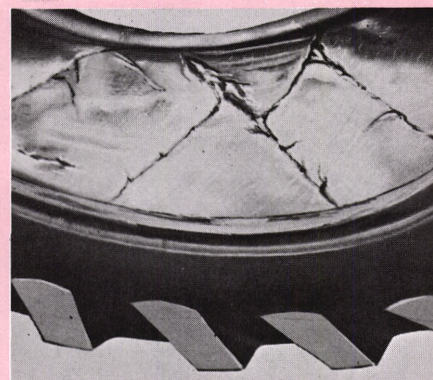


Fig. 17 The result of too much speed over rocks and other obstructions.



Fig. 18 Ground your tractor when doing belt work.



Even if you use a crawler tractor, it will be easy for you to find a rubber-tired tractor or other equipment using rubber tires. Look them over and see what you can learn about care of tires.

1. What make and model of tractor are you using? _____
2. What size are the tires on your tractor?

	<u>Front</u>	<u>Rear</u>
Left	_____	_____
Right	_____	_____
3. What is the recommended air pressure for these tires?
 Rear _____ Front _____
4. Check them and write down the pressure readings.
 Right front _____ Right rear _____
 Left front _____ Left rear _____
 How often should you check the tires? _____ How often do you add air? _____
5. Do the tires contain an anti-freeze solution? _____
 If so, what did you use and how much? _____
6. Does the tractor have wheel weights? _____
 How much added weight is used when plowing? _____
 List weight for each wheel: Left _____ Right _____
 Do you use weight on the front of the tractor? _____
7. What type of tire gauge did you use for checking pressure? _____
8. Do you ground your tractor when doing belt work? _____ How should you ground a rubber-tired tractor? _____
9. Inspect all the tires carefully and record any repairs or corrections to be made. _____

10. While the tractor is pulling a heavy load in the field, determine the exact amount of slippage on the rear tires by making the demonstration outlined.
 No. of revolutions tractor rear wheels turned when pulling load _____
 No. of revolutions tractor rear wheels turned without load _____
 Percent slippage _____

Note: Fill out this work unit, using your own tractor at home. Be ready to discuss your experiences with the other 4-H members at your next club meeting.

ADDITIONAL NOTES _____

Lined area for additional notes, consisting of 20 horizontal lines.

MEMBERS'



CHECK-UP

SECOND YEAR UNIT 6

CARE OF TIRES

Place the letter for the correct answer at the right of the page.

1. Tractor tire replacement and repair makes up about (A - 10%) (B - 30%) (C - 50%) of the total repair costs for a tractor. _____
2. Extra weight carried by tractor tires to give greater pulling power is needed: (A - only for heavy pulling) (B - for road operation) (C - only when heavy equipment is mounted on tractors). _____
3. For each 100 pounds added to the rear wheels of a tractor being operated in sandy loam the average drawbar pull will increase: (A - 66 lbs.) (B - 50 lbs.) (C - 36 lbs.). _____
4. For more efficient field operation the rate of slippage of rear tractor tires should not exceed: (A - 16%) (B - 11%) (C - 5%). _____
5. The most commonly neglected service in tractor care is: (A - rotation of the tires) (B - keeping mud from caking around lug grips) (C - proper inflation). _____
6. Over-inflation: (A - allows the tire to slip on the rim) (B - reduces traction, resulting in excessive slippage) (C - results in repeated buckling of the sidewall). _____
7. Under-inflation causes (A - damage to the sidewall of a tire) (B - reduced traction). _____
8. The right gauge to use regularly in checking air-inflated tractor tires accurately: (A - should have 3-pound graduations) (B - should have a minimum reading of 50 lbs.) (C - should be a low-pressure gauge with 1-pound graduations). _____
9. When a rubber-tired tractor is operated on belt work: (A - ground the tractor so the ignition will not be shorted) (B - ground the tractor to eliminate static electricity). _____
10. Tractor tire slippage can be reduced by: (A - increasing the air pressure) (B - increasing the engine speed) (C - adding weights to rear wheels). _____

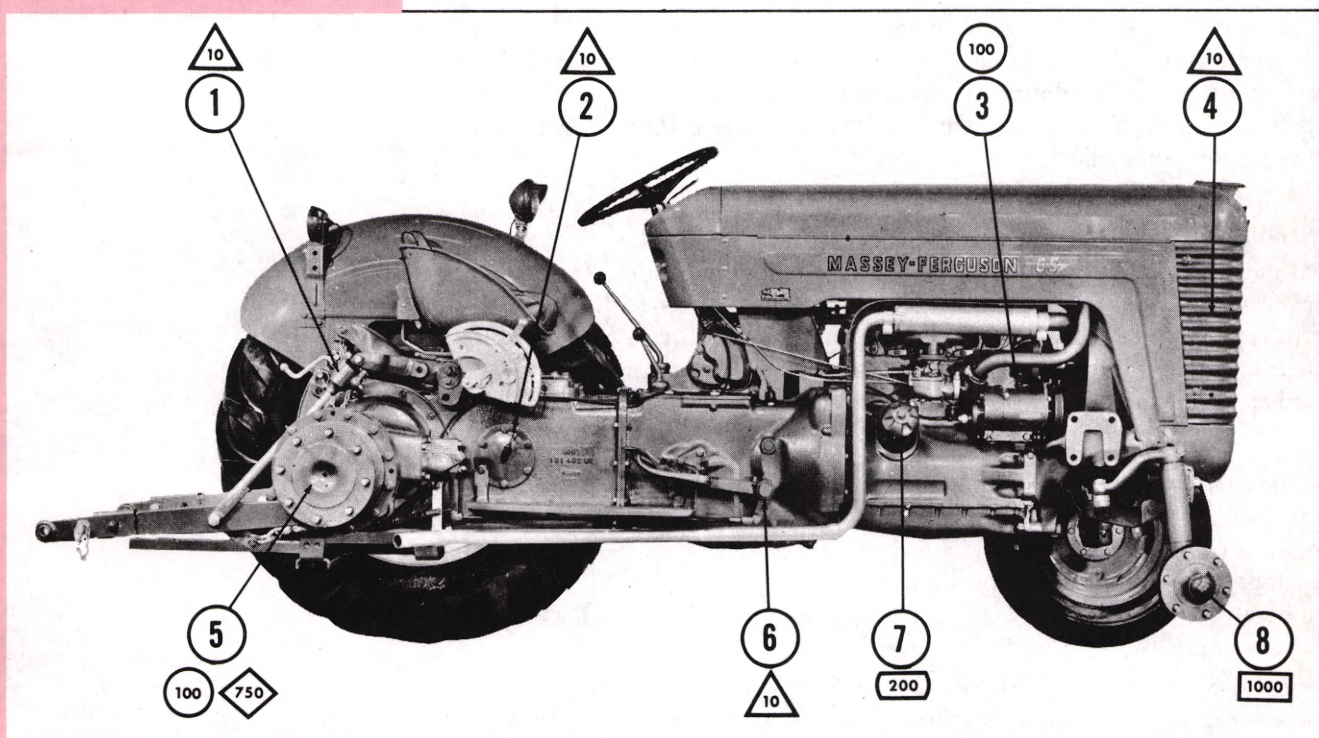
Note: This Check-Up Sheet is intended to test what you have learned and to stimulate discussion with the other members. The more you discuss these questions with your leader and the other members the more you learn.



Regular lubrication with the proper lubricant is necessary for the long life and trouble-free operation of your tractor. Your Operator's Manual will show a lubrication guide for your tractor. It tells you what kind of lubricant to use, how to use it, and how often it needs to be used.

An example of a lubrication chart is shown below. Notice that symbols are used to show how often, in terms of hours, each point should be lubricated.

-  Daily or after every 10 hours
-  Semi-monthly or after every 100 hours
-  Monthly or after every 200 hours
-  Spring and fall or after every 750 hours
-  Yearly or after every 1,000 hours



Lubrication Chart (Right side)

- | | |
|---|-------------------------|
| 1. Lift leveling box | 5. Rear axle planetary |
| 2. Transmission, differential, and hydraulic system | 6. Brake pedal assembly |
| 3. Generator | 7. Oil filter element |
| 4. Air cleaner | 8. Front wheel bearings |



GENERAL LUBRICATION

As shown by the diagrams on page 1, there are several places on a tractor that require lubrication. Several different kinds of lubricants may be needed, including oils, greases, and gear lubricants. Some of the more common lubrication systems are covered in more detail in other parts of the 4-H Tractor Program literature.

OIL THE GENERATOR AND STARTER

A lightweight motor oil (SAE 20, for example) is generally needed wherever you are supposed to use an oil can. A few drops of motor oil are usually needed on the generator bearings and sometimes on the starter.

OIL THE DISTRIBUTOR OR MAGNETO

If the engine has battery ignition, you may find a piece of felt, which is really a wick, under the distributor rotor. To oil it you need to remove the distributor cap. At the same time, check the cam that opens and closes the breaker points. It needs only very light lubrication, usually with petroleum jelly or a special grease. Be careful not to get the oil or grease on the breaker points, as it might cause them to burn or short out the spark.

The distributor shaft also needs lubrication. On some distributors, there is an oil cup. Others have a plug that can be removed for installing a grease fitting or filling an oil reservoir.

If you have a magneto on your engine, it may need to be oiled. Here again, you should use only a little oil. Some magnetos have an oil reservoir in the base of the magneto. Before filling it you must remove a plug. The oil is fed to the bearings by a wick. On this type of magneto there is little danger of using too much oil.

GREASE THE BEARINGS

There are many bearings and wearing surfaces in engines and tractors that need greasing. Grease is used because it will stay on the bearings much longer than oil. Before applying grease you should wipe off the fittings. It is very important that you be careful not to get dirt into the bearings. Greasing a dirty grease fitting is a common way of getting dirt into the bearings. Wipe off surplus grease from the fitting to keep dirt from collecting.

WHAT ARE GREASES?

Grease contains mostly oil and some special soap to thicken it. The type of soap used determines the type of grease. For instance, pressure gun or chassis grease is commonly made from what is known as lime soap. Such a grease is resistant to the washing action of water; but it should not be used where temperatures exceed 190°F. High temperatures would cause the soap and oil to separate.

A grease commonly used for tractors and automotive equipment is wheel-bearing grease. Made with soda soap, it operates well at high temperatures. Another type of grease widely used as a general-purpose product is made by using lithium soap. It is resistant to water washing and can also be used for high-temperature operation.

OIL CUPS

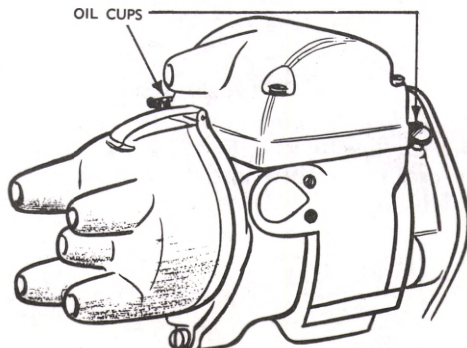


Fig. 5 Oil the magneto.

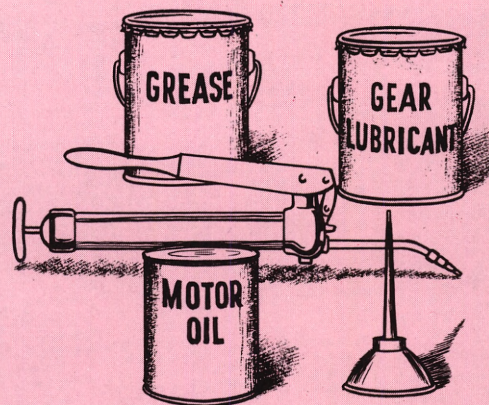


Fig. 1 Oils and greases.

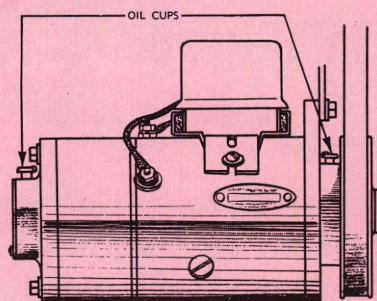


Fig. 2 Oil the generator.

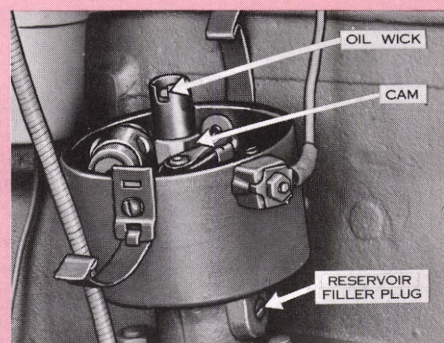


Fig. 3 Oil the distributor.



Fig. 4 Wipe fittings before greasing.

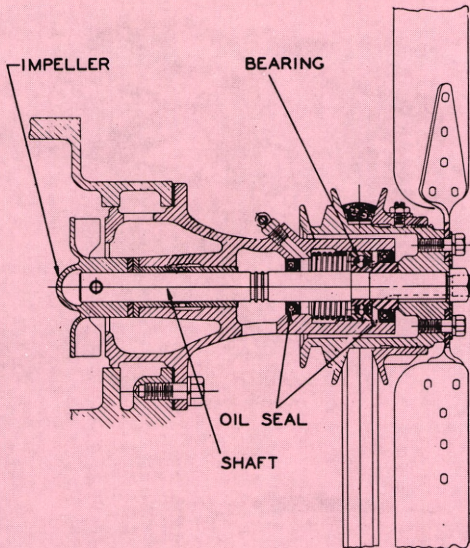


Fig. 6 Water pump with one grease fitting.



Fig. 7 How to fill a grease gun.



Fig. 8 Greasing a roller bearing.

WATER PUMP LUBRICATION

The water pump bearing on most of the newer tractors has been sealed at the factory and does not need further lubrication. If it starts to leak or develops a squeak, check with your local dealer. He may suggest the addition of a "soluble" oil to the radiator water, or the bearing may need to be repaired. If the water pump or fan bearing is equipped with a pressure-gun fitting for lubrication, a chassis grease can be used. Be careful not to overlubricate these bearings. Check your Operator's Manual.

HANDLING GREASE

You must be "especially" careful in handling greases. Be sure to keep the grease pail tightly covered while it is stored, so that dirt or water will not get into it. Keep the grease pail in a shed. Here's a tip for a good demonstration: If you dip the grease gun into oil before you start to fill it, the oil will keep the grease from sticking to the outside of the gun. By keeping a quart can of oil in your pail of grease you will have it handy when you want to fill your gun. The lid for the grease pail will also cover the oil and keep the dirt out.

When greasing ball or roller bearings by hand, keep in mind that it is the grease in the bearing that will actually lubricate it. Before packing the bearing, clean it carefully by washing in solvent and allow it to dry. Then dip the bearing in oil and allow to drain for a short time. A film of oil on the bearing makes it much easier to get the grease into it. The oil soon mixes with the grease. Because grease is mostly oil, anyway, a few drops of oil won't affect it.

Showing how easily oil will mix with grease makes a good demonstration. To make this demonstration put some grease in the palm of your hand. Make a cup in the grease. Add a few drops of oil. Stir with your finger and note how rapidly the oil mixes with the grease.

HOW TO GREASE

If the bearing is hand-packed, it is not necessary to fully pack the hub around the bearing. Putting too much grease into this space would cause the grease to work and become soft and oily. It might work out around the seals and damage them. (This makes a good demonstration. See your Club Leader.)

It is good practice always to grease at the end of a day's work. Then the bearing will be warm and will take grease more rapidly. The grease also will be warm and easier to handle. There are several other reasons why this is good practice. If it rains and you don't use your equipment for several days, the bearings will be protected by grease. If you get grease on your hands, you can wash them immediately when you get to the house. If the grease gun is almost empty when it's time to go home, fill it when you get there.

DEMONSTRATION!

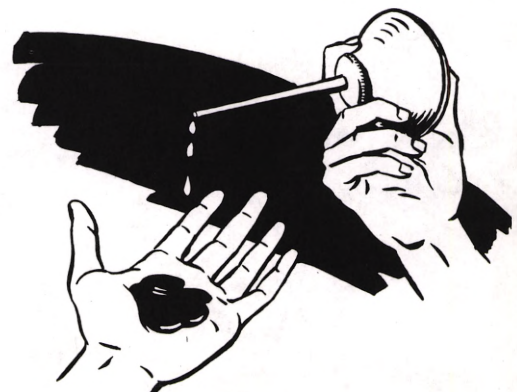


Fig. 9 Oil and grease will mix.



GENERAL LUBRICATION

GREASING CLUTCH

When greasing a clutch throw-out bearing or clutch pilot bearing, apply the grease sparingly. Too much grease on clutch bearings is a common cause of faulty clutch operation. Grease on the clutch face may cause the clutch to slip. Such a condition may cause heat to be generated and it often scores the plate, which becomes rough so that the clutch grabs.

On some tractors the fitting for lubricating the clutch throw-out bearings is located on the flywheel. It may be necessary to align the fitting with the hole in the bottom of the clutch housing. The point to remember is not to over-lubricate this bearing. Follow your instructions.

Some greases are stringy and tacky. If you are using a grease of this type in cold weather, remove the gun by sliding it sideways off the fitting. This will shear the grease strings and help prevent their being blown into your face by the wind. Another way to prevent this is to place a cloth around the tip of the nozzle before you remove it from the fitting. (This makes a good demonstration for showing how to handle the grease gun.)

FRONT WHEEL GREASING

If you lubricate with a grease gun and if the front wheel bearings of your tractor are equipped with grease fittings, lubricate the wheels frequently. Keep enough grease in the hubs to permit a little of it to work out around the seal and keep the dirt worked out. This type of lubrication is often used in irrigated areas where the tractor may be operated in water. Keeping the wheels filled with grease will keep out water.

TRACK ROLLER GREASING

On some crawler tractors grease fittings are used for the lubrication of the track rollers. The grease fittings are usually of the button-head type requiring a special gun for lubrication. When greasing this type of bearing, a soft grease is recommended. If the grease works satisfactorily in the low-pressure gun it is usually considered satisfactory for the track rollers. When applying the grease you can usually tell by a snapping sound when the bearing is filled. Be careful not to force too much grease into the bearing. A grease gun can have enough pressure to damage the bearing seals.

GEAR LUBRICANTS

The gear lubricant level in the transmission should be checked to make sure that you have sufficient lubrication. You may have other gear cases, such as final drive or a special differential case. If so, check your lubricant level in these cases also. The steering gear case should be checked to be sure of sufficient lubrication. Most gear cases are equipped with an air ventilating hole. Make sure the air vent is open.

In the Third Year Project, complete servicing of steering gear, transmissions and front wheels is covered. Ask your Club Leader when your 4-H Club will start these units.



Fig. 15 Checking lubricant level in the steering gear case.

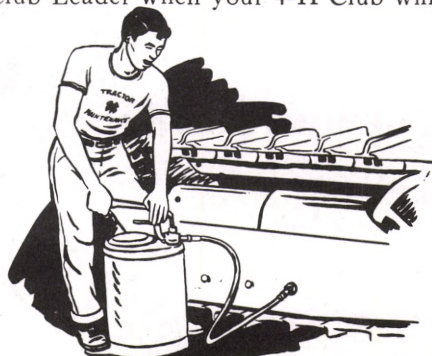


Fig. 14 Greasing track rollers.

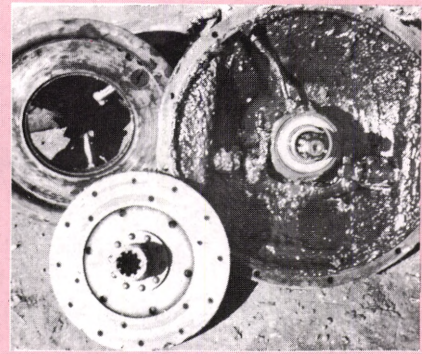


Fig. 10 Clutch parts ruined by over-greasing.

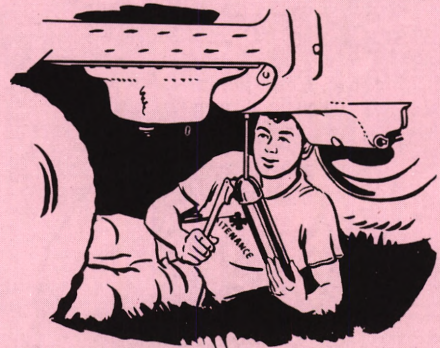


Fig. 11 Greasing a clutch pilot bearing.

DEMONSTRATION

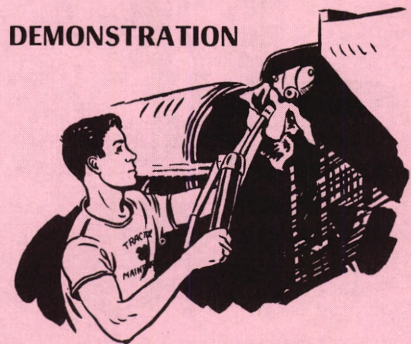


Fig. 12 Hold a cloth around the tip before you take away the grease gun.

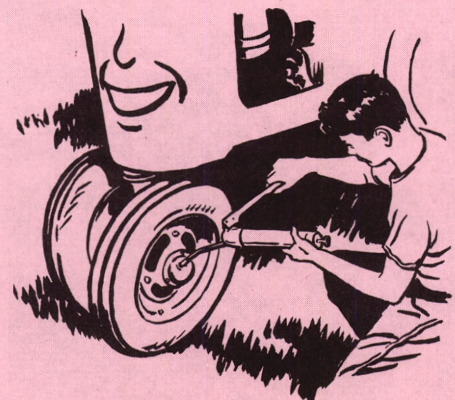


Fig. 13 Greasing a front wheel.



Let's lubricate the tractor.

1. Refer to your Operator's Manual and locate all the points that require lubrication.

How many grease fittings are there on your engine or tractor? _____

How many places need to be oiled? _____

How many gear cases did you find that needed lubrication? _____

2. What weight of oil do you use in your oil can? _____

3. Lubricate the electrical equipment on your engine.

Did you find any hidden places that might easily be overlooked? _____

Where? _____

Does the engine have battery ignition? _____

4. Wipe off the grease fittings before applying the gun, and grease your equipment.

5. How many places did you find that could be lubricated with chassis grease? _____

6. How many points on your engine require a high-temperature grease? _____

7. Does your engine have a water pump? _____ Does it require special grease? _____

8. Demonstrate how easy it is to fill a grease gun by first dipping it in oil.

How do you normally fill your grease gun? _____

Where do you keep the grease containers? _____

9. How many bearings do you find on your tractor where it is desirable to force in a little extra grease to work out the dirt? _____

When do you grease your equipment? _____

10. How many places are there for greasing the clutch on your engine? _____

What type of grease do you use for the clutch? _____

11. List two ways for removing the grease gun from fittings without stringing the grease.

12. How do you service the front wheel bearings? _____

(Over)

13. For crawler tractors: How many grease fittings do you have on track rollers? _____

What type of fittings did you find? _____

Do you need a special gun for greasing the track rollers? _____

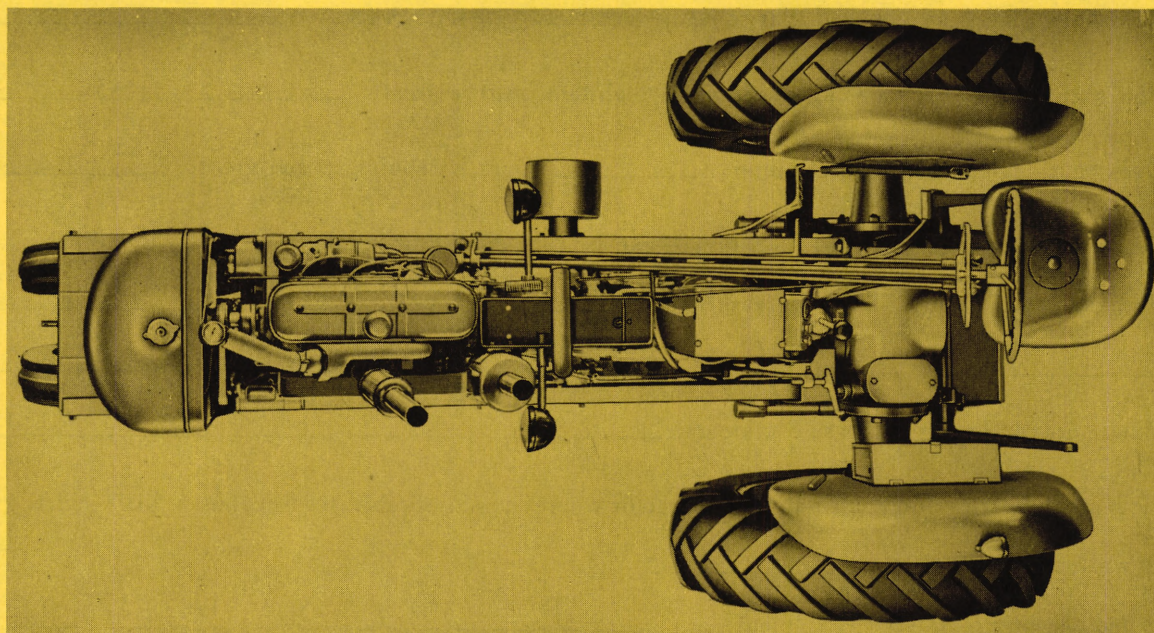
How often should they be greased? _____

14. Check the gear lubricant level in all cases. Did you find any of the cases low? _____

What grade of lubricant did you use for filling the case? _____

15. On the tractor shown below, mark all the points that require lubrication.

Mark points requiring daily lubrication with the letter "D", and those requiring less frequent lubrication with the number of hours, such as 50, 100, etc.



Note: Fill out this work unit, using your own tractor at home. Be ready to discuss your experiences with the other 4-H members at your next club meeting.

MEMBERS'



CHECK-UP

SECOND YEAR UNIT 7

GENERAL LUBRICATION

Place the letter for the correct answer at the right of the page.

1. Front wheel bearings having no grease fittings (A - do) (B - do not) need to be lubricated. _____
2. (A - All) (B - Some) water pump bearings are sealed and do not need periodic lubrication. _____
3. Too much grease on the clutch pilot bearing will cause the clutch to (A - work too slowly) (B - slip) (C - fail to work). _____
4. Tractor steering-gear cases are filled with oil and: (A - do) (B - do not) need servicing. _____
5. (A - Lighter) (B - Heavier) lubricants should be used during cold weather. _____
6. Hydraulic tractor power-lifts (A - sometimes) (B - never) (C - always) get their lubrication from the transmission case. _____
7. A little grease (A - should) (B - should not) be left on fittings to seal the openings against water and dirt. _____
8. Fittings should be wiped off before the grease gun is applied (A - so the nozzle of the gun will fit perfectly) (B - to prevent any dirt, dust or other harmful materials from being forced into the bearing). _____
9. Contaminants (A - do) (B - do not) get into grease as they do into oil. _____
10. Track tractors (A - usually) (B - seldom) have special fittings requiring: (A - high-pressure gun) (B - a special gun) for lubricating them. (Mark two answers). _____

Note: This Check-Up Sheet is intended to test what you have learned and to stimulate discussion with the other members. The more you discuss these questions with your leader and the other members the more you learn.

TRACTOR RECORDS AND OPERATING COSTS

UNIT 8
Page 1

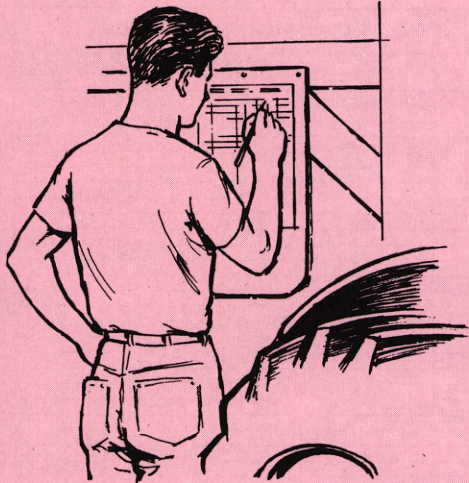


Fig. 1 Use records instead of depending on your memory—it will pay dividends.

Although you already know that service jobs have to be done at various regular intervals as recommended by your Operator's Manual, the big question is, how many jobs slip your mind; how many jobs do you put off; and how many are forgotten entirely because they are required so infrequently?

For instance, how long has it been since you oiled the rubbing block in the distributor? Have you serviced the steering recently? How's the oil in the hydraulic system? If you've done every one of these jobs at the proper intervals by memory, you're pretty good. Of course it's easier—and safer—if you keep records on service, as every careful tractor operator should.

RECORDS

Records are necessary for systematic servicing of your tractor. The record forms in this unit are as simple as complete forms can be. If you study carefully the instructions for using them, and then keep the records faithfully, you'll be well repaid by savings in repairs and time, and by longer tractor life at peak performance.

HOW TO USE RECORD FORMS

The service record forms suggested in this manual have two purposes. They will give you a record of operation and the types of service performed, and provide you with a record of fuel, oil, and repair expenses. Keeping service records helps you to put into practice all the things you learn in the 4-H Tractor Program.

The first form contains a list of tractor services and the normal periods for these services. Below the listing of the services, spaces are provided for checking off the hours the tractor is used. The square spaces are arranged in a vertical row. Each square represents one hour, and there are 10 blocks or hours for each vertical line. The date should be inserted for the first hour of use and thereafter during the same day a check mark should be inserted for each additional hour the tractor is used. Then whenever a service is performed on the tractor you simply insert the code letter for that service.

For instance, if you look at the sample form (Fig. 2), you will see that on October 31 the tractor was used 5 hours, and on November 1 it was used 5 more hours. Then the "A" or 10-hour services were completed. The next day, on November 2, the tractor was used 9 hours. For the sake of convenience it was serviced before being taken out for the next day's work.

This method of checking off the hours provides an accurate account of how many hours the tractor is used during the year and how frequently each service is performed.

From the chart you can see that for convenience the 50-hour check-up and servicing were given at 49 hours. At this time all the services listed for the 50-hour or "B" periods were completed, as well as those for the 10-hour "A" service. The same applies to the other service periods. Each time you do the "C" service you do the "A" and "B" services, and so on.

WORK UNIT
Second Year Unit 8

TRACTOR RECORDS AND OPERATING COSTS

RECORD of HOURS and TYPES of SERVICES PERFORMED

A 10 Hrs.	- CHECK CRANKCASE OIL LEVEL - CHECK WATER IN RADIATOR - FUEL TRACTOR - SERVICE AIR CLEANER - GREASE THE TRACTOR - CHECK THE BATTERY	C 100 Hrs.	- CHANGE CRANKCASE OIL - CLEAN OIL SUMP SCREEN - ADJUST THE CLUTCH - CHECK TRANSMISSION OIL - CHECK TIRE PRESSURE - REPLACE OIL FILTER ELEMENT - CHECK SPARK PLUGS - ADJUST VALVE TAPPETS - INSPECT BREAKER POINTS
B 50 Hrs.	- LUBRICATE CLUTCH BEARINGS - CLEAN RADIATOR FINS - ADJUST THE BRAKES - CHECK FAN BELT TENSION - CHECK HYDRAULIC SYSTEM OIL - CLEAN SEDIMENT BOWL - GREASE CLUTCH AND BRAKE SHAFTS - OIL STARTER AND GENERATOR	D 200 Hrs.	- CHECK FRONT WHEEL BEARINGS - FLUSH COOLING SYSTEM - CLEAN AIR CLEANER ASSEMBLY - CLEAN FUEL SCREENS - CHECK GOVERNOR ADJUSTMENT
		E 500 Hrs.	- OIL HOUR METER - TIGHTEN ALL BOLTS - DRAIN AND REPLACE TRANSMISSION - HYDRAULIC AND DIFFERENTIAL OIL - HAVE TRACTOR CHECKED BY DEALER
		F 750 Hrs.	

10/31	11/1	11/2	11/3	11/4	11/5	11/6	11/7	11/8	11/9	11/10	11/11	11/12	11/13	11/14	11/15	11/16	11/17	11/18	11/19	11/20	11/21	11/22	11/23	11/24	11/25	11/26	11/27	11/28	11/29	11/30	12/1	12/2	12/3	12/4	12/5	12/6	12/7	12/8	12/9	12/10	12/11	12/12	12/13	12/14	12/15	12/16	12/17	12/18	12/19	12/20	12/21	12/22	12/23	12/24	12/25	12/26	12/27	12/28	12/29	12/30	12/31	1/1	1/2	1/3	1/4	1/5	1/6	1/7	1/8	1/9	1/10	1/11	1/12	1/13	1/14	1/15	1/16	1/17	1/18	1/19	1/20	1/21	1/22	1/23	1/24	1/25	1/26	1/27	1/28	1/29	1/30	1/31	2/1	2/2	2/3	2/4	2/5	2/6	2/7	2/8	2/9	2/10	2/11	2/12	2/13	2/14	2/15	2/16	2/17	2/18	2/19	2/20	2/21	2/22	2/23	2/24	2/25	2/26	2/27	2/28	2/29	2/30	3/1	3/2	3/3	3/4	3/5	3/6	3/7	3/8	3/9	3/10	3/11	3/12	3/13	3/14	3/15	3/16	3/17	3/18	3/19	3/20	3/21	3/22	3/23	3/24	3/25	3/26	3/27	3/28	3/29	3/30	3/31	4/1	4/2	4/3	4/4	4/5	4/6	4/7	4/8	4/9	4/10	4/11	4/12	4/13	4/14	4/15	4/16	4/17	4/18	4/19	4/20	4/21	4/22	4/23	4/24	4/25	4/26	4/27	4/28	4/29	4/30	5/1	5/2	5/3	5/4	5/5	5/6	5/7	5/8	5/9	5/10	5/11	5/12	5/13	5/14	5/15	5/16	5/17	5/18	5/19	5/20	5/21	5/22	5/23	5/24	5/25	5/26	5/27	5/28	5/29	5/30	5/31	6/1	6/2	6/3	6/4	6/5	6/6	6/7	6/8	6/9	6/10	6/11	6/12	6/13	6/14	6/15	6/16	6/17	6/18	6/19	6/20	6/21	6/22	6/23	6/24	6/25	6/26	6/27	6/28	6/29	6/30	7/1	7/2	7/3	7/4	7/5	7/6	7/7	7/8	7/9	7/10	7/11	7/12	7/13	7/14	7/15	7/16	7/17	7/18	7/19	7/20	7/21	7/22	7/23	7/24	7/25	7/26	7/27	7/28	7/29	7/30	7/31	8/1	8/2	8/3	8/4	8/5	8/6	8/7	8/8	8/9	8/10	8/11	8/12	8/13	8/14	8/15	8/16	8/17	8/18	8/19	8/20	8/21	8/22	8/23	8/24	8/25	8/26	8/27	8/28	8/29	8/30	8/31	9/1	9/2	9/3	9/4	9/5	9/6	9/7	9/8	9/9	9/10	9/11	9/12	9/13	9/14	9/15	9/16	9/17	9/18	9/19	9/20	9/21	9/22	9/23	9/24	9/25	9/26	9/27	9/28	9/29	9/30	10/1	10/2	10/3	10/4	10/5	10/6	10/7	10/8	10/9	10/10	10/11	10/12	10/13	10/14	10/15	10/16	10/17	10/18	10/19	10/20	10/21	10/22	10/23	10/24	10/25	10/26	10/27	10/28	10/29	10/30	10/31	11/1	11/2	11/3	11/4	11/5	11/6	11/7	11/8	11/9	11/10	11/11	11/12	11/13	11/14	11/15	11/16	11/17	11/18	11/19	11/20	11/21	11/22	11/23	11/24	11/25	11/26	11/27	11/28	11/29	11/30	12/1	12/2	12/3	12/4	12/5	12/6	12/7	12/8	12/9	12/10	12/11	12/12	12/13	12/14	12/15	12/16	12/17	12/18	12/19	12/20	12/21	12/22	12/23	12/24	12/25	12/26	12/27	12/28	12/29	12/30	12/31
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50 HRS. 100 HRS. 150 HRS. 200 HRS. 250 HRS. 300 HRS. 350 HRS. 400 HRS. 450 HRS. 500 HRS.

This is an example of how the upper portion of the form might be filled out, and how the lower portion might be checked (through the first "C" service only shown here). In the lower portion each small square stands for one hour of tractor operation; each vertical row represents ten hours or a tractor-day's work.

Fig. 2 A positive reminder of service required at regular intervals.

[illegible][illegible]

50 HRS.

[illegible]

100 HRS.

[illegible]

150 HRS.

[illegible]

200 HRS.

[illegible]

250 HRS.

[illegible]

300 HRS.

[illegible]

350 HRS.

[illegible]

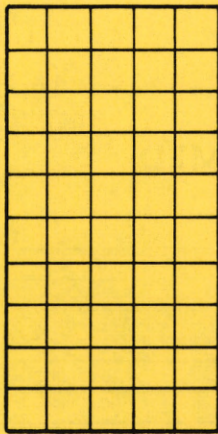
400 HRS.

[illegible]

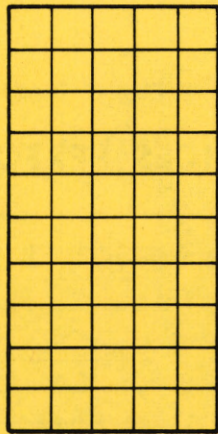
450 HRS.

[illegible]

500 HRS.



550 HRS.



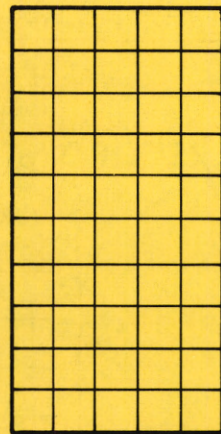
600 HRS.



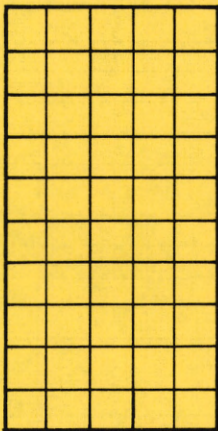
650 HRS.



700 HRS.



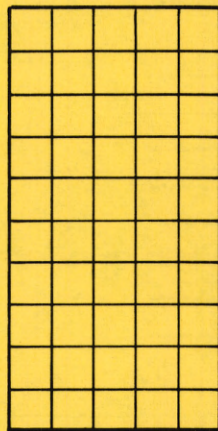
750 HRS.



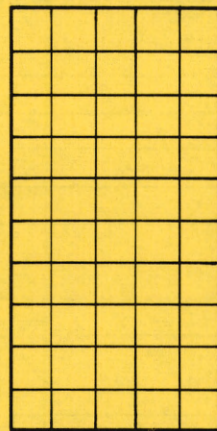
800 HRS.



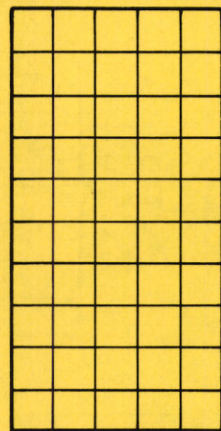
850 HRS.



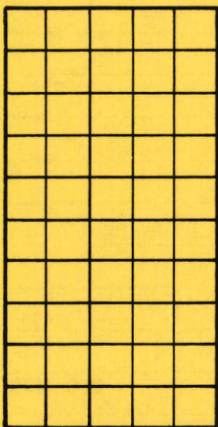
900 HRS.



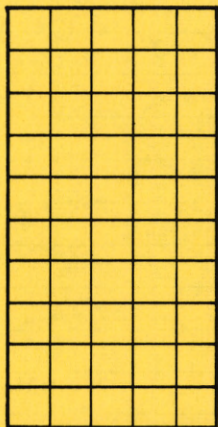
950 HRS.



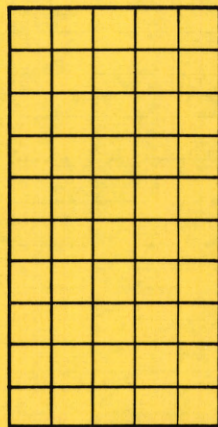
1,000 HRS.



1,050 HRS.



1,100 HRS.



1,150 HRS.



1,200 HRS.



1,250 HRS.

ADDITIONAL NOTES _____

RECORD of FUEL, OIL and REPAIRS

[illegible]

LEARNING THE OPERATING COST FOR YOUR TRACTOR

Keep a daily record of your tractor's use and fuel consumption for one month or longer. (Select a time when the tractor is used frequently.) From the tractor record sheet determine the hours the tractor was used, gallons of fuel used, quarts or gallons of oil used, and pounds of lubricating grease used. (It may be necessary to estimate grease amount.)

Summarize and figure costs for the period during which records were kept.

Beginning date _____ Ending date _____

Total hours tractor was used (A) _____

Item	Quantity	Price	Total
Gallons of fuel used			
Gallons of starting fuel (if used)			
Quarts or gallons of oil			
Pounds of grease			

Total cost for period (B) \$ _____

Figure the average hourly cost for the fuel, oil, and grease used in your tractor for the period during which records were kept.

Total cost (B) \$ _____

Total hours (A) _____

Average operating cost per hour* \$ _____

* Note that this is for operating cost only, and does not include repair costs.

Discuss your records with Dad and estimate the annual repair cost for your tractor.

Estimated annual repair costs \$ _____

Based on the above figures, what would you estimate the total annual costs for your tractor to be for fuel, oil, grease, and repairs. \$ _____



SECOND YEAR

MY ACHIEVEMENTS AND EXPERIENCES

IN THE 4-H TRACTOR CARE AND SAFETY PROJECT



WHAT TO WRITE

In telling the story of your work in the 4-H Tractor Care and Safety Project you might give the reasons you decided to enroll in the club, the number of meetings you attended, and the demonstrations you gave. If you were an officer of the club describe your duties and how you carried them out. Mention any special awards or recognition you received for your work. How many hours did you spend on maintenance work during the club year? Tell about people who assisted you or people to whom you gave assistance. What part of the program was the most interesting to you?

(continued on next page)

ADDITIONAL NOTES _____

Lined area for additional notes, consisting of 25 horizontal lines.

NOTES



