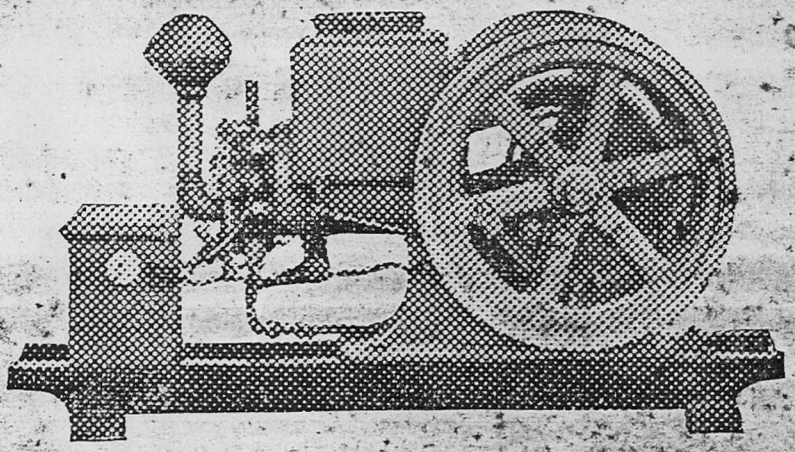
INSTRUCTION BOOK

FOR

Open Jacket Jump Spark "Rockford" Engines

4 H P and Larger

The purchaser of a "Rockford" Engine is requested to read this little book carefully. His doing so will give him a more intelligent understanding of the engine and will save him needless trouble and expense.



ROCKFORD ENGINE WORKS,
ROCKFORD, ILL.

Mfg. of High Grade General Purpose Engines

To those without whom we cannot prosper—our customers—this Instruction Book and short Treatise on Gasoline Engines is respectfully dedicated. Trusting that they may realize the spirit in which it is written, and that it may be helpful.

—Rockford Engine Works.

INTRODUCTION.

No man has ever been able yet to know all there is to know about any one subject, because if today he is possessed of all the knowledge on a certain subject, by tomorrow somebody has discovered something new about it which he has yet to learn.

Fortunately, it is not necessary for a man to know all there is to know about a gasoline engine in order to operate it successfully. There are, however, certain things about the general principles of an engine which the operator ought to know in order to save himself trouble and in order to intelligently care for his engine. The life of an engine, the same as that of any other machine, depends mainly on the degree of intelligent attention bestowed upon it by the operator. Much harm has been done to the reputation of gasoline engines by the extravagant statements made by some engine builders, that anybody, even a child, can run their engines. Such statements are equally true of a steam engine, providing the child is strong enough to shovel coal, and understands the figures on the dial of the steam gauge, and the limits to the height of the column of water in the gauge glass. That is really all the knowledge necessary in running a steam engine as long as everything is in perfect adjustment. Running a steam engine, however, demands a knowledge in the engineer of all the different adjustments in the engine; ignorance on these points has been fully demonstrated as highly dangerous to public safety; for this reason steam engineers are required to pass an examination before they are allowed to operate an engine.

It is just as essential for the gasoline engine operator to understand all the adjustments in the engine, but owing to the fact that the gasoline engine has been demonstrated to be almost an absolutely safe machine, no danger to the public is likely to result in its operation or attempted operation by even the

most unskilled operator. Many engine build have curtailed their instructions in regard to star ing and running their engines to just a few rule with the mistaken idea that the absence of elabora instructions would lead the uninformed purchase to believe that the engine was extremely simple i its operation. We are branching out in a new with this instruction book, believing that a thor explanation of the engine and its parts can c harm to those who already understand an eng and must certainly prove a great help to those are entirely ignorant, and inexperienced in g line engines. All gasoline engines of the four c type, which is the commonest, in fact almost only type of engine used for ordinary every da work, where power under 50HP is used, are similar in the principles on which they operate, and only differ in minor details of construction. It really requires only a limited amount of study to understand the principles of the four cycle gasoline engine, and after these are understood the extreme simplicity of the gasoline engine in comparison with the steam engine is readily apparent.

In the following pages, we will try to explain in a clear, concise and simple manner, understandable to the most inexperienced operator of a gasoline engine the principles of operation, name of parts, and general features of all four cycle gasoline engines, and more especially of the Rockford Open Jacket Engines. Our new system of instruction involves a use of printed tags attached to the different parts of the engine explaining in a measure their use, and also referring to more explicit instructions in this book. Special stress is laid on the names of the different parts of the engine; many men seem to have only a hazy idea of the names used in designating the various details of an engine. As these names are more or less general to all standard makes of four cycle engines, this information may be of value to others besides the purchasers and users of "Rockford" engines. We are broad minded enough to honestly say that if any

rmation contained in this instruction book proves value to any of our brother Gas Engine Builders' ustomers, we are glad of it. As time goes on, the asoline engine will become more and more standardized, and the application of any instructions will become more universal. Our idea of sending this book to the purchaser immediately on receipt s order, is, that, by a careful reading of these uctions even the most inexperienced may gain ideas about the engine before it arrives. We ot adopting this course because our engines are complicated or harder to operate than other es of engines, but because we are trying as far s in our power to spread abroad real information t gasoline engines in general, and of course particularly our own. We have entirely discarded the older methods of making extravagant claims for our own engine, and the making of odious comparisons about our competitors' machines. We are taking the field on an honest basis, we are confident that we have a good engine, honestly built, guaranteed to give full power, and to carry a reasonable amount of overload in emergencies; an engine that will give efficient service to any one who will devote a few spare minutes to its study.

We do not claim that our engine will use less gasoline than any other make of engine, but we know that it has been designed by a thoroughly competent designer, who has had experience enough in his profession to design an engine which will give the maximum of efficiency.

A BRIEF EXPLANATION OF THE FOUR CYCLE ENGINE.

Engines are called four cycle, or more correctly four stroke cycle, because to complete all the different operations necessary for the securing of one explosion requires four strokes of the piston, or two complete revolutions of the flywheels and crank

shaft. If the piston is clear back in the cylinder as far away from the crank shaft as it can get, we will call that "The Inner Position of the Piston." The other position when it is at the open end of the cylinder—as near to the crank shaft as it can we will call, "The Outer Position of the Pist Starting with the piston in the inner position turn the engine flywheels one half revolution, bring the piston to the outer position. This is first or suction stroke; the stroke when the ch of air and gasoline vapor is pulled into the cylin On this stroke the piston acts just the same as plunger in a pump; as it moves forward a vacuu is created behind it and the air rushes in throu the inlet valve, and as this air comes through mixer valve it is there charged with gasoline va At the end of the suction stroke the whole cylin behind the piston is full of the charge. By turni the flywheels another half revolution the pist again brought back to the inner position, this co pletes the second or compression stroke. In this stroke the piston acts the same as a piston in an air compressor, and at the end of this stroke the w charge which at the beginning of the stroke the entire cylinder is now squeezed or comp into the comparatively small space betwe head of the piston and the inside surface of gine head. This space is called the comp space, and sometimes the combustion char

Just at the moment when the piston reac end of the second or compression stroke, the m ism of the engine moving in a certain fixed h ay with the crank shaft has closed the electric circuit from the battery, and at that moment the spark occurs or jumps between the points of the spark plug which protrude into the compression space of the engine. This electric spark ignites the charge and the explosion occurs, resulting in a sudden increase of pressure in the compression space behind the piston. This pressure forces the piston outwards on its third stroke, called the working or expansion stroke.

When the piston is nearly at the end of this stroke and is almost at its outer position, the exhaust valve ca[illegible]on the side shaft of the engine has arrived at [illegible]sition in its rotation where the bump or pro[illegible]ion on the cam begins to press on the roller on exhaust valve lever; the construction and design hese parts the cam, roller and exhaust lever, is [illegible] that as the roller rides the projection on the , the exhaust valve is opened, allowing the nt gases to escape into the atmosphere through e exhaust pipe. This opening of the exhaust valve ccurs just before the piston reaches the end of its hird or expansion stroke. Having reached its outer sition the piston now starts backwards again on fourth or last stroke of the cycle. This stroke called the exhaust stroke, because during this roke the exhaust, or the allowing of the products ombustion to escape occurs.

The cam on the side shaft is of such shape and proortions, as to hold the exhaust valve open during the entire stroke, allowing the valve to close only when the piston has reached its inner position at the end fourth stroke. The engine is now in exactly ime position and condition as at the beginning first stroke. The cycle of events has been ted and it has taken four strokes of the pistwo revolutions of the crank shaft and flyto do it. The two first strokes, the suction mpression strokes, were preparatory events up to the explosion. The third, the exn or working stroke, in which the engine recei[illegible] its power, storing up the surplus in the momentum given the fly wheels to carry it through the other three strokes. In the fourth stroke or exhaust stroke the engine cleans up after the explosion.

DESCRIPTION OF ENGINE AND PARTS IN CONJUNCTION WITH OUR TAG SYSTEM.

Ignition The ignition on the Rockford Open Jacket engines is Jump Spark. The Spark Plug, which will be found in the box of parts shipped with the engine and tagged with tag No. 7, screws into the ½-in. pipe tap hole in engine head, on the side away from the governor, and which we call the off or pulley side of the engine. This hole will be found plugged with a wooden plug to which Tag No. 2 is attached and is called the spark plug hole. Remove the wooden plug and screw the spark plug firmly into the hole, being careful not to damage the insulation in the plug and observing if the small wires on inner end of the plug are the right distance apart. Try these with the gauge attached to Tag No. 7. The heavy insulation wire which will be found attached to the wooden plug in spark plug hole, and to which Tag No. 3 is attached should be attached to the spark plug by the binding screw, or nut on outer end of the spark plug, precisely in the same place and manner as Tag No. 1 was attached to the spark plug.

The other end of the heavy insulated wire to which Tag No. 3 is attached, runs to the battery box, and is attached to the binding screw on the side of the Jump Spark Coil inside of the battery box. Another smaller electric wire coming from the switch on the battery box is attached at Tag No. 4 on the flat spring on the off

Locking Rod side of the engine head. This flat spring is called the make and break contact spring, its use being to cut out, or break the electric circuit when the engine is running under a light load and is under control of the governor. This spring is insulated from the engine head by fibre plates at its lower end where it is attached to the engine head by two small cap screws. By turning the engine it will be observed that when the exhaust valve is opened by the action of the cam on

side shaft (the exhaust valve is the lower valve whose stem projects from the under side of the engine head, and is kept to its seat by a strong spring around its stem) the locking rod to which Tag No. 5 is attached is also moved in an upward direction.

On the upper end of the locking rod a flat plate called the locking rod top plate is attached by two adjusting nuts on the locking rod. Another plate similarly attached to the lower end of the locking rod is called the locking rod lower plate. The locking rod top plate extends inward over the top of the inlet ell, and the inlet valve stem, which projects on the upper side of the engine head and is controlled by two springs—one inside the other—is run through a drilled hole in the end of this plate. When the exhaust valve is closed, and the locking rod is in its lower position, the locking-rod top plate at its outer end should make a firm electrical contact with the make and break contact spring. As the exhaust valve is opened by being raised from its seat, the locking rod as already shown is also raised, and the contact between the outer end of the locking rod top plate and the make and break contact spring is broken.

Important See that the make and break contact spring makes a good contact with the outer end of locking rod top plate when the locking rod is in lower position. That this contact is broken when the locking rod is in upper position and that the points on the end of locking rod top plate and on the make and break contact spring are clean, free from dirt and grease.

To insure this cleanliness pull a piece of emery cloth or sandpaper between the plate and the spring when the locking rod is in its lower position. At Tag No. 6 on the governor side of the engine the other small electric wire is attached to the binding screw on timer lever contact spring. The other end of the wire is attached inside the battery box to the binding screw on the end of the spark coil marked T. The timer lever contact spring makes a contact with the brass pin in the back of the ex-

haust cam on the side shaft of the engine ev[illegible]N- revolution of the side shaft. The spring i[illegible] lated from the timer lever to which it is [illegible] precisely in the same manner as the make a[illegible] contact spring is from the engine head.

Important

See that the spring makes good [illegible]act with the brass pin every time [illegible] com[illegible]s around, and see that both are clean.

Timer Lever

Tag No. 7 is attached to the timer lever. This lever is used to change the time of ignition. When it is in its inner position, up against the governor bracket on top of the side shaft bearing it is in the position of latest ignition. When starting the engine the timer lever should always be in this position. Pulling it outwards gives earlier ignition for running. The amount the timer lever must be pulled outwards to give the proper ignition when running, depends on the speed of the engine. At the highest speed of the engine it ought to be out against the pin at the end of the ratchet segment. If after the engine has warmed up it should give a hard pounding noise, the ignition is too early, and the timer lever should be set back nearer the starting position.

The best efficiency will be obtained when the timer lever is set just one notch later than where the engine will pound when working hard. Tag No. 8 is attached to the adjusting screw on outer end of exhaust lever. The case hardened head of this screw comes in contact with the lower end of the exhaust valve stem. The exhaust lever is operated by the cam on the side shaft and opens the exhaust valve to let out the burnt gases from the cylinder after they have performed their work by expansion inside the cylinder. This screw should not come in contact with the end of the exhaust valve stem until the roller on the inner end of the exhaust lever starts to ride the cam projection. When the exhaust valve is closed and the exhaust lever roller is clear of the cam projection, there ought to be about 1-64 of an inch space between the head of this adjusting screw and the end of the exhaust

[illegible]ve stem. Just enough so that by working the [illegible] lever up and down by hand you can feel [illegible] clear of the end of the valve stem.

Inlet Valve

[illegible]let valve stem to which Tag No. 9 is at-[illegible]ed projects from the top of the inlet ell on the upper side of the engine head, through the end of locking rod top plate. Around the inlet valve stem and controlling the action of the valve are two springs. The outer one, a weak spring holding the valve to its seat, but allowing it to open by the suction of the piston when the engine is drawing in its charge. The inner, a strong short spring is the locking spring. This spring comes into action when the locking rod is in its upper position. When the locking rod is in its lower position by pressing down on the end of the inlet valve stem the valve opens easily. If, however, the locking rod is in its upper position the valve stem cannot be pressed down without considerable force being used owing to the fact that the inner, strong locking spring has been carried upwards by the locking rod top plate, until its upper end is in contact with the under side of the adjusting nuts on the end of the inlet valve stem.

To adjust the inlet valve springs should it ever be necessary to do so, or in case of the adjusting nuts on the inlet valve stem working loose, turn the engine by the flywheels until the locking rod is in its upper position, and set the lower nut on the inlet valve stem down until it just strikes the inner locking spring; give it one half turn more after it strikes the locking spring and then screw the upper or locking nut hard down on it thus locking both nuts firmly in position. Should the nuts on locking rod at each side or both the upper and lower locking rod plates ever work loose screw them up against the plates when the locking rod is in its lower position. When the nuts are tight the upper plate should just clear the top of the inlet ell where the inlet valve stem enters the ell. The top plate should never rest on the top of the inlet ell, its doing so will release the spring tension on the exhaust valve

allowing the exhaust valve to be sucked slightly open on the suction stroke of the engine, permitting the greater part of the charge to enter through this valve instead of the inlet valve.

Governor

The governor detent finger to which Tag No. is attached is the part which holds the exhaust lever in the position in which it stands when the exhaust valve is open. This is only thrown into action when the speed of the engine gets to a point where the governor acts. When the exhaust lever roller is on top of the cam projection the exhaust valve being fully open this finger should be so adjusted as to enter the notch in the tool steel catch behind the roller when the governor balls are pulled out. It should be allowed a little clearance so as to enter and leave the catch freely. When the governor balls fly out due to the engine running above normal speed this finger is forced down into the catch when the exhaust valve is opened by the cam, and stays there holding the exhaust valve open until the speed of the engine falls to a point where the governor balls having lost a part of their momentum and centrifugal force are again pulled inwards by the governor springs. As the governor balls move inwards the finger is pulled out of the catch allowing the exhaust valve to close. It can be easily understood that when the exhaust valve is held open all the time the engine simply sucks air in and out of the exhaust valve and there is no explosion, the moment, however, that the detent finger leaves the catch the exhaust valve closes and allows the engine to again pull in a charge through the inlet valve, which is immediately followed by an explosion. The clearance between the end of the finger and the catch should be such that when the engine is running under a light load and the exhaust valve and locking rod held, by the action of the roller, in the upper position, a slight jumping movement should be observable in the locking rod, every time the projection on the cam hits the roller on the exhaust lever, showing that it moves the exhaust lever enough for the detent finger to leave

notch in the catch and enabling the finger to leave the notch freely if the speed of the engine has fallen to a point where the governor balls are moving inwards. If the finger is adjusted with too much clearance, the jumping movement of the lock-rod will be too great, and the cam projection will knock hard on the roller. The finger can be adjusted by means of the screw pressing against its inner end first, however, loosening the cap screw which holds the finger to the detent casting. Relief cock found in box of parts and tagged with Tag No. 11 screws into the hole where Tag No. 12 is attached to the wooden plug in the hole.

Relief Cock This hole is forward of the governor, over the detent finger. This cock should be opened in starting the engine to allow part of the charge to escape, thus relieving the compression, and allowing the engine to be turned with greater freedom in starting.

Needle Valve Tag No. 13 is attached to the needle valve for regulating the amount of gasoline fed to the engine. On our regular Stationary and Portable engines this needle valve is located on the side of the mixer pipe at a point slightly above the level of the gasoline in the tank when tank is full. Open this valve the amount marked on the tag. For further instructions see "Explanation of Mixing Mechanism."

Priming Cock Tag No. 14 is attached to the small pet cock in the gasoline pipe close to the lower end of mixer pipe. Before starting the engine by opening the cock and allowing gasoline to flow into the cap at the lower end of the mixer pipe the engine will always suck up a charge at the first turn of the flywheels, no matter how slow it is turned. Allow gasoline to flow into the cap until it overflows through the samll hole in the side of the cap. In cold weather if it is desired to warm up the mixer before starting the engine, allow the gasoline to overflow until it fills the lower open cup. Shut the pet cock and light the gasoline in the lower cup

with a match. When the gasoline
the mixer will be sufficiently warmed
engine to start easy, no matter how col

Tag No. 15 is attach-

Air Throttle throttle, used only on
gines equipped with

This air throttle is an ordinary
should be nearly but not quite
the engine. After the engine ma
explosions open it full and leave i
open the T handle stands parallel with the pipe, when closed it stands crosswise to the pipe.

Tag No. 16 is attached to cyl-

Cylinder Lubricator inder lubricator in box of parts.

This lubricator is screwed into the ell where Tag No. 17 is attached, right in front of the water jacket. Regulate the feed to 5 or 6 drops a minute. Immediately behind the ell where Tag No. 17 is attached there is a $\frac{5}{16}$ in. hole running down into the cylinder bore at an angle. If the engine flywheels are turned until the piston is in its outer position, and oil is squirted into this hole it will go right through to the crosshead or piston pin in the inner end of connecting rod. Before starting the engine it is well to turn the flywheels to this position and squirt some oil into this hole, it will always insure the thorough oiling of the piston pin before starting. After the engine is started the piston pin is oiled automatically from the cylinder lubricator. If at any time it is apparant that the piston is not getting sufficient oil, or the lubricator has been allowed to empty itself without being noticed, the piston can quickly be flooded with oil by squirting oil from a can into this hole. By an occasional oiling with kerosene through this hole any tendency of the piston rings to stick or gum up will be overcome, and may save the removal of the

Filler Cap piston from the cylinder to loosen up the rings. Tag No. 18 is attached to filler cap on the gasoline tank. The gasoline tank capacity is in proportion to the size of the engine.

Tag No. 19, on stationary engines only, is attached to the thumb lever on the gasoline pump. This is used to pump the gasoline by hand before starting

OF THE MIXING MECHANISM.

The mixer on the "Rockford" Portable and Stationary engines as regularly equipped, consists of a straight mixer pipe extending downwards from the inlet ell on the cylinder head of the engine. The lower end terminates in a cap which extends slightly below the level of the bottom of the gasoline tank in the engine base. Through a hole in the side of the cap the nozzle of a small pet cock (known as the priming cock) is introduced into the mixer pipe, this pet cock is in the gasoline supply pipe. Behind the pet cock a branch of the gasoline supply pipe runs upward parallel with the mixer pipe to a point about one inch above the level of the top of the gasoline tank. At this point the gasoline pipe is connected to the mixer pipe and its opening into this pipe is controlled by a needle valve. A check valve opening upwards is placed in the vertical branch of the gasoline pipe to prevent the gasoline from flowing back to the tank between the suction strokes of the engine. The action of the mixer is as follows: A small quantity of gasoline is allowed to run into the cap on the mixer pipe by opening the Priming pet cock. A small overflow hole in the side of the cap prevents the possibility of too much gasoline being run in. When the gasoline starts to run out at this overflow hole it indicates that enough has been run in, and the pet cock should be closed.

The construction of the cap and the end of the mixer pipe is such that when the engine is turned in starting gasoline is bound to mix with the air, and the engine thereby receives a charge on the first turn of the wheels. After the engine has received

its first few explosions from the gasoline in the cap, it will have attained enough speed to increase the suction in the mixer to a point where it will suck the necessary amount of gasoline through the check and needle valves in the vertical supply pipe. The open drip cup under the cap on the lower end of mixer is used in cold weather to warm up the mixer before starting the engine. By simply allowing the gasoline to overflow from the cap until this cup is full and then lighting the gasoline in the cup with a match, the mixer will be warmed up sufficiently so that the engine will start easily no matter how cold the weather may be. It is a good plan to turn the engine whilst this gasoline is burning, by doing so hot air from the flames will be pulled into the cylinder and the frozen lubricating oil will be thawed to some extent.

The Mixer on Stationary engines equipped with Gasoline pump and tank placed outside the building consists of a pipe through which air is sucked at a high velocity by the action of the piston during the suction stroke of the engine. A small hole, controlled by the needle valve at its upper end, opens into the underside of this air pipe. The lower end of this small hole opens into a gasoline reservoir, immediately below the air pipe, and into which reservoir, the gasoline pump forces gasoline. The gasoline in the reservoir is maintained at a certain, constant level, owing to the fact that when it rises above a certain level it overflows through a return pipe back to the supply tank to be again pumped. The level of the gasoline is about ¾ of an inch below the lower inner surface of the air pipe. It, therefore, cannot flow into the air pipe, but requires the suction of the air to lift it this ¾ of an inch. Every time the engine sucks in a charge the suction of the air rushing through the air pipe, lifts a certain amount of gasoline, this being regulated by the needle valve. Due to the rapid motion of the air, the gasoline is immediately broken up into a fine spray and vaporized, and is carried along with the air through the inlet

valve into the cylinder. This form of mixer is very general among gasoline engines, it has many forms, but the fundamental principle is always the same. Gasoline is maintained at a constant level, slightly below the level of a small hole controlled by a needle valve, the lower end of the hole being immersed in the gasoline whilst the upper end opens into an air pipe, where the air, during the suction stroke of the engine is moving at a high velocity, thereby creating a partial vacuum in the pipe. Almost all Automobile carburetors, no matter how it may be concealed by special details and refinements of construction, operate on this same old principle.

GENERAL INSTRUCTIONS IN TAKING CARE OF AN ENGINE.

A great many good engines are damaged more or less when new by the purchaser being in too great a hurry to start them up; and also because they too often try to start the engine without a careful reading of the instruction book. For this reason we are adopting the plan of sending the purchaser of a "Rockford" engine an instruction book before he receives the engine, believing that the average man will take time to read this carefully, and will be to a certain extent posted before the engine arrives. It too often happens when the instruction book is enclosed in the battery box or box of parts shipped with the engine, that the purchaser being naturally anxious to see the engine run does not take the time to read the instructions carefully, or else does not read them at all, before trying to start the engine. On the arrival of the engine at the railroad depot the first thing is to look it over carefully and see if it is in apparently good shape and that all the parts called for by the bill of lading are there. The time to check shortages and breakages is before the goods are removed from the depot. It is a hard matter to bring the railroad company to assume any responsibility after the goods have left their

premises. After the engine has been taken
go over it very carefully, reading the tags att
If any of them are torn or the writing effaced
number being printed on both sides of the ta
usually be deciphered and a duplicate is print
the last pages in this book. Do not remove
more of the tags than is absolutely necessary
you have become a little acquainted with the eng
One of the most important things very seldom d
to a new engine, however—and the neglect in th
particular has spoiled the cylinder and pis on of
many a new engine during its first hours of operation—is to thoroughly clean out and oil the cylinder before starting. To do this properly, turn the flywheels until the piston is in its inner positio In this position a large area of the walls of th er bore is exposed. With a piece of waste or a clean rag wipe out the cylinder bore as far back as you can get for the piston, and rub on a liberal supply of cylinder oil on the clean surface. The reason for this cleaning and oiling is readily apparant. During transportation dust and grit are blown all over the engine, and should the piston happen to be in its inner position, this dust and grit will adhere to the oily walls of the engine cylinder; again the engine may have stood around for quite a while since it left the factory and the oil film between the piston and cylinder have to some extent become dry and thick. If the cylinder of the engine is dry and the engine runs for even a few minutes, the chances are greatly in favor of the cylinder and piston cutting, and after a cylinder and piston have been cut. It is almost impossible to have a tight piston until the cylinder has been rebored and a new piston fitted. Before the engine is started, hunt up all the oil holes and see if they are clean, and oil everything thoroughly, putting on the cylinder lubricator and setting it to feed 5 or 6 drops a minute.

The oil cup on the out end of the connecting rod only feeds when the engine is in motion. The regulation of the feed on this is by means of a small screw immediately under the filler cap. The oil

n the main bearing are fed by a wick. After
urn the flywheels over a few times, watch-
see if everything seems to be all right, and
k the oil into all the bearings. Connect the
ry wires, fill the gasoline tank, and the en-
is ready to start. The ignition system in an
e is the most important of the details. If the
k is good and occurs in the cylinder at the
it moment, the engine will run even if the mix-
re and the setting of the valves is quite a little
off. A thorough understanding of the ignition system is therefore vitally important to the successful operation of a gasoline engine. If we go into this subject in considerable detail, it is because we fully realize its importance. The ignition system con-

Wiring System

sists of four cells dry batteries, a jump spark coil and a switch, all in the battery box. The igniter parts on the engine are the spark plug, the make and break spring, and the timer lever. The four cells dry battery are wired up by short wire connections between the outside binding screw on one cell, and the center binding screw on its neighboring cell. Three of these connections connect the four cells having one outside binding screw at one end of the line of cells free, and one center binding screw at the other end of the line free. One of these binding screws or terminals of our series of cells is connected by a short wire to one binding screw on the switch on the outside of the battery box. From the other binding screw on the switch a wire runs to the make and break spring on the engine head. The other terminal of our series of cells is attached by a short wire to the binding screw on the upper end of the spark coil marked B. From the other binding screw on the same end of the spark coil marked T a wire is run to the binding screw on the timer lever contact spring. This wiring completes what is called the primary or battery circuit. From the binding screw on the side of the spark coil marked S a heavy insulated wire or cable is carried to the spark plug in engine head. The one wire is all that

is needed in this circuit, called the secondary circuit. The return of the circuit is through one of the other wires. The function of the spark coil is to transform the low voltage current of the dry cell battery into a current of much higher voltage by a process called induction. When the coil is working properly the vibrator in the center of the upper end of the spark coil gives off a buzzing sound when the switch is closed and the make and break contact spring and contact spring on the timer lever are both in contact.

Spark Coil

The adjusting screw over the viabrator is used to increase or decrease the intensity of the spark. As it is screwed downward when the vibrator is buzzing it will be observed that the tone of the vibrator changes, giving out a higher note showing that the velocity of the vibrations is increased. If you keep on turning it down a point will be reached where it ceases to vibrate. If it is now turned the other way, backing it out, the tone of the vibrator will get lower and lower until it reaches a point where the vibrator again ceases to vibrate. It is usually necessary to adjust the adjusting screw on the vibrator from time to time as the batteries get weaker. The screw has to be screwed downwards the older the batteries get. The adjustment of this screw on the vibrator has a good deal to do with the length of the life of the batteries, and the best efficiency is obtained from the batteries when the vibrator adjusting screw is backed out to the point where the vibrator almost ceases to vibrate. The easiest way to adjust this screw is to back it out slowly, when the vibrator is buzzing, until the buzzing ceases, then screw it back again until the buzzing again starts. The vibrator may buzz all right when the switch is closed and the engine not in motion, but when the engine is running the contact between the timer lever contact spring and the brass pin in the back of the cam only endures for the merest fraction of a second. In order, therefore, to simulate the rapid making and breaking of the electric

circuit as performed by the engine when in motion, take hold of the switch lever and work it backwards and forwards as rapidly as you can. If the vibrator works every time the circuit is closed it is all right; if it does not work, screw down the vibrator adjusting screw until it does.

Testing Ignition System

To further satisfy yourself when adjusting and testing the ignition system on your engine, unscrew the spark plug from the engine head, attach the wire to it and lay it on some part of the engine, with the part that screws into the engine in contact with the metal of the engine, being careful, however, that the metal part on the out end of the plug where the wire is attached is not touching the metal of the engine in any way. Now work the switch lever the same as before and if the spark appears between the wire points on the inner end of the spark plug every time the contact is made by the switch lever you are sure that your ignition system is all in working order. In making these tests always remember that the contact make and break spring must be in contact with the end of the locking rod top plate, and that the timer lever spring is in contact with the brass pin in the back of the cam. If the flywheels are turned until the timer lever spring is in contact, the other, the make and break contact spring, is also in contact.

One thing, however, must be taken into consideration here which has been at times puzzling to the new beginner with gasoline engines, and that is, sometimes the spark will appear all right in the spark plug when it is unscrewed from the engine, and still when in the engine it will not give a spark, or at least the indications would seem to point that such is the case. Now this may be true, and reason is that the conditions are different inside the engine cylinder than they are on the outside. Inside the cylinder just at the time when the ignition occurs the gaseous contents of the cylinder are compressed up to a high pressure. Now air at atmospheric pressure is an insulator, but air at a higher

pressure is a better insulator. If, the vibrator adjusting screw is set just [illegible] where the vibrator works and the [illegible] between the points when the spark plug from the engine, the current may not enough to arc the gap between the plug p[illegible] the resistance is increased by the compression in the cylinder Screwing down the adjusting screw on the vibrator just a trifle will fix this all right. Particular attention when testing up the ignition system as above mentioned should be given to the contact surfaces on the end of locking rod top plate, contact make and break spring, timer lever contact spring and the brass pin in the back of the cam.

THE DRY CELLS OF THE BATTERY.

The battery cells are one of the things connected with a gasoline engine which are really little understood and which when improperly handled are a very frequent source of trouble. A few pointers about dry battery cells should be of interest to the gasoline engine user and something ought to be known by him about them, [illegible] to do, and what not to do.

There is really no method known to accurately test just how much electricity a dry battery contains. The ammeter test is not any indication of how long a dry cell will last. It indicates only how fast it discharges, not how much is still left in it. You would not measure the amount of gasoline in your gasoline tank by opening the drain cock and measuring the size of the stream. If such were the case increasing the opening in the drain cock would increase the capacity, or the amount of gasoline in the tank. If, when the cells are new, the ammeter shows a high amperage, it is no indication that the batteries will be long lived, but rather the reverse. It is just like a big drain cock in the tank you will have a fine large stream, but it does not last long. So with the high amperage, you will have

spark at first but it soon runs down. in all cells so far made an internal causes a battery cell to slowly discharge the circuit between the terminals is a wire connection. This is known as and means that a dry cell will become exhausted after a certain period of time, even if it is never used. The ammeter, as before stated only measures the rate of discharge and it stands to reason just as it is with a tank, the discharge will be greatest through a certain sized opening when the tank is full, so with the battery cell as it empties itself or runs down, the amperage or rate of discharge diminishes.

AMPERAGE TEST OF DRY CELLS.

The following figures from experiments with a No. 7, or 7 x 9 in. dry cell short circuited through an ammeter show the rapid deterioration of a cell under short circuit. Before starting the test the cell showed 22 amperes.

At the end of	1	minute	it showed	20	amperes.
"	"	"	"	2	"	"	"	18	"
"	"	"	"	3	"	"	"	17	"
"	"	"	"		"	"	"	16	"
"	"				"	"	"	15	"
"	"	..			..	..	"	12	"
"	"	"	..		"	"	"	$10\frac{1}{2}$	"
"	"	"	"	20	"	"	"	10	"
"	"	"	"	25	"	"	"	9	"
"	"	"	"	30	"	"	"	$8\frac{1}{4}$	"

Showing that the amperage drops very rapidly at first, and that the direct short circuiting of a battery is extremely detrimental, even if only continued for a few minutes. In using the ammeter it is well to allow only the very shortest contact possible, just long enough to take the reading. The ammeter when properly used is a very handy instrument and should be in the possession of every gasoline engine user. By its use dead or nearly dead cells can be picked out. A dead cell amongst live ones will interfere with the proper action of the live ones, and is the same as the weakest link in the chain.

DRY CELLS IN COLD WEATHER.

The effect of cold on dry cells is another poi[nt] which is not very well understood, and batteries are often condemned dead when they are simply frozen up. In the construction of a dry battery there is a certain percentage of moisture, in cold weather this moisture is, to a more or less extent congealed by the cold and the amperage or rate of discharge is reduced. In cold weather it is a good plan, especially with engines such as portable engines standing out doors, to remove the batteries from the engine over night, keeping them in a warm place. The doing of this in extremely cold weather facilitates greatly in starting the engine on cold mornings as the removing of a battery from an engine requires quite a little work disconnecting the wires, etc. We have designed a battery box for our open jacket portables which is really a box within a box. The inner box contains the battery cells and the spark coil and can be easily lifted out of the outer box. By a special construction no connecting or disconnecting of wires is necessary in removing the battery from the engine, the inner box making its own connections with the wires as it is slipped into the outer box.

The cold does not really harm the bat[tery] is it does not produce any real detrime[nt] in the battery. It only, as it were, pa[cks] up the opening through which it discha[rges], ing the amperage and producing a weak spark. though the dry cell battery has its defects it is far the handiest and cheapest form of the low v[olt]age electric current on the market. Always remember that the expense of running a gasoline engine for an hour is not only the amount of gasoline consumed, but also involves a certain amount of electricity and also a certain amount of lubricating oil. It is a common complaint with purchasers of gasoline engines after using the engine a few months that the batteries are dead, and expecting to be supplied with a new set free. Suppose the manu-

urer had filled the gasoline tank before he shipped the engine. Would you expect him to fill it again after it was empty, or would you expect him to send you a second can of cylinder oil after you used up the sample half gallon sent with the engine? No, you would expect to pay for both the gasoline and the cylinder oil. An engine will not run without gasoline, neither will it run without a battery, but these two things are not parts of the engine, they constitute the fuel and it would be just as logical to expect the manufacturer to supply you with gasoline as it would to expect him to keep you supplied with batteries.

THE EFFECT OF COLD ON THE GASOLINE ENGINE.

Every gasoline engine builder is often asked, "Will your engine start in very cold weather?" Any engine will start, no matter how cold the weather is, providing the operator knows how to go about it, but all gasoline engines are harder to start in cold weather. Like everything else there is a reason for this. In the section of this instruction devoted to dry batteries it has been shown that batteries become sluggish when exposed to cold. This is one reason why engines are harder to start in cold weather; the spark is weak, but it is not the principal reason. Every observing gasoline engine operator has noticed that even in warm weather the mixer on his engine, no matter what its construction may be, is ice cold, and the harder the engine is worked the colder it is. This phenomenon holds good even if the mixer is in close proximity to a warm part of the engine. If you rub a little gasoline over your hands it quickly evaporates and the hand feels chilly for a few moments during the evaporation. What is it that makes your hand feel cold? It is not the gasoline because it can be warmed and the same cold feeling experienced when the hands are rubbed with it. The reason is that

evaporation requires heat, and the hand ... stuff. because the heat necessary to evaporate ... ing line has been taken from the hands ar... are quickly that the blood has not had ti... s. the heat ... quickly as it was absor... r cess of ...ting t... gasoline. F... rt son t... he engir... m- as th... rom i... es evapo... This ... re much ... n col... n- ammo... ...gines such as ... res fact... ...ors, to remove the ... en- mo... ...e over night, keeping them ... in is r... ...oing of this in extremely ... all A little ... eatly in starting the ... t warm r... the removing of a bat... ... doors ... quite a little work ... hours evapo... We have designed ... rated and D into... cket portable ...ine engin der... The inn... half full o... line ... spark coi... ...o get an exp... at a... box. ... outdoors in a m... discor... oke of the engin sta... he bat... d into the cylinder ri... its o... f spray or very sm...l di... slipp... a vapor. These small drop... ... of the cylinder and lie there ...oline. The first explosion is the ...; after even one explosion the chill is ...he cylinder walls and there is always a ... percentage of the products of combustion left in the cylinder in the form of hot gases. The second incoming charge absorbs heat from these gases and the gasoline is vaporized. It is evident from the above that what we want in starting an engine on a cold morning is heat supplied from some outside source, and many ingenious devices have been adopted by gas engine operators to secure this end. In our Open Jacket engines the easiest way is to pour a pailful of hot water into the jacket before starting, another and very effective way is to use an ordinary plumber's torch, ap-

name to the mixer, inlet pipe, and engine simple modification of this is a rag tied d of a stick, the rag being soaked with lighted up. One farmer of consider- soaks a corn cob in g line and he air openi g of t r. He ne on th is the revol uction sucg ngs a t pipe nstitute the fu asked o expect the ma e on a asoline as it would to exp sked with batteries. do On when ll bottle slightly start- t of we our ther. yl- ne e.

OF COLD ON ENGINE.

builder very co natter rator gin eryth n of th has ed en- make eather strictly

Op
speci
Se
T
Our new
ook on the
de especially
r valve when n
cold weather th
er freezes and bec
rd to turn over unt
Some manufacturers a
by prospective custom
gines in cold weather have
of engine would start just as
as in warm. Any such stateme
true and are misleading. We belie to make such erroneous statements is a grave mistake, and is only laying our customers and ourselves liable for trouble. We believe that it is best to tell the customer the truth about what difficulties he is apt to encounter, believing that the man forewarned is better equipped than he who has not been, and certainly far better equipped than the man who has been laid on the ice by erroneous statements. Mechanics is a science which deals in facts; facts based on the natural laws, and any attempt at an explanation of these facts by erroneous and mis-

leading statements is not going to be successful. The causes that operate against the easy starting of a gasoline engine in extremely cold weather are natural and must be overcome by natural means. No amount of hot air talked by a manufacturer or his salesman will ever supply heat enough to start a gasoline engine standing outdoors when the temperature of the atmosphere is from 10 to 40 degrees below zero; heat has to be applied from some more efficient source. The purchaser of any gasoline engine therefore must not think because it requires a little more attention and trouble to start his engine in cold weather that it is an inherent fault in that particular make of engine; it is common to all and when thoroughly understood is a trouble that is easily overcome.

STARTING THE REGULAR STATIONARY AND PORTABLE ENGINES

Open the needle valve the amount marked on Tag No. 13.

See that timing lever is in starting position, See Tag No. 7.

Close the switch on the battery box.

Open the Relief Cock, see Tag No. 11.

Open the Priming Pet Cock in gasoline pipe, and allow gasoline to flow into the cap on lower end of mixer pipe. See Tag No. 14.

Turn the fly wheels until an explosion occurs; after a few explosions close the relief cock and as the engine comes up to its speed pull the timer lever outwards to point of proper ignition. See Tag No. 7.

TO START STATIONARY ENGINE WHEN EQUIPPED WITH GASOLINE PUMP.

Pump up the gasoline by means of the thumb lever on the pump. See Tag No. 19.

Open the needle valve on top of the mixer, amount marked on Tag No. 13.

Close, or nearly close, the Air Throttle at Tag No. 15.

See that timer lever is in starting position. See Tag No. 7.

Close the Battery Switch on the battery box.

Open the Relief Cock. See Tag No. 11.

Turn the engine by the flywheels until an explosion occurs; after the first explosion open the air throttle, Tag No. 15, and after the third or fourth explosion close the relief cock, Tag No. 11, as the engine comes up to its speed, pull the timing lever outwards to point of proper ignition. See Tag No. 7.

STARTING THE PORTABLE ENGINE.

Open the needle valve on the mixer mount specified on Tag No. 13.

See that timer lever is in starting position. See Tag No. 7.

Close the battery switch on the battery box.

Open the Relief Cock. See Tag No. 11.

Turn engine by the flywheels until an explosion occurs. See No. 14.

on Mixer Tag No. 14, and leave it open.

Close the Relief Cock, Tag No. 11, and as the engine comes up to its speed, pull the timer lever outwards to point of proper ignition. See Tag No.

Remarks for both Stationary and Portable Engines: See that everything is well oiled and the cylinder lubricator is feeding properly.

Keep contact springs clean. See Tags Nos. 4 and 6.

Be sure that cylinder is oiling all around. No dry spots.

Stopping Engine

To stop the engine throw off the Battery switch and close the cylinder lubricator. It is not necessary to shut off the gasoline on either the Stationary or Portable engines. Always stop the engine by throwing battery switch. Wipe the engine up after you stop it whilst it is warm. Keep your engine clean. It only takes a few minutes every day and is time well spent.

WHERE TO LOOK FOR TROUBLE IN THE ENGINE, AND WHAT TO DO.

There are many troubles talked by a ma... or is apt ... supply he... the ...anding out ... ...cting the Ignition ...mosphere ...ndar... ...econdly in ...at has to ... ...e not ... ...ng the proper mixture ...e. The p... e. If the trouble is ... the ignition ...e must ... ...ark plug and examine the points ... e attenti... ...ecome sooted up or covered with oi... ...d weat... ...h lubricating oil being fed to the cylinder ... short circuit. If necessary, take the ... the... (Most plugs are made in two ... ...ore ... ...e two hexagon parts.) In ... ...ul not to damage the insu- ... ...nall packing ring found in ...re the insulated core comes ...n. Clean thoroughly in gaso- Ope... ... ...e parts with a rag, screw the pieces ...g ... ... see that points are the thickness of Se... ...ttached to Tag No. 1) apart and test ag... ...ystem as directed in the section of this C... ... devoted to Igni...ion. The trouble in (... ... mixing system of the Stationary is usually (... ... to improper setting of the needle valve, al... ...e gets either too little or too much gasoline; ...er in the gasoline, the check valves of the leaking, the pump itself leaking where it is ...d; the gasoline tank may be empty or dirt ... ...y have got in the needle hole. To test the pump open the pet cock on the side of the gasoline reservoir and work the pump by hand. If gasoline flows freely from the pet cock then the pump is all right. If it does not examine the check valves on the pump and be sure that the gasoline tank is not empty. The remedy for the other troubles is self apparent, only in taking any of the engine apart be sure you remember just how it goes together, and be sure you clean everything before putting it back in its place. The troubles from the mixer in the portable

...are usually the ga...line tank empty, water ...line, dirt in th... and needle valves, Cl... in ...ck and needle Open the Relief Coc... ...per ...e needle Tu... ...ngine by the flyw... ...t arbitrary, ... the first exp... It is **Gasoline** ... and after ...rked ... in cock, Ta... test. The setting n... have t...d, pull the ...g on the q...lity of gasoline us... ignition. ...ality you get. A little experienc... ...ation will soon enable the opera... ...just the needle valve from the ...E... ...acts. Until such time as this expe... ...he operator is safe in using the setti... ...N... 13.

USING HARD WATER IN T... AND ITS EFF...

When hard water is used in the w... the engine, a deposit of lime, etc., is fo... walls of the cylinder and water jacket. ... allowed to accumulat... beyond a certa... the cooling effect of the water will be g... duced and trouble will ensue from the engin... too hot. A little boiler compound added ... water will loosen up the deposit, after usi... boiler compound the engine head should b... moved and all the loose scale scraped out. If desired to remove this deposit in a hurry a solut... of sulphuric acid, one part acid to ten of water, can be left in the engine jacket for 24 hours. After the acid is run off the head should be removed and the loosened scale scraped out as before. A good plan after the acid is used and the scale scraped out is to fill the Jacket with some kind of oil (any cheap machinery oil will do) allowing the oil to stand in the jacket for half an hour. The reason for doing this is to check any further action by the acid on the cast iron of the cylinder.

SOME FINAL CAUTIONS.

See that the oil cup on the crank pin connecting rod feeds oil properly; this cup o[il] when engine is running, the adjustment [is] a small screw inside the cup directly [over] the filler cup. Turning this screw out increases the feed, the reverse of course decreasing the feed. When first starting the engine do not run it long at a time but shut it down every little while and carefully examine it all over. Examine the inside of the cylinder from the open end, and be sure that it is properly oiled, no dry spots. If there are, rub on some oil. This degree of caution is necessary during the first day's running, but being careful in the start may save you much vexation and expense later on. The writer of this instruction book has gone out to start engines, particularly portable engines on farms where they wanted to start the engine up immediately on its arrival and put it to hard work without any preliminaries, nay, more, I have had to put engines on to almost a dead load inside of 10 minutes after their first start. There was really no reason for doing so only some people pride themselves on sticking a gasoline engine pulling a shredder, corn sheller or grinder. There is probably no danger to the engine in such a test where there is an expert from the factory to start it up, but for a man who has never run an engine before to try it is running chances of 100 to 1 of damaging the engine to some extent. It may be claimed by the purchaser that all manufacturers of gasoline engines claim that their engines are thoroughly tested and worked down to carry a load before leaving the factory, all of which is substantially true. But it must be remembered that the men who do this testing are men of years of experience in running and testing engines, men who can tell by the slightest change in the action or sound of an engine just exactly what is wrong with it, or what is going wrong. It is well therefore for the purchaser of a new Gasoline engine to exercise due

ntil he becomes familiar with the engine. In hink that this caution is too extreme. We a business have to use a great deal of care in lp machine tools, such as lathes, planers, e new. It may take a week sometimes befo dare put a new mach tool to doing work to its maximum capaci f course are me anics and are supposed to se things and if we happen to damage a m ool when new through lack of sufficient car would get little sympathy from the manufact of the machine.

Finally, w a li care and t e on your engine and k clean ist s woman judges another woma by th lin of her house, so we gas engine builder gage a n by the cleanliness of his engine If you ha e carefully read this instruction bo k we are sure that you now have some clearer ideas about a gasoline engine. In it we have honestly told you the truth. The old saying applies in the gasoline engine business just as in anything else. "Ye shall know the truth, and the truth shall make you free," We sincerely trust you will be free from gas engine troubles.

TAG No. 1—SPARK PLUG AND GAUGE.

This p ved into engine head where Tag No. 2 is . Do not damage the insulation on the pl crewing it in. Attach heavy insulated wire to which Tag No. 3 is attached to the outer end of the spark plug by means of the binding screw. The small sheet metal gauge attached to this tag is for setting the points on the inner end of the plug the right distance apart. It ought to just slip in between the wire points. The thickness of this gauge is $^1/_{32}$ in. If lost we will send a new one at any time for price of postage.

TAG No. 11—RELIEF COCK.

Screw this cock into the hole to which Tag No. 12 is attached by a wooden plug. This hole is forward of the governor, immediately above the detent. Open this cock in starting the engine and close it after the engine has made a few explosions.

TAG No. 12—RELIEF COCK HOLE.

Screw the Relief Cock found in box of parts and tagged No. 11 in this hole.

TAG No. 13—MIXER NEEDLE VALVE.

Open this.....turns.
This regulates the supply of gasoline.

TAG No. 14—PRIMING PET COCK.

Before starting the engine open this cock and allow gasoline to flow into the cap on the lower end of mixer pipe until it overflows through the small hole in the side of the cap. (See Instruction Book)

TAG No. 15—AIR THROTTLE ON MIXER.

onary Engines Epuipped with Gasoline Pump Only.

valve is closed when the T handle stands
se of the pipe, and full open when standing
with the pipe. Shut this valve almost close
ting the engine, and after a few explosions
full and leave it so. (See Instruction Book.)

AG No. 16—CYLINDER LUBRICATOR.

Screw this lubricator into the $\frac{1}{4}$-in. pipe ell in front of water jacket where tag No. 17 is attached. Adjust cup to feed 5 or 6 drops of oil per minute. In cold weather, the oil being thick, the cup will have to be opened up more, when the engine is cold, and gradually closed down a little as it warms up. Use only good Gas Engine Cylinder Oil. This is very important.

TAG No. 17—LOCATION OF CYLINDER LUBRICATOR.

Screw Lubricator in here and adjust as per Tag No. 16. Immediately behind this ell you will observe a $^{5}/_{16}$ hole running into the cylinder at an angle. If the engine is turned until the piston is in the outer position and oil poured in this hole, it will go directly to the crosshead pin in the piston. Always do this before starting the engine.

See Instruction Book.

TAG No. 18—GASOLINE TANK FILLER PIPE.

Fill gasoline tank here.

TAG No. 19—GASOLINE PUMP THUMB LEVER

For Stationary Engines equipped with Gasoline Pump only.

This lever is used to pump the gasoline up to reservoir of the mixer before starting the engir