Circulator
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Circlemasters CIRCULATOR

Newsletter of the Circlemasters Flying Club
Milwaukee Wisconsin
Academy of Model Aeronautics Chartered Club # 662

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At The Handle

Ramblings from your editor

If you would like to contribute material, please submit to the address on the cover or contact me at (715) 697-8458 I may be reached via e-mail at clmodman@wctc.net

Ho Ho Ho ! Merry Circlemasters Christmas greetings. Now that you're done stuffing your pie hole with turkey and all of those Thanksgiving trappings, it's time to get down to the big show of the holiday season. Santy probably won't be bringing you guys anything but coal in your stockings anyway but you can always hope for some control line stuff under the tree. Try to be good next year.

As long as we are on the topic, this meeting marks another Circlemasters Christmas party. Be sure to jingle your bells over to Dan's shop by noon to get in on the holiday fun. We also have another movie to entertain you while you indulge.

This issue is packed like a sack full of toys with an article that is as informative today as it was when written back in February of 1968. The piece is an exhaustive explination by ukie speed guru Glenn Lee on the theories of operation behind various types of two cycle model engines. Enjoy the article and realize that the ground work laid down back then has given us the really excellent engines that we have available to us today.

Now the ranting starts, just so you know. While digging through old mags to ferret out worthwhile verbage to lay on you, it dawned on me that I am kind of glad that I missed out on the glory days of control line aviation. It would be a bit of a bummer to be in on that era and then see it become what is has transformed into today. Even though there are tons of kits and engines out nowadays that are light years ahead in quality to what was available back then. Lets face it, in the 50s and 60s control line was king. Some of the periodicals in my collection from way back have three U/C construction plans… *in one issue*! I ran across one article where R/C and free flight guys were griping about how unfair it was that the magazines were dominated by C/L articles and they felt slighted. Wow. As another year draws to a close, I'm thankful for what we have in control line today and especially for the great people it has brought into my family members lives, but it blows my mind to think of what it must have been like to see .40 rat racers flown three up at over 120 mph. And then to realize that contests had to be organized in an efficient manner just to be sure everyone got to fly with the number of participants. Rat has been diminished to .15 engines today because there probably aren't three guys left in all of u/controldom who could handle the old rats the way they were flown, at least not with a reasonable margin of safety. How about contests with hundreds of entrants *and*, hundreds of spectators. Holy cow, now if anyone even takes notice of our activities, it's usually an older gent who talks about how he flew one when he was a kid. If what we have is progress, I want to *re*-gress a little bit.

Come to the party. Enjoy the company of your fellow club members and have a great Christmas. Keep Kelsey in your thoughts and prayers. Uncle Sam has seen fit to ship her down to Texas for basic training just in time to miss Christmas at home.

Howard

CIRCLEMASTERS FLYING CLUB
MEETING MINUTES FOR NOVEMBER 2010

The monthly meeting of the Circlemasters Flying Club was held at the shops of Dan Tetzlaff in Sussex on Saturday November 6th. The meeting was preceded by a fine DVD on restored aircraft.

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***MEMBERS PRESENT:* Ralph Kohn, Don Adriano, Mike Strand, Howard Olson, Dan Tetzlaff, Jason Netteshiem, Wayne Schmidt, Jerry Bobb, Len Dopke & Pete Mick.**

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The meeting was brought to order at 1:35 PM by Pres. Jason. He began by asking the members if all had received the October newsletter and had taken the time to read the minutes of that meeting. All present had received the newsletter and had read the minutes. Jason asked if there were any additions or corrections to the minutes. There were none and the minutes were approved as published. The treasurers report was given by club treasurer Ralph Kohn. He reported on the current financial status of the club noting all recent transactions. A motion to accept Ralph's report was made by Pete and seconded by Mike.

REPORTS AND ANNOUNCEMENTS:

Don reported that the R/C Association is prepared to offer matching funds for the Make-A-Wish project once the club provides a letter indicating the amount of the clubs donation. Also, Don said that he will be volunteering at the January R/C Association Auction and if anyone else wants to assist to let him know asap.

OLD BUSINESS:

A discussion regarding the club Fun-Fly was continued from last month. It was proposed to invite members from other clubs to participate in control line flying. R/C aircraft will not be allowed to participate. An early club meeting would begin the day and would also include flying and food. The primary reason for this event is to promote club member participation. Howard volunteered to produce a flyer to be distributed at the next R/C Association meeting which will describe this event to be held on August 6th at the Sussex Village Park. Further discussion will continue at the next meeting.

NEW BUSINESS:

Pete began a discussion about the next club contest. He suggested that due to some of the difficulties experienced at last years contest that we consider renting the entire parking lot as well as the pavilion for the duration of the contest. June 5th was selected as the primary date and June 12th as the alternate. Further discussion will continue at upcoming meetings.
An election of club officers was held and surprisingly there were no new volunteers. Therefore, it was unanimously voted to retain the existing officers.
The December meeting will be the Holiday meeting/party/movie day.
Attendees are encouraged to bring holiday fare to share. The action will begin at 12:00 with a video "Hook Down, Wheels Down", the history of U.S. Navel Aviation.
Since there was no further business Jason called for a motion to adjourn the meeting. A motion was made by Dan and was seconded by Howard. The meeting was adjourned at 2:32 PM.

Submitted by:
Wayne M. Schmidt, Secretary

Upcoming Events

Come to the meeting early and watch the show

Saturday December 4, 2010 - Monthly meeting at Dan's shop. Movie and annual Christmas party begins at noon with meeting to follow.

Saturday January 1, 2011? - Monthly meeting at Dan's shop. Movie @ noon, meeting @ 1pm

Circlemasters 2010 Club Officers

President:	Peter Mick	(262) 677-2835
Vice President:	Jason Nettsheim	(262) 246-0348
Secretary:	Wayne Schmidt	(414) 321-7875
Treasurer:	Ralph Kohn	(414) 962-1232

Circlemasters Annual Membership Fees:	Age 19+	$18.00
Family rate also available	12 to 18	$ 5.00
Newsletter Subscription Only: $10.00		

THE TRAILING EDGE

By Wayne M. Schmidt

While paging thru my latest issue of Sport Aviation, I came across a picture of the founder of the EAA, Paul Poberezny. He was pictured along with his wife in front of one of his restored airplanes. This picture reminded me of a chance encounter I had with Mr. Poberzeny a number of years ago.

The year was 1960 and my friends and I had recently discovered golf. Building and flying model airplanes was not enough to fill the voids of time during a Wisconsin summer and golf seemed like cheap fun. In those days we would take the bus, $0.10, up Forest Home Avenue, walk three miles to Whitnall Park and play eighteen holes twice for $0.70, drink two sodas, $0.20. That blew the whole buck I "borrowed" from my Mom. So now we began the trek back home. Even if we had money we were not allowed on the afternoon bus with golf clubs. Those drivers either did not like kids or golf clubs and so we walked.

Shortly after reaching Forest Home Avenue a station wagon slowed down and this guy in an Air Force flight suit got out and said, "You guys want a ride?" You bet we did. He let us put the clubs in the back, we got in and away we went. He asked us where we needed to go to and we told him that the bus stop on 60th Street would be perfect. I asked him where he was going and he explained that he was an Air Force Reserve pilot and was going to work at Mitchell Field (that is what it was called then). He went on to explain that he was also a private pilot and flew experimental or home built aircraft from Hales Corners airport which was next to Whitnall Park. I told him that I loved watching those planes while we were golfing that day. He went on to explain that he had an idea to organize the people who build and fly experimental aircraft and form an association which could work for a common goal. He had just started what was to become the EAA!

He asked us what our future plans were. We both responded with "I do not know". Although, I had been thinking of joining the military but had not told my parents. He thought that a career or even four years in the Air Force would suit me just fine. I told him that I was fascinated with aircraft engines especially the new jets. They were fairly new back then. I was encouraged by his enthusiastic response and began to think of a future in the Air Force. Well, by that time we had reached 60th Street but he was not quite done talking so he drove us the remaining four blocks home and dropped us off in front of my house. We thanked him for the ride as we removed the clubs from the back of the station wagon. He reminded me to check out the Air Force and wished me luck. I promised him that I would and added my wish of success for his future plans.

A little over a year from then I was lying in my bunk at Lackland Air Force Base wondering what I was doing there! Well, the Air Force experience lasted four years, jet engines were not so mysterious any more, and I enjoyed serving my country. No one shot at me. I did not pursue an aviation career after I left the military but I never lost my interest in most anything that flew and still look up when I hear aircraft. I was pleased to find out that the idea that Mr. Poberezny told me about that summer afternoon in 1960 turned out as he had envisioned. I am also proud to be a recent member of the EAA. Thanks for the ride.

Wayne M. Schmidt EAA 1026910

Way Back

...Inside...the two-cycle engine by Glenn Lee

Many test articles have been written about engines, but few have explained many of the terms used. Almost all model engines used today are two-cycle; that is the engine fires every revolution. (See Fig. 1) They are much simpler than four-cycle engines since they have no oil pumps, timing gears, camshafts, or head valves. They have their own problems, however, and this article will try to explain some of the design differences in engine available today and yesterday.

Two-cycle engines: First, consider the methods of getting a fresh charge of fuel and air into the cylinder and the exhaust gases out. The four strokes use an entire revolution of the crankshaft to pump the exhaust gases out and draw in a fresh charge. This pumping process results in a large frictional loss within the engine. In the two strokes, the charge is allowed in and the exhaust out during the lower part of each revolution. This results in a loss of power stroke and also mixes the fresh charge with part of the just-fired charge.

The two-stroke engine also labors from “crankcase scavenging.” The crankcase is sealed, and the up and down travel of the piston acts like a pump to give positive and negative pressure in the crankcase. Valves are used to allow a fresh fuel-air charge to enter the case when the piston is going up. The valve is then closed and the downward travel of the piston compresses the charge. When the piston opens the bypass port, this compressed charge is directed up into the cylinder. As shown in Fig. 1, the exhaust port usually opens just before the bypass port and allows the burned gases to get out, with a minimum of mixing with the fresh charge. This is “cylinder scavenging.” Several different methods of scavenging will be discussed later.

Since the crankcase acts as the fuel pump, lubricating oil must be mixed with the fuel. The fuel is vaporized, and the layer of oil is left on all surfaces. Most of the oil goes through the crankcase and is burned in the cylinder or blown out the exhaust. This system is simpler than any pressure oil system, and you get an oil change every revolution. The cylinder walls are lubricated very well this way, resulting in low friction and long life.

The oil mist lubrication, however, does reduce the amount of fuel—air mixture we can get into the cylinder. Bearings do not always get an adequate supply of oil, and sleeve type bearings must be very loose.

Scavenging: Going back to cylinder scavenging, there are several different designs regularly used as diagramed in Fig. 2. All of them use an air blast coming through ports in the cylinder walls to force the exhaust gases out. Some names given to these methods of scavenging are: Uniflow, double-piston, cross and loop. There are several variations of loop scavenging: Schnuerle, Curtis, reverse loop and laminar flow.

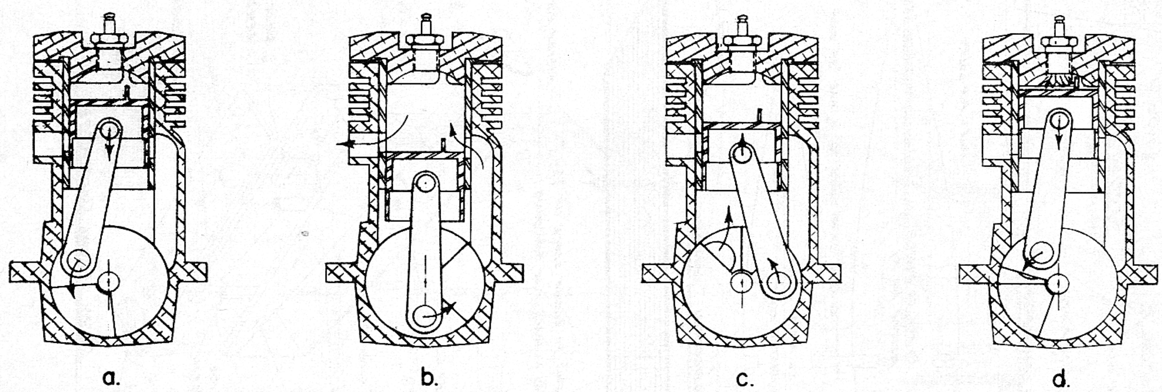


Figure 1: The two-cycle sequence. a.Air intake is closed, piston is compressing the crankcase charge. b.Bottom of stroke, ports open, cylinder scavenging takes place. c. Piston is drawing in a fresh charge as it compresses the cylinder charge. d. Combustion takes place, air intake is almost closed again.

The uniflow engine has the exhaust port or poppet valve in the top of the cylinder, and gases flow only one way. The fresh charge coming in just above the piston pushes the exhaust gases out the top. Some method must be used to open the valve at the proper time, such as a cam and rocker arm. Many years ago, Dooling experimented with an engine using a rotary valve in the head driven by a gear train, but was troubled by seizing problems due to high temperature exhaust gases.

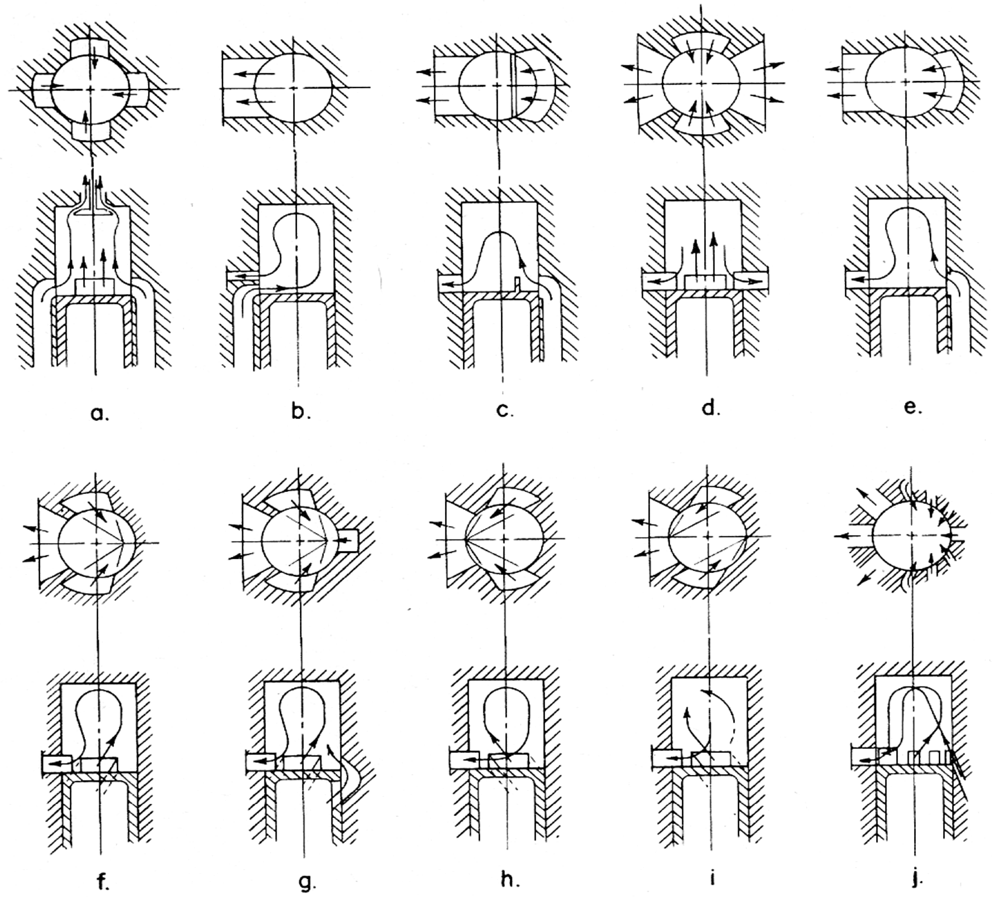


Figure 2: Types of scavenging. a. Uniflow, b. Loop, c. Cross, d. Original Schnuerle, e. Laminar, f. Schnuerle, g. Schnuerle with a boost port, h. Reverse loop, i. Swirl, j. Curtis.

Cross scavenging is the type used in many engines sold today, such as McCoy, K&B, Fox and O.S. Cross-flow engines have the bypass ports located on one side of the cylinder and the exhaust ports on the opposite side. The piston has a deflector baffle on the top to deflect the incoming charge up into the top of the cylinder.

The cross-flow engines have several minor disadvantages. The piston baffle is directly in the combustion chamber, and disturbs uniform combustion. It also over heats and distorts the piston. In fact, the baffle on speed engines usually gets melted away by ultra-high nitro content fuels. There is also a tendency toward a loss of the fresh charge out the exhaust port, with a resulting loss of power and economy.

A modification of the cross-flow design is the laminar-flow engine, notably the Super Tigre with its patented bypass port system. In this design, the top edges of the bypass ports are beveled with a double angle such as that the air does not break away from the cylinder wall. The fresh charge flows around the bevel and is directed up into the cylinder. The piston top can now be flat, resulting in a uniform combustion chamber, and heat distortions on the piston are minimized.

The loop scavenged engines have the bypass ports located to direct the fresh charge against the wall opposite the exhaust port. The charge then loops up into the cylinder, forcing the exhaust gases down the opposite side and out.

The original Schnuerle system used four ports. The bypass ports were on opposite sides of the cylinder and the exhaust ports were between them. The charge came through the bypass ports, net in the center, and then traveled to the top of the cylinder. The exhaust gases were forced down the sides. Several brands of engines have been built using this system – well-known engines, too.

Better results were obtained using a single exhaust port with the bypass ports located on each side of the exhaust and directed toward the opposite cylinder wall. The latest MVVA engine uses this system. Bill Wisniewski's engines with which he won the last two World Championships used Schnuerle porting with a small additional port opposite the exhaust port. This is called a boost port, uses a laminar flow bevel at the top edge, and directs a charge from under the piston up the cylinder wall. The newest Cox Mark II also uses a similar system.

One additional benefit from the Schnuerle porting is improved idling characteristics for RC or other throttle operation. In a cross scavenged engine, the wet fuel charge is directed at the glow plug. At rich settings and low rpm this wet charge puts out the glow plug and the engine stops. With the loop scavenging the charge loops past the filament, and the engines can run at very rich, slow settings without stopping.

The Curtis scavenging uses multiple ports. The ones opposite the exhaust have laminar flow top edges while the others direct the flow away from the exhaust similar to the Schnuerle system.

The reverse-loop scavenging has tow bypass ports that direct the fresh charge just above the exhaust port. The charge loops up that cylinder wall, down the side opposite the exhaust, and across the top of the piston. A slight variation to this is the swirl scavenging where one port is directed above the exhaust port and one is directed against the wall opposite the exhaust port. This results in a rotation charge giving high turbulence in the cylinder.

The double-piston engine shown in Fig. 3 has two cylinders with a common combustion chamber and two crankshafts geared together. The inlet ports are located in one end of the cylinder and exhaust ports in the other. By properly phasing the pistons, the exhaust ports can open before the inlet ports, and also close before the inlet ports. The exhaust gases can be cleared with a minimum loss of fresh charge. Complications are the gears and the double height of the engine. Vibration is minimized, however.

Porting: The biggest problem of scavenging two-cycle engines is to separate the exhaust residue and the incoming fresh charge. In most engines, the exhaust port opens slightly ahead of the bypass port. The rapid rush of the exhaust gases from the cylinder can cause the pressure in the cylinder to drop below atmospheric, and the resulting vacuum can draw part of the exhaust back into the cylinder.

If the exhaust port opens too soon, part of the incoming fresh charge can be lost out the exhaust. The pressure in the cylinder is very high during combustion, and very little time is required to let these gases out when the exhaust port opens. The crankcase pressure, however, is very low, on the order of six pounds per square inch. This low pressure cannot force the fresh charge into the cylinder very fast, so the bypass ports must be raised or widened to improve performance.

The exhaust port must open before the bypass port, so it must be raised along with the bypass port. The portion of the wall given to porting must be subtracted from the working stroke. So, the height of the ports must be matched to the rpm range at which the engine will be run and also to the burning rate of the fuel used. Racing engines using high nitro content fuels have very high, wide ports, while stunt or sport engines have much lower ports.

Port opening periods are usually noted as so many degrees of crankshaft rotation. This is “exhaust timing” and “bypassing timing.” For speed engines the best exhaust timing has been found to be near 140 degrees, which means that the piston starts to uncover the exhaust opening when the crankshaft is 70 degrees from bottom dead center and closes when the crankshaft is 70 degrees past bottom dead center. Bypass timing varies from 120 to 130 degrees. The Super Tigre engines have symmetrical timing, the exhaust and bypass open simultaneously. The high pressure of the exhaust gases holds the fresh charge in the crankcase until the majority of the exhaust has gone out the exhaust port and pressure in the cylinder has been reduced below that of the crankcase. This gives the same effect as opening the exhaust port before the bypass yet allows a higher, larger bypass port to be used.

To improve scavenging in the cylinder, the main factors are time and the amount of fresh charge that you can get in. At 24,000 rpm, the bypass port is open for less than 1/1000 of a second. This is not enough time to allow a fresh charge to travel from the lower part of the crankcase all the way up into the cylinder. The top of the bypass chamber in the crankcase must be large enough to store a charge until the piston opens the port, letting the charge into the cylinder quite quickly.

Crankcase passages must be as large as possible to allow unrestricted flow of gases. On the other hand, this reduces crankcase pumping efficiency and can be detrimental to high speed performance. It has been found that the best solution to this problem is to “pack” the crankcase as much as possible, yet leave a large chamber right next to the bypass ports. Some engines, notably the Dooling, have transfer passages cut through the wall into short, curved bypass passages. This also allows fresh charges to cool the inside of the piston a little better.

One of the greatest improvements in engine design in the last years has been the metallurgy of the sleeve-piston combination. The leaded steel sleeve and hardened cast iron piston is hard to beat, although chrome plating is still being experimentally used. A chrome plated sleeve is almost a necessity for top performance from a ringed, aluminum piston engine since friction is very high between aluminum and steel.

Pistons: Pistons whether iron or aluminum must be as stiff as possible to minimize warping and heat distortion. The best pistons have annular rings inside just above or below the wrist pin holes which aid in keeping then round. This greatly increases the cost of manufacture, but is usually necessary for high performance.

Even with a properly designed and manufactured engine, proper break-in of the sleeve and piston is required. Many attempts have been made to minimize or eliminate break-in running, but few methods are successful. For best performance, both the cylinder and the piston should be a s round as possible and have the proper clearance to start with. Lapping the piston in its sleeve with some kind of abrasive compound usually results in a ruined engine since softer parts of the sleeve get cut deeper than harder areas. Also, the harder piston will force the abrasive into the soft metal of the sleeve; it does not get washed out, and will most likely cut too much clearance during the first runs.

Heating of the piston is not uniform during running, since intensely hot combustion gasses heat the top causing it to expand more than the rest of the piston. The metal near the top of a lapped piston must be worn away to allow for this expansion before peak performance can be reached and maximum nitro fuel can be used. This metal worn away amounts to several thousandths of an inch off the diameter. Some of it can be ground away before running, but it is easy to grind too much unless you really know what you are doing. The piston also develops a bulge on the hotter exhaust side which must be worn away. Larger engines have used asymmetrical “cam-turned” pistons where this metal was ground away before assembly. It again is very difficult to grind the proper amount from a piston of the size we use.

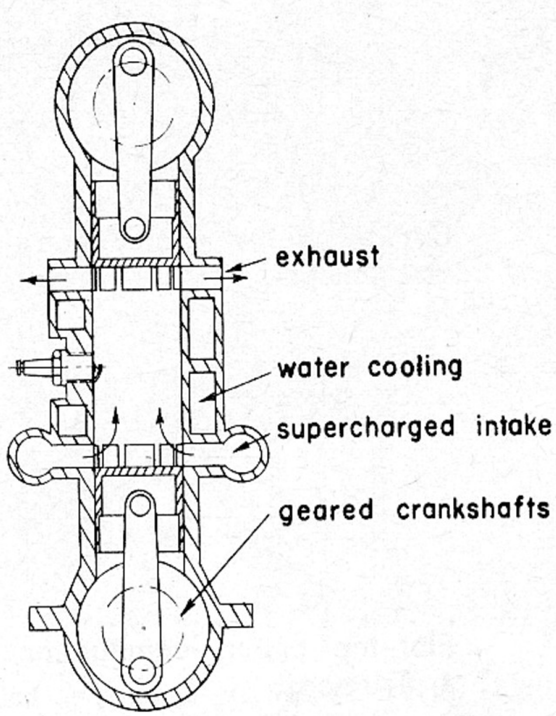
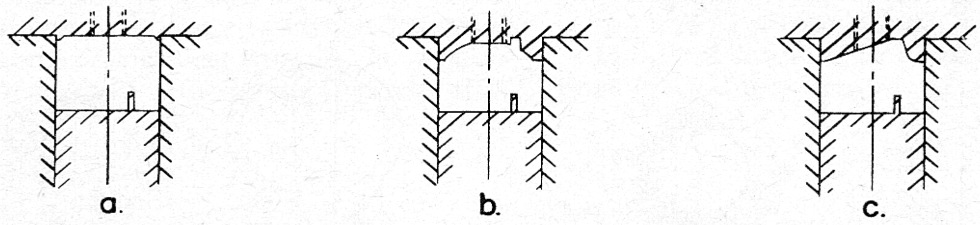


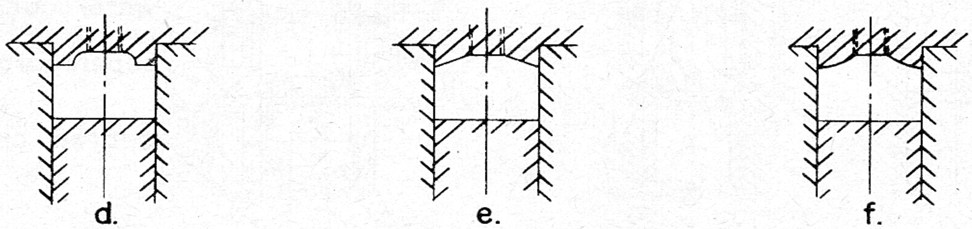
Figure 3: A "double-piston" engine.

The two stroke engines run very hot, and air cooling is usually uneven and inadequate. The main cooling is from the fresh air and fuel coming into the crankcase. Most high performance engines use a “hanger” type cylinder sleeve supported only by the lip at the top. The aluminum crankcase expands more than the sleeve, and even though it may expand unevenly, it does not squeeze the sleeve out of shape. Warped cases or warped sleeves are usually the greatest detriments to engine performance.

The importance of proper break-in cannot be overemphasized. Engines on the bench should be run at or slightly above the rpm that they will operate at in the air. A smaller diameter, lower pitch prop allows the engine to be run at operating rpm with a rich needle valve setting. The excess fuel mixture keeps the engine cool and lubricated to prevent tight parts from seizing.



Baffled-piston combustion chambers: a. Flat, low compression. b. Hemispherical. c. Wedge.



Flat-top piston combustion chambers: d. Squish. e. Cone. f. Trumpet.

Figure 4

One other aspect of proper break-in has to do with the instability of some piston materials. Hardened cast iron is unstable and will actually grow in dimension when it is heat cycled. This growth can be as much as .001” per inch of diameter. As an engine is run, the piston is heated and cooled during every stroke, resulting in a slow growth. This growth, however slight, must be worn away, and the engine is not broken in until the piston has stabilized. The time required for this varies according to the heat treatment and the alloy and can be several hours of high rpm running.

Head Design: Various head shapes are shown in Fig. 4. The classic domed piston and hemispherical or matched combustion chamber has almost totally been replaced by flat top pistons and “squishband” heads. The squish band is a circular band that fits very close to the piston at top dead center, and “squishes” the trapped charge into a central combustion chamber. The diameter of the chamber is usually about 65% of the bore diameter, and the depth is varied to give the correct compression ratio. A variation of the squish band head is the “trench” head, where the combustion chamber is a trench milled strait across, leaving wide squish flats on each side.

If the squish band is too close to the piston, a hydraulic lock can occur. That is, part of the fuel charge cannot get squished out of the way in time and is trapped. Extreme compression ratios result in the squish areas, and the result is erratic running and broken conrods. One way to relieve this problem is to give the squish band a slight angle relative to the piston; three degrees seems to work.

Squish band heads do have an effect on the allowable nitro content of racing fuels. Nitro contents as high as 70 and 80 % have been used without detonation.

Many other head shapes have been tried, such as the trumpet head in the “Rattler” engines, but compression ratio seems to make a bigger difference than head shape. Compression ratios as high as 18 to one have been used, but few glow plugs will stand up to such punishment. The compression ratio must be matched not only to your fuel, but to the weather as well. Test running and test flying is the only way to find the proper combinations.

Air intake: So far, we have talked about cylinder-piston combinations and head shapes, but we must also have an efficient means of getting fuel and air into the engine.

The simplest method of air induction is the "side port" system as shown in Fig 5 where the intake port is uncovered by the piston skirt when the piston nears the top of its stroke. A pipe leads from the needle valve to the port, and when the port is opened by the piston skirt, the vacuum in the crankcase draws in the fresh charge. Many model engines have been built this way, but better results are obtained by rotary valves.

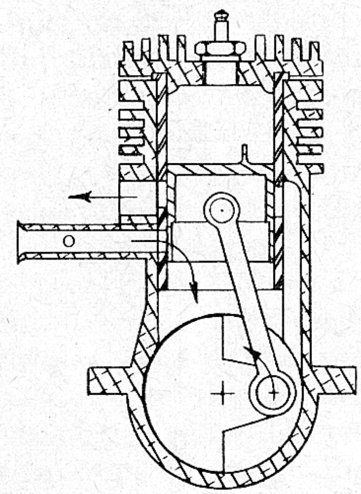


Figure 5: A "side-port" engine. The air intake usually enters at the rear of the case.

Some engines have been built using reed valves. These are simply a one-way valve formed by flat, thin, spring steel or beryllium copper reeds. When the piston goes up, negative pressure opens the reed allowing the fresh charge to come in, and when the piston starts down the reed closes. Disadvantages to this system are that the intake timing cannot be controlled, and the engine can also run in either direction.

The best, yet most complicated and most expensive system is the rotary valve. There are several types, but all of them use a rotary shaft or disk to open and close the air intake hole at the proper time. The simple rotary valve is the hole through the crankshaft that valves the fuel and air into the crankcase through a port in the main bearing. One advantage to this system is the oil mist cooling of the crankshaft and bearings. The disadvantage is that the crankcase compression cannot be very high with the large hole in the crankshaft. Over size bearing s must also be used.

The rear rotary valve is a disk or drum that is rotated by the crankpin. A large segment of the disk is cut away to allow passage of fuel and air, and opens and closes the intake port as it is rotated. Different manufacturers use different intake timing, but usually the valve opens after the crankshaft has rotated 35 to 45 degrees past bottom dead center and closes near 45 degrees after top dead center.

Much has been written on hop-up procedures where techniques are stressed on polishing all air passages, but this can sometimes give a reduction of performance. Oil from the fuel will stick to a highly polished surface while it can be swept away from a rougher surface. If it sticks and piles up in the bypass, the result will be a smaller passage for air flow. Any gain from polishing is usually from the removal of metal, giving a larger passage.

I hope this article has explained a few of the principles of two-cycle engines without antagonizing anyone. I have purposely neglected such things as superchargers or tuned systems. Most engine designs are many years old, but there should be room for more development of the basic systems. Titanium pistons, for example, do not work, but bused titanium conrods are already being used. Such metals as beryllium and single crystal iron must be tried for pistons or sleeves. Much experimental work is left.

Editors Note: from the American Aircraft Modeler February 1968