Designs and Building Specifications to the Four Stroke Engine WT3030
New revision!

Construction and designs of
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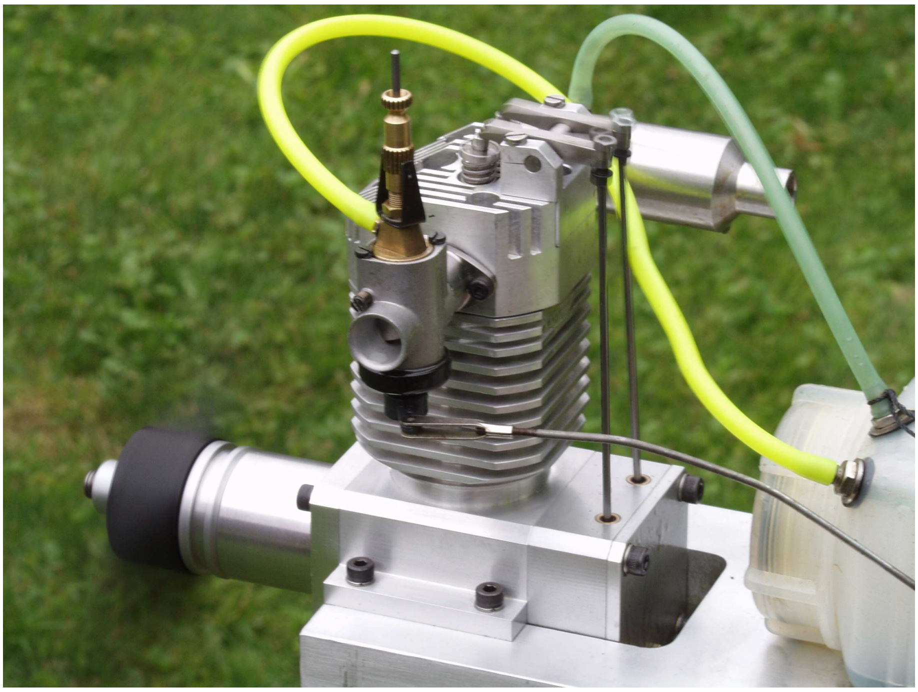

Technical data:

Cylinder capacity:	21 cm3
Stroke:	30 mm
Bore:	30 mm
Performance (5% Nitro):	Propeller 16 x 8
RPM Range:	1700 - 9200
Mass:	990g including muffler

Nærsnes, den 10.07.2006

Preface. My goal is to make multi-cylinder engines (radial engines) in my own workshop. One should be careful not to take too big a step on the first project. Therefore the first engine I produced myself was a two-stroker and came from a set of plans. The plans were published by “Verlag für Technik und Handwerk”. The engine ran acceptable after some trials and it was a satisfying achievement. The engine was of old design with low performance (maybe good enough to drive a kitchen fan) and without a muffler, to some irritation for my neighbours!

The next (natural) step was the building of a 1 cylinder, 4 stroke engine. Since no plans for such an engine, in that desired size existed within easy reach, I dared myself to a construct one. The building and the construction were accomplished according to the evolution method. I drew a part on the board and then manufactured it in the workshop. This method actually worked quite well for most of the parts. Gradually I developed my own 4-stroke engine!

As is the case for most projects, the day finally arrived to test it. The engine was mounted on a test stand and was taken to the garage for final set up. I fueled up the gas tank, put a finger on the carburettor throat and gave the propeller 5 to 6 flips around. The engine ran on the first attempt! Subsequently, I have had to reduce some vibrations and have made various other improvements. After the second test run, the engine showed noticeable improvements and my goal was being achieved. I am currently building a test plane around the engine for a long-term fitness test report. Up to now the project looks very promising. I therefore decided to document the engine plans using a CAD program (Draft Board Pocket) and to make the construction accessible to others. The drawings are of high standard because dimensioning is done automatically in the CAD program and part assembling is simulated in the computer. Keeping that in mind, the workshop should be equipped with the following machine tools: Lathe: Milling Machine: Surface Plate: Dividing Head, possibility for cylindrical surface grinding and a heat treating oven for hardening some parts. You will also need gear cutters of module 0.75, and reamers up to 10 mm.

I wish everyone great success with the project and I hope you have as much fun as I did with the machining work.

Wolfgang Trötscher / 12.12.1999

Part list of the Four Stroke Engine WT3030

Part	Num ber of	Sheet	Designation	Material / Supplier	Dimension
1	1	3/4	Crank case	Al Cu Mg Pb F38	52 x 70 x 101
2	1	6	Front housing	Al Cu Mg Pb F38	52 x 52 x 45
3	1	5	Crank shaft	34CrNiMo6 / SS2541-03	Ø45 x 112
4	1	18	Drive washer	Al Cu Mg Pb F38	Ø34 x12
5	1	18	Drive washer cone	Bronze	Ø14 x 12
6	1	19	Propeller nut	C45	Ø22 x23
7	1		Ball bearing	SKF 6001Z	12 x 28 x 8 (d x D x B)
8	1		Ball bearing	SKF 6202	15 x 35 x 11
9	2		O – ring	NITRILE	Ø42 x 2
10	1	4	Cylinder liner	Cast iron	Ø36 x 53
11	1	16	Connecting rod with bronze bush	Al Cu Mg Pb F38	9 x14 x 58
12	1	15	Piston	Al Cu Mg Pb F38	Ø30 x 22
13	1	17	Gudgeon	Silver steel, hardened	Ø7 x 29
14	1	15	Piston ring	Spheroidal graphite cast iron	Ø30 x 1,3
15	1		Spring ring	Gutekunst DIN 7993 / A	C420-6
16	2	13	Bumper	Bronze	Ø6x2,5
17	1	20/22	Cylinder head	Al Cu Mg Pb F38	55 x 50 x 28
18	1	25	Rocker arm bridge	Al Cu Mg Pb F38	14 x 27 x 30
19	2	23	Valve	Chrome nickel steel	Ø12 x 34
20	2	23	Valve seat	Bronze JM1	Ø13 x 26
21	2		Valve spring	Gutekunst d0,8 De 8,3 Lo19 n 5,5	VD-127C
22	2	24	Valve cotter	Silver steel, hardened.	Ø6 x 1
23	2	24	Valve spring washer	Silver steel	Ø9 x 2
24	2	26	Valve rocker screw	Made from DIN 912	M3 x 10
25	2	26	Rocker arm	C45 , hardened	5 x 9 x 35
26	1	26	Rocker shaft	Silver steel, hardened	Ø6 x 30
27	1	26	Distance piece	Brass or bronze	Ø6 x 10
28	2		Push rod	Spring steel	Ø2 x 81
29	1	7/8	Cam gear housing	Al Cu Mg Pb F38	52 x 52 x 37
30	1	13	Back plate	Al Cu Mg Pb F38	52 x 39 x 2
31	1	14	Timing gear drive	C45	Ø40 x 6
32	1	11	Gear wheel, m = 0.75 , z = 12 or m 0,7 z = 13	C45	Ø12 x 31
33	1		Clamping screw, cone	Made from DIN 912	M4 x 32
34	2	10	Camshaft	Silver steel, hardened	Ø15 x 36
35	2	13	Gear wheel m = 0,75 , z = 24 or m 0,7 z = 26	Brass	Ø22 x 6
36	2	12	Cam tappet	Silver steel , hardened	Ø9 x 16
37	1	9	Bush for timing gear	Bronze	Ø12 x 18
38	2	9	Bush for cam shaft	Bronze	Ø12 x 21
39	1		Breathing nipple	Brass	M5
40	2	27	Flange for Carburettor / muffler	Al Cu Mg Pb F38	Ø28 x 20 (Adapt to carburettor / muffler)
41	2	12	Bush for cam tappet	Bronze	Ø10x10
41	2		O – ring	VITON	Ø10 x 1,5
42	6		Socket-head cap screw	DIN 912	M4 x 10
43	2		Socket-head cap screw	DIN 912	M4 x 35
44	5		Socket-head cap screw	DIN 912	M4 x 20
45	6		Socket-head cap screw	DIN 912	M3 x 8
46	2		Nut	DIN 934	M3
47	2		Socket-head cap screw	DIN 912	M2,5 x 8
48	1		Nut	DIN 934	M4
49	1		Washer	DIN7089	Ø4
49	1		Propeller		18” x 6” or 16” x 8”
50	1		Glow plug	Graupner	”F”

Crankcase. Work on the outlines on the milling machine. Clamp the work piece on the rotary faceplate and turn the bores for the crankshaft and the cylinder liner. The right angle between the two holes is particularly important. Cut the ribs in the same clamping procedure. Then cut the threads.

Front housing. The housing should fit easily into the crankcase. The O-ring provides the sealing. Turn according to the drawings. The bearing fit must be in line, and perform a press fit with the ball bearings. The square outline, chamfers and holes are manufactured during the clamping procedure.

Crank shaft. Cut and sharpen all cylindrical surfaces. Cut the M8 thread on the shank on the lathe. Make a transition fit for the ball bearings. For the turning of the crank pin, use a Ø50mm x 95mm steel bar. Drill a Ø15H7 hole eccentrically 15mm off centre. Drilling must run exactly parallel to the centreline. (If not you can adjust the outline later). Put the shank into the drilled hole, secured by a nut. Clamp the arrangement on the lathe. Support the tap with the headstock. Turn the tap and sharpen & hone the fit for the connecting rod with 1 to 2/100mm play. The accurate balance is determined after completion of the piston and connecting rod. In addition a weight totalling half the mass of the piston and ¾ the mass of the piston rod is manufactured. This weight has a bore of 7mm and fits onto the crank pin. The crankshaft should be statically balanced with this weight on the crank tap.

Drive washer and drive washer cone. Turn the cone of both parts with the same angular adjustment on the lathe. On the mill with the spindle at 45 degrees, clamp the drive washer in horizontal position on the rotary table and with an end cutter make the pattern.

Cylinder liner. Take your time! Hone inside until no scoring is present. Clean the cylinder liner well and put in a suitable (30mm) fit. Continue the outside work. Heat the crankcase (to 250 degrees centigrade) to expand it, then press the cylinder liner into position.

Piston. Make the piston out of round material with excess length for clamping. Turn the outside diameter accurately, use 1200 grit wet sandpaper and cutting oil while turning it. The diameter of the lower part of the piston shell should be approximately 7/100mm smaller than the inside diameter of the cylinder liner. At the piston top, the play should amount to 1/10mm or more (depends on the type of aluminium and running temperature of the engine). Use a cut-off tool to make the groove for the piston ring. This tool should be tested before using it on the piston. The walls of the groove must be right-angled and of good surface condition. Work the inside of the piston now. Implement the remaining " inner work " on the milling machine. The piston should be as light as possible. Install the piston on the rotary table horizontally. Drill and ream the 5 H7 bore for the gudgeon pin accurately and at a right angle. Mill the radius 22 into the piston shell. Cut off the piston in your lathe and sharpen and polish the piston top.

Piston ring. Make a ring with an inner diameter according to the drawings, and an outside diameter of plus 3/10mm. Turn and cut off. Deburr the internal edges, then sharpen the ring flat on wet sandpaper on both sides with cutting oil until correct thickness is achieved. For sharpening, make a holder from 30mm diameter round stock with appropriate groove for the admission of the ring. Open the ring with a 2mm end mill. Now the ring is pushed into a cone pipe with Ø29.5mm – Ø30.5mm so that the joints of the ring meet. In a holder with a screw in the centre and a fitting disk, the ring is wedged in the closed condition between holder and disk. With a light impact the device is to be loosened from the inner cone. With the round sharpening mechanism (on the lathe) the outside diameter is sharpened to its nominal dimension. The lateral surface of the ring has a light bevel of 1/2 degree (this results in a shorter run-in period of the engine). The "thick" end of the ring is then placed to point towards the piston foot. Test the ring in the cylinder. The joint between the ring ends is to have a small light opening. The groove for the rotating safety device is attached to the topside of the piston ring.

Connecting rod. Prepare the bronze bushing for the connecting rod with 2/100mm oversize for a press fit. All work takes place on the same clamping course. Bore and rim, press in the bronze bushing and rim if necessary for a good slip fit. Proceed with the second drilling in the same way. Manufacture the outlines according to the drawings.

Cam housing. Bore and turn out the centre diameter of 44mm. On the milling machine, the holes for the cams are accurately drilled. The distance of the drilled holes to the centre is 14.63 mm. If there should be difficulties in keeping this distance accurately, it can, with an eccentrically bored bronze bushing, be corrected

Cam with gear wheel. Start with a shank, which has a pre-turned diameter of +3/10mm. Work on the cams on the milling machine rotary table. Drill the 2mm hole. Harden. Support the shank between the centre points on the lathe. Sharpen to the nominal diameter, plus 2/100mm. The slip fit range should be approx. -1/100mm of the nominal diameter. Turn the material for the tooth wheel to the correct width and prepare to drill it for the press fit. Drill the 2mm hole together with the cams and fix with a clamping sleeve to secure against rotation. Now turn outside diameters for the 26er gear wheel directly on the camshaft. Mill the tooth with 0.75 module – tooth cutter number 4. Mill the first tooth gap 3.3 degrees transferred from the top of the cam. The two cams must be manufactured as mirror images. See also sheet 10

Timing gear shaft with driver. Lock the gear wheel with the tooth gap in the 12 o'clock position. In order to tighten the conical clamping screw for the driver, make a short "tooth rack" which fits exactly into the groove over the gear wheel. The screw will tighten the connection god enough without additional effort.

Tappet. Pre-turn the tappet +3/10mm. The hemisphere shaped bores for the push rods are manufactured with a special cutter made from a (centre) - drill or otherwise use a radius cutter. Harden and sharpen the tappets.

Cylinder head. Turn and mill the outlines. Align the cylinder head in such a way, on a 5 degrees tapered plate on the rotary faceplate of your lathe, so that it can be drilled and turned Bore out the area for the valve seats and glow plug from the combustion chamber side. Before pressing the valve cups in, the combustion chamber must be modified by hand. An additional piece of round material (steel) with a diameter of 13mm must be cut to 15mm length. With it, fill the opening for the valve cups. Work down the edges of the Valve Cup press fit to the steel plugs. A Dremel mini drill tool with a small ball cutter and various sharpening tools will work well here.

Valve. Manufacture shank and valve disk according to the drawings. Sharpen the shank in the same clamping action. Separate the valve at the valve disk. Clamp the shank in a collet and carefully flat turn it. With 1200 grit sandpaper, and using cutting oil, polish the valve disk. Grind the valve with fine lapping paste in order to obtain a good seat. Do not interchange the valves. Be careful not to leave lapping paste on the valve guides. Drill the holes for the ports with the help of a centre drill. It fits into the guidance of the valve seats, which are made for it. Tap the M3 thread for the mufflers and carburettor attachment using a template bore. You can make the valve springs on the lathe by winding 1mm spring steel or obtain stock feathers/springs. The feathers/springs I made have a strength of approx. 25 - 30 kN.

Carburettor. A carburettor from a 10cc two-stroke engine is useable**.**