ZÜNDAPP KS600 Oiling

Notes about Zündapp KS600 engines lubrication system.
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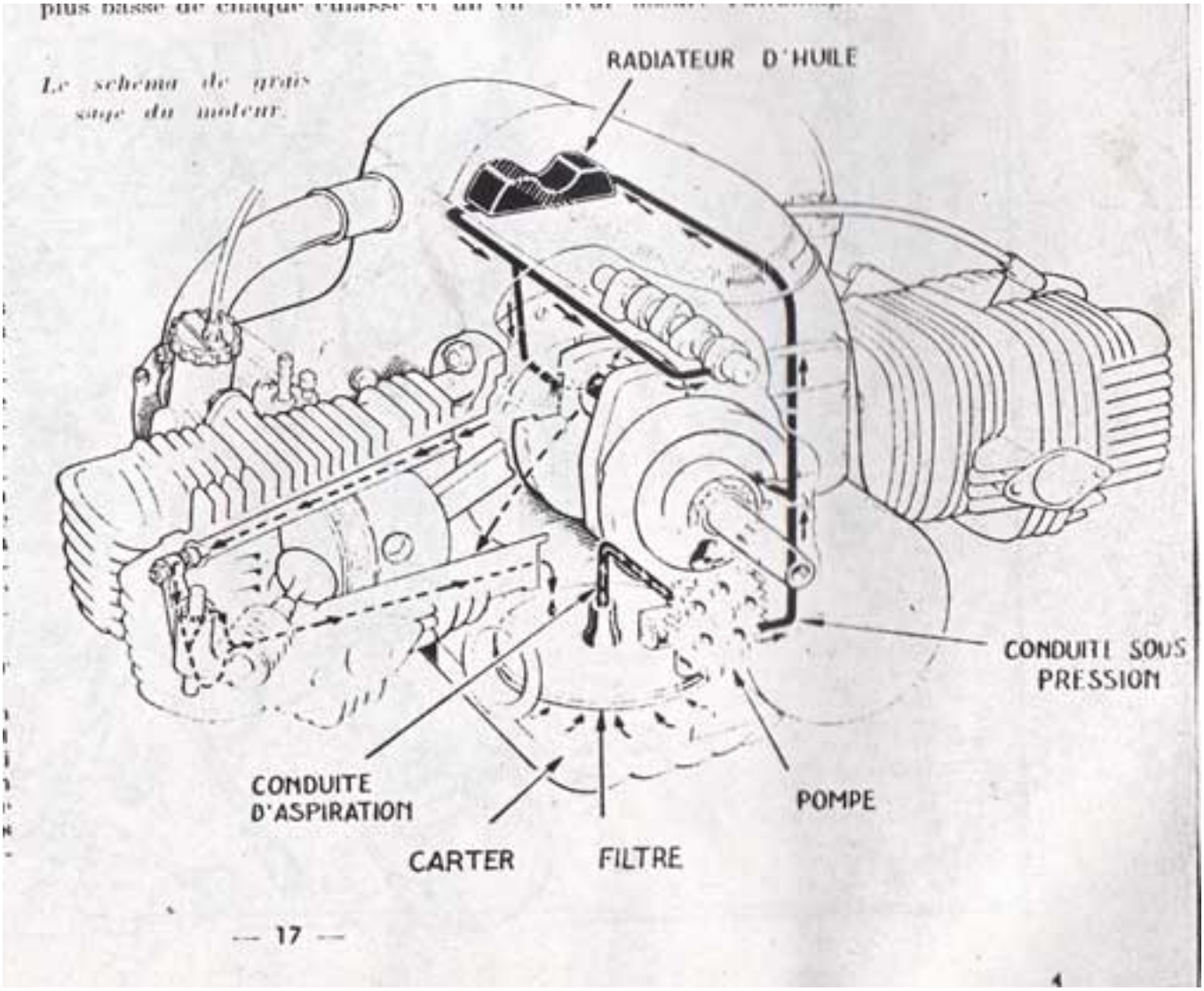
I don't pretend to be an expert on matters discussed here. This is simply an abstract of my observations and conclusions. Corrections about them welcomed.
Also I apologize for inaccuracies in my limited technical English.

History:
I just completed the restoration of my Zündapp KS600 which I began about 5 years ago. This bike was bought right after WWII by my late father in auctions by the French state which was selling vehicles abandoned by the German army. I restored it as it was with rod needle bearings, no paper filter and the original oil pump.

The problem:
I did some "empty" kicks without the ignition and after I engaged the key the bike started quickly after a few more kicks. I was very satisfied untill I had a look at the pressure gauge that I had installed on one of the plugs on top of the engine opening on what is supposed to be an oil radiator (“radiateur d'huile” on the image down) right in front of the carburetor. No pressure at all. I removed the gauge and started the engine again for I was confident that I had generously oiled everything and there will be no damage. As I had poured oil there too there was some but the level was certainly not climbing.

Looking inside:
I removed the engine from the bike and dismantled it completely, leaving only in the crankcase the rear bearing of the camshaft which is a pain in the neck to remove without destroying it. As I wanted to see the most I could about the oil passages, I unscrewed the two plugs in front of the engine up behind the camshaft wheel.

Oil circuit:
Here is a diagram of the oil circuit taken from the french « Revue Technique Motocycliste » Février 1953. The depicted engine is a KS601 with some differences re KS600 that I will enhance.

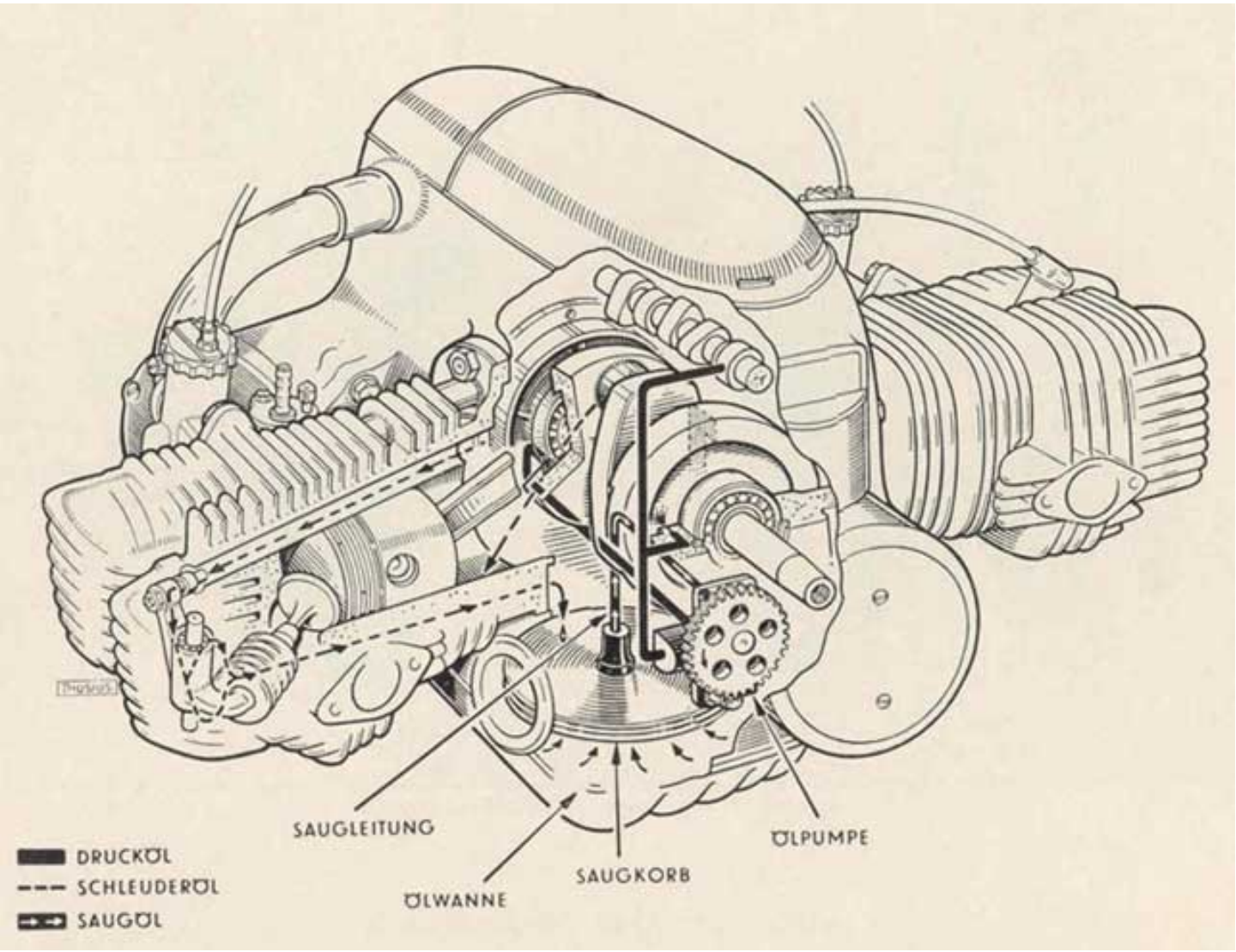


Oil is taken in the sump through a strainer which is a simple steel mesh. (I changed this mesh I found too large for a finer stainless steel one). The figure above mentions « filtre » (filter) which is for the KS601 engine depicted, not existing on my KS600.

After the pump, the oil goes first to the left, *(Note 1)* then climbs in a vertical passage (6mm, 1/4"). At the crankshaft level it lubricates the front bearing of the crankshaft, then, on the left, a small hole (1mm, 40 thou) pours inside a channel in the crankshaft where centrifugal forces drives it to the bearing of the front rod. Above that level the oil climbs again (8mm, 0.3"), then rides back to the so-called « radiateur d'huile » (oil cooler) which is simply a chamber with two large plugs screwed on top (my gauge was there). Then it goes to the rear bearing of the crankshaft and to the bearing of the rear rod in similar fashion to that of the front one. At last to the front bearing of the camshaft. The rest of the engine is oiled by what is centrifugated by the crankshaft.

Note 1:
On earlier engines (like mine) between the pump and the first vertical passage on the left, a recess closed by a small hood was supposed to receive a paper filter which is said to have never been installed. On later engines this compartment is not machined at all. On those it is said to have a pressure tap on the right side at the pump level. Any confirmation welcome please.

Note 2:
Another diagram down here exists showing a different circuit with no oil radiator. This one too is for the KS601. This is most probably a simplified view with no physical reality. Again any confirmation welcome.



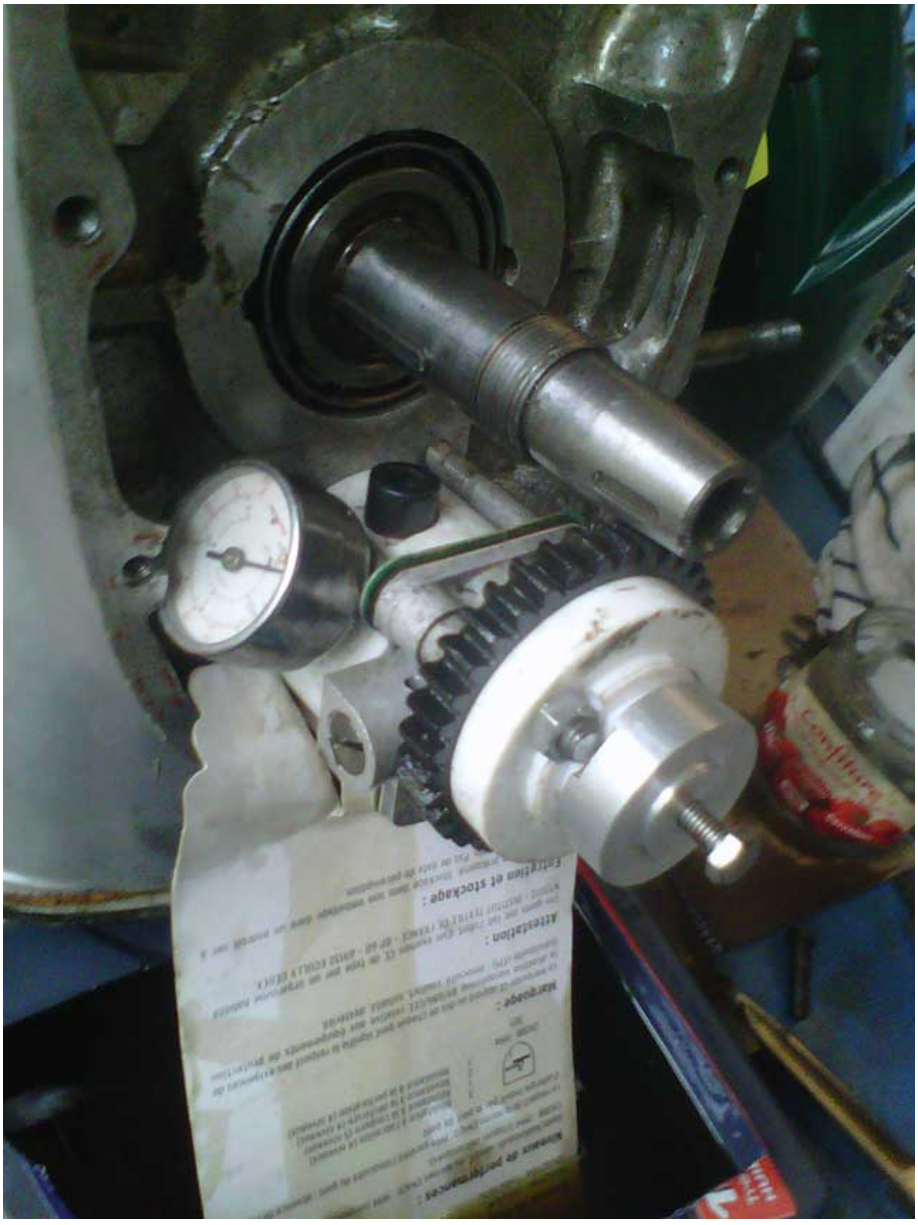
Pump :
The gear pump, uses the usual arrangement of ball/spring discharge valve to limit the output pressure. The ball is steel, 10 mm (0.4") diameter. The 3 pumps I saw had all the screw used to adjust the pressure flush with the pump's corpse. There is a gasket between the pump casing and the copper counterplate which defines the axial play of the pump. There's also a thicker gasket between the copper plate and the crankcase but that one is only there for oil tightness.

Tests :
I cleaned all the oil passages thoroughly (petrol then compressed air)but found no dirt or clogging (thanks to my previous cleaning after my bead-blasting of the crankcase !). However I found something I had forgotten which is that, right after the pump, in the horizontal passage to that recess for an inexistant filter on the left, is a jet limiting the oil passage downstream. This jet has a 1 mm (40 thou) diameter. More about it later.

I reinstalled the strainer, sump and pump, filled the sump with oil (20/50) and rotated the oiled pump ccw by a hand drill. No oil came through the discharge valve and when rotating by hand it was

obvious the pump was not initiated for there was no torque needed. I then spent a lot of time fiddling around, removing the pump, filling it with more oil and generally splashing a lot of oil all around too. There was some axial play which I did not found disturbing. I measured it to be 0,1 mm (4 thou). I tried to diminish it by tightening the 3 screws fixing the pump to squeeze more the gasket but my tightening would only reduce it to around 0,05 mm (2 thou) and the pump would still not initiate. I then realized that 0,05 mm x 50 mm (2") (height of the two gears) would equate to 2,5 mm2 which one may compare to the 0,75 mm2 surface of the output jet of diameter 1 mm. For a minimal axial play of 0,05 mm (2 thou) the short circuit inside the pump is more than 3 times the surface of the output jet feeding the whole engine. I then cut another gasket in another material (strong paper 0,35 mm (14 thou) thick). To make it short with that paper gasket, by thoroughly tightening the 3 screws I was able to reach no axial play and the pump would then initiate. It is also possible to tighten too much and the pump would not rotate at all. Working the pump by hand, even slowly, oil would now pour through the discharge valve and through the downstream jet.

As I wanted to measure the output pressure I machined a nylon spacer to insert between the pump and the crankcase:



This spacer allowed me to insert my gauge in the pump output before the limiting jet. The cardboard is there to help the oil from the discharge valve to reach the can under.

Pressure measurements:

With the screw used to adjust the pressure flush with the pump's corpse the pressure fluctuates around 1,5 bar (22 PSI).

One more turn on the screw and the pressure is now 2 bar (29 PSI).

The pump was rotated by means of my drill there but by hand, even slowly, the pressure is immediate and of course the discharge valve pours. I readjusted it to the previous 1,5 bar. When rotated by the drill oil will eventually reach the oil radiator and pour over the two large plug holes.

First conclusion:
It is now evident to me that with 1,5 bar (22 PSI) through a 1 mm (40 thou) jet no pressure could be established downstream. Oil simply pours quietly through the much larger holes. I asked experienced mechanics who confirmed that this kind of oil system is indeed pressure free.

More tests :
I rebuilt the engine without rods and installed it on my lathe for more tests:

As a pressure gauge I used a transparent plastic pipe to have an idea of the real low pressure there:

One can see that, once the circuit is filled, the crankshaft splashes on the paper. That was done at 125 rpm. The pressure stabilizes at around 15 millibar (0.2 PSI) after some time:

400 rpm here but the oil level is independent of the rpm because as soon as the pump's discharge valve is opened the output pressure of 1,5 bar is constant. This happens well under the engine's idle rpm.

Naturally when stopped the oil pours through 3 holes and even somewhat through the pump's gears which are only in contact when rotating but have a lot of play between teeth.

More about the jet :
I have a spare crankcase which I shot here. This is the recess without its lid just under the left cylinder.

The jet can be better seen here:

It is made of bronze and force fed in a 6 mm hole coming from the pump output. It can be removed with the aid of an M5 screw and nut:

I turned the nut cw and the jet came eventually:

Oil enters the jet by the 1 mm hole on the left. The cone shape is to avoid dirt clogging the small hole.

There was considerable dirt behind the jet of that spare crankcase (the oil passage between the pump and the jet) although it has been pressure cleaned before removing the jet. So it is probably better to remove it to clean everything. It can be reinserted in place with some industrial light glue but it is kept in place by the lid of the recess anyway and can't go.

Recommendations:
• Make sure that there's no axial play in the pump but that it rotates freely anyway.
• If you dismantle the pump fill it with oil when reinstalling it, this helps to initiate pumping.
• Of course, clean very thoroughly all the oil passages. In particular the small jet near the pump output. His small size renders the blockage by small debris (of gasket for example) possible.
• For that reason I installed a much thinner mesh on the sump's strainer. Maybe a paper filter there would do but I have no experience about that.
• Remove the bronze jet and clean the passage between it and the pump.

Conclusions :
I was driven to this by the absence of any pressure where I put my gauge. This absence of any pressure there is, in fact, normal.

A real problem existed elsewhere though with a non-initiating pump because of too much axial play.