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Fused Filament Fabrication printer with integrated bath

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Title: Fused Filament Fabrication printer with integrated bath

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We designed an FFF printer with a heated print bed and a special bath arranged in the build volume. The bath can be filled with e.g. a mineral oil up to the nozzle height. As an object gets printed, the printed object gets submerged in the oil by lowering the print bed down into the oil, or in an alternative embodiment, by increasing the oil level. The mineral oil can transfer heat well and has a high surface energy. The oil will get heated up by the heated print bed. Because the oil has a high heat capacity (compared to air) and transfers the heat well, the oil functions like a heated chamber in that it keeps the print at a fixed temperature for an extended period of time. This allows the crystalline structures in the plastic to relax, making the final print more tough and improving layer adhesion.

Fig. 1

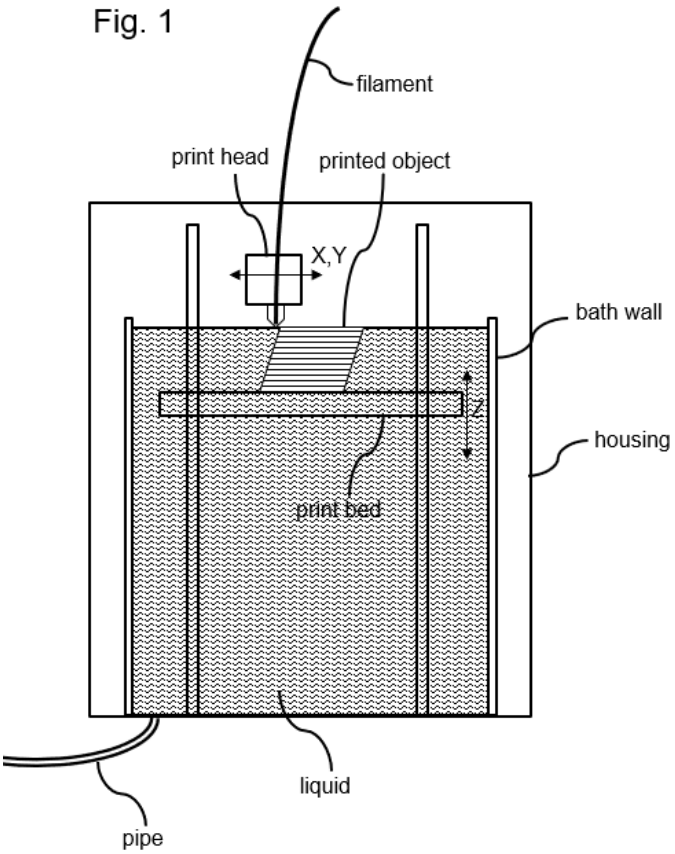

Figure 1 shows a schematic side view of a first example of the FFF printer with a print bed that can be moved up and down in the Z-direction. A print head can be moved in the X and Y directions by means of a gantry which is not shown here. In the example shown in Figure 1, the bath envelops the build platform (i.e. the print bed) in all its freedom of motion.

The FFF printer also comprises a supply pipe for supplying the oil, or other liquid, to the bath. In this example the inlet is at the bottom of the bath, but other locations are possible of course. The supply pipe may be connected to a pump that is controlled to regulate the level of the liquid. Following the suitable filling of the bath to a start level, the built object will take up volume in the liquid, and to compensate, the pump will gradually pump out some liquid to keep the fluid at the correct level.

Fig. 2

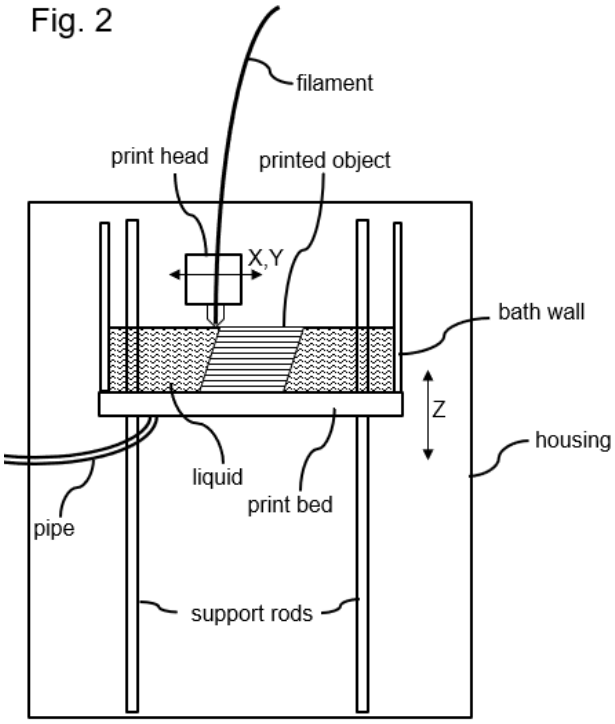

Figure 2 shows a schematic side view of a second example of an FFF printer with a print bed that can be moved up and down in the Z-direction. In this example the bath walls are arranged at the edges of the print bed. So only the top of the print bed is in contact with the liquid. In fact, the print bed forms the bottom of the bath. The shafts (i.e. support rods) along which the build platform is suspended will pierce through the bottom of the bath. If this is the case, then the Z axis worm gear must be driven from the top side because the worm gear cannot pierce through the bottom of the bath without leaking oil.

Fig. 3

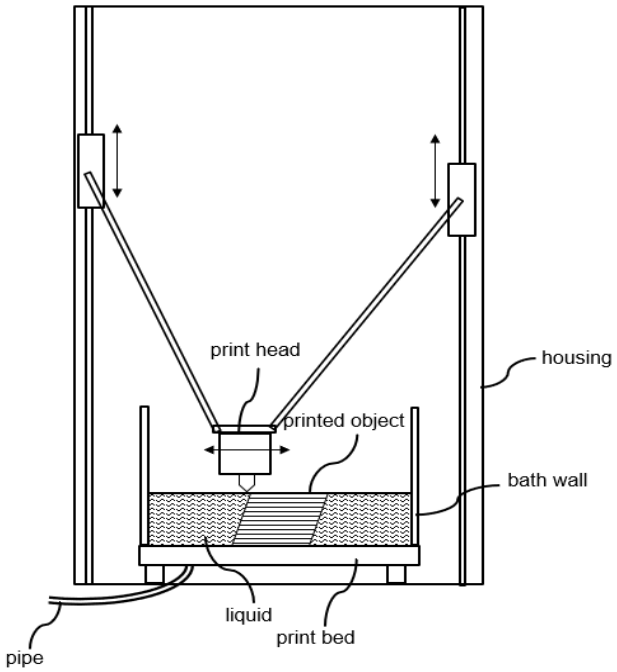

Figure 3 shows a schematic side view of a third example of an FFF printer with a print bed that is fixed in the Z-direction. As the object gets printed, the print gets submerged in the oil by pumping in more oil via the pipe so as to increase the oil level. Preferably this is done after printing one or two layers. This FFF printer uses a tripod to manipulate the print head. An advantage of using a tripod as compared to X-Y gantries, is that the arms of the tripod partly extend in the Z-direction which provides for more space to design higher bath walls.

The proposed solutions have some further advantages. The oil has a high surface energy, which causes the plastic to drift on top of the surface of the oil. When bridging an overhang, the oil avoids the plastic from drooping too far down which improves the accuracy of the print. Furthermore, the ultrafine particles emitted by the plastic after printing get captured inside the oil, preventing them from being breathed by humans or getting stuck on electronics.

It is noted that instead of using oil, other liquids could be used, that might be more suitable in some cases.