Final Diploma

Patent Examination Board

Drafting of Specifications FD2 (P3)

Thursday 15 October 10:00 to 14:00

INSTRUCTIONS TO CANDIDATES

1. The whole assessment task is to be attempted.
2. The marks to be awarded are given at the end of the assessment task.
3. The total number of marks available for this paper is 100.
4. Start each part of your answer on a new sheet of paper.
5. Do not state your name anywhere in the answers.
6. Write clearly as examiners cannot award marks to answer scripts that cannot be read.
7. The scripts may be photocopied for marking purposes.
   (a) Use only **black ink**.
   (b) Write on one side of the paper only.
   (c) Write within the printed margins.
   (d) Do not use highlighter pens on your answer script.
8. Instructions on what to do at the end of the examination are on the Candidate Cover Sheet.
9. This question paper consists of 10 sheets, including this sheet and comprises: 1 page of the Assessment Task, 2 pages of the Client Letter, 3 pages of Client's drawings, and a further set of the drawings for use in your answer.

Assessment Task

Your client sends you the correspondence listed on the Instructions to Candidates sheet regarding a new idea.

Your task is to prepare a complete patent specification that is ready for filing at the UK Intellectual Property Office. The specification should be drafted with a view to obtaining a UK patent.

Note the following:

a) You should assume that the client's description of the prior art in the field is complete.

b) You should not make use of any other prior art or special knowledge that you may have of the subject matter concerned.

c) You should also assume that the client's description of the device and its operation is accurate, i.e. that the device works as described.

Allocation of marks

Introduction and Description: 35 marks
Claims: 60 marks
Abstract: 5 marks

Total: 100 marks

As you may know, the late 1970's saw the development of a really important invention – the amplification of DNA. Called polymerase chain reaction, or PCR, it enables a tiny amount of a specific DNA sequence to be copied multiple times to a point where the quantity of the DNA is sufficient for it to be detected. Basically, in a first step, a sample likely to contain some of a target DNA is placed in a reaction chamber with appropriate reagents and heated to a temperature at which the two strands of the DNA double helix are physically separated ('denaturation'). In the second step, the temperature is lowered and the two DNA strands become templates for producing copies of the target DNA by an enzyme called DNA polymerase. Each time this cycle is repeated the amount of the DNA present is doubled.

Usually the reagents include a molecule that binds selectively to the target DNA and glows only when activated by a light having a specific wavelength. The glow can be detected by suitable optical apparatus and indicates that the target DNA is indeed present in a sample.

Obviously we are dealing with extremely small quantities of sample. As a result, it is usual for the reaction chamber to be of 'microtitre' capacity. That is, holding somewhere between tens of nanolitres to several millilitres of liquid and so to be not a lot more than one to three cubic millimetres in volume. A typical microtitre vessel or tube has a length of the order of 2cm, an outside diameter tapering down from about 5mm at the opening to about 2.5mm at base and a wall thickness of the order of 0.8mm. Such a vessel is shown in the figures, in which you will see that there is also a lid at the top of the reaction chamber which penetrates deep into the vessel. The lid is made of a transparent plastic so the contents of the reaction chamber can be observed. These vessels are much used in the biological, chemical and biochemical fields, for reactions as well as storage of liquids and solids. The tubes are usually used only once so we sell millions each year.

As you can imagine, PCR is not an instantaneous process and this can be an issue in circumstances where detection of a specific DNA is required quickly, for example when detecting the possible presence of an extremely dangerous pathogen such as Ebola or a possible battlefield pathogen.

One of the rate-limiting steps is the time it takes to bring a sample to the required 'denaturation' temperature in the first heating cycle. There has been tried, and patented, the manufacture of microtitre vessels by extruding nylon or polypropylene with carbon powder to create a material containing carbon, followed by rolling and stamping to form the vessels. Electrodes are then attached to the finished vessel, either by attachment to the surface or embedding in the fabric of the vessel, so that an electric current can be applied. The carbon provides an integral electrical resistance which acts as a heating element and enables the required heating to be applied to the contents of the reaction chamber.

Various problems have been found with this known vessel, for example ensuring a consistent distribution of carbon throughout the material that the vessel is made from; ensuring consistent manufacture of the vessels to accurate dimensions; and ensuring the secure, accurate and consistent attachment of electrodes. There can also be leaching of carbon from both the inner surface of the vessel into the reagents, often resulting in compatibility issues between the vessel and its contents, and loss from the outer surface through handling and friction.

We have found a solution, if you will excuse the pun! It goes like this.

It is relatively easy to form a vessel of the required dimensions by injection moulding a polymer having appropriate biological/chemical compatibility, such as polypropylene or nylon, even when it contains an additive to improve thermal conductivity. Obviously, when choosing a suitable polymer, the melting point of the polymer needs to be considered so the vessel does not melt when it is heated.

Then, a solution can be coated on the exterior of the reaction chamber part of the vessel, the coating being carbon or metal, such as copper, among other possible electrically conductive materials, such as boron nitride and aluminium nitride, suspended in a liquid to form an ink. Actually we use carbon-loaded phenolic ink CHSN8034 supplied by Coates. We find the use of an ink particularly amenable and it suits our method of coating, but other coating formulations in fluid form could also be used, such as pastes and gels.

This ink is put in a bath, as shown in one of the figures below. The level of fluid in the bath is kept at a constant level using a typical set-up of a weir, a supply reservoir and a pump. In this way, constant movement of the fluid helps to preserve the homogeneity of the ink.

A vessel to be coated is put into a guard tube and mounted onto a mandrel. The mandrel is then rotated in front of a corona discharge device to clean and prepare the vessel surface before being dipped in the ink. The mandrel spins at about 12000rpm for a few seconds. Once coated, the vessels are then withdrawn from the guard tube and spun again for two seconds to remove excess ink. After an initial drying period of about an hour at room temperature, the vessels can be pushed from the mandrel by a pusher and cured in an oven at 130°C with an airflow to remove solvent vapour and fix the coating to the surface of the vessel. The use of a corona discharge to clean a surface before the application of inks is a standard technique in other fields and is necessary to achieve a uniform coating. Of course, a number of coatings may be required or desired so this process may be repeated as many times as necessary. Also, we use this particular dipping method but there are other ways of applying a coating, including spraying, printing and vapour deposition.

In use, the vessel is loaded into thermocycling apparatus, usually into an array that carries 6, 24, 96, 384 or even 1536 vessels typically arranged in a 2:3 rectangular matrix. Electrodes are put into contact with the coating via a printed circuit board and attached to a power supply to provide heat when required in a reaction process. The vessel is concurrently held in an air current at a constant low temperature so that the vessel and its contents are cooled when power to the electrodes is switched off, for example because heating is no longer required, cooling of a reaction is required, or to prevent overheating.

Temperature of the reaction chamber is monitored by a thermopile connected to a printed circuit board which allows control of the electrical supply to the vessels. I am sure you know this but just in case there is any confusion, a thermopile is an electronic device that converts thermal energy into electrical energy. Rather than responding to absolute temperature a thermopile generates an output voltage proportional to a local temperature difference or temperature gradient.

The progress of the reaction is monitored with a well-known optical apparatus that shines a fluorescence excitation beam through the transparent lid and detects when fluorescence occurs. In the case of PCR, this will indicate whether or not a target DNA is indeed present. Typically, we allow 40 cycles of PCR to occur, which is measured using a calibrated control reaction. We are confident that, if no fluorescence is seen within this time, the target DNA is not present in the test sample.

Thanks to the new coating, we have managed to reduce the time to identify tiny amounts of a specific DNA in a sample down from an hour to less than 10 minutes. Another benefit has been to solve the issue of contamination from leakage of the electrically conductive material from the vessel wall into the contents of the vessel. Also, because the use of small tubes of the nature described above is so ubiquitous in the lab, no change of apparatus is required, just the purchase of these tubes when heating of the contents is required. I suppose the tubes could be used to thaw frozen material but maybe this is a step too far as time is generally not of the essence in such a situation.

While we are really excited about this, we need to be cautious of costs so I'd really appreciate it if you kept the claim number down to 20 or fewer.

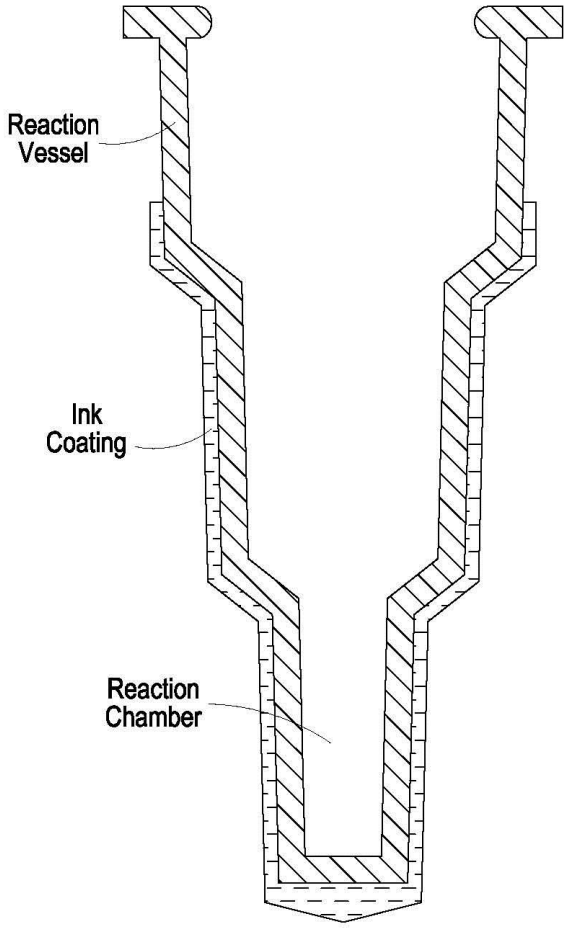


Fig. 1

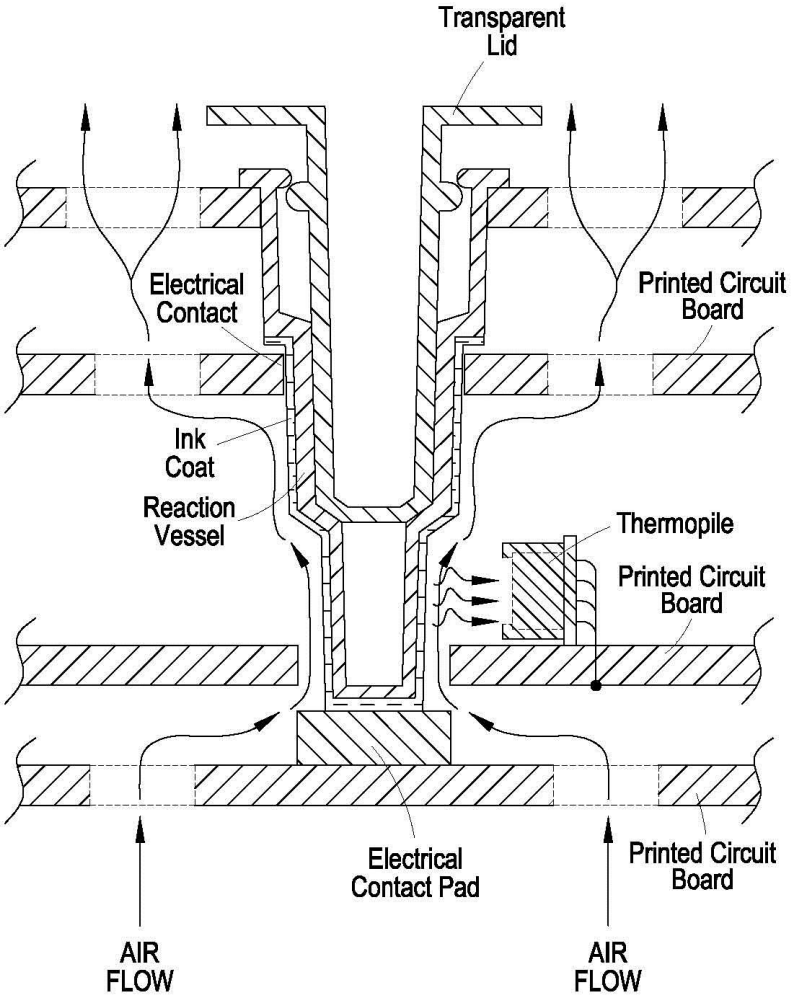

Transparent
Lid
Electrical
Contact
Printed Circuit
Board
Ink
Coat
Reaction
Vessel
Thermopile
Printed Circuit
Board
Electrical
Contact Pad
Printed Circuit
Board
AIR
FLOW
AIR
FLOW

Fig. 2

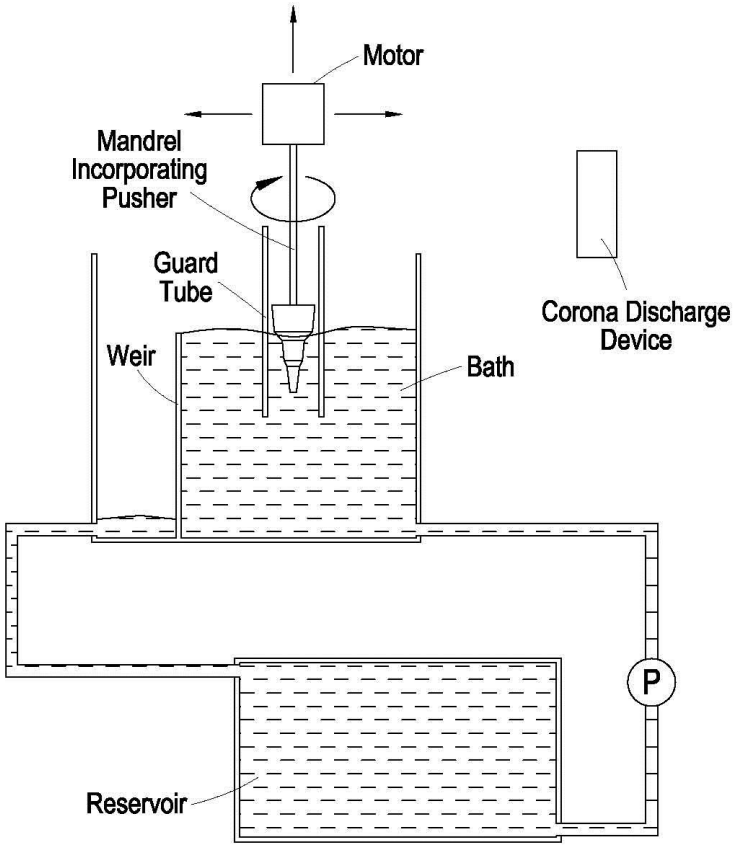
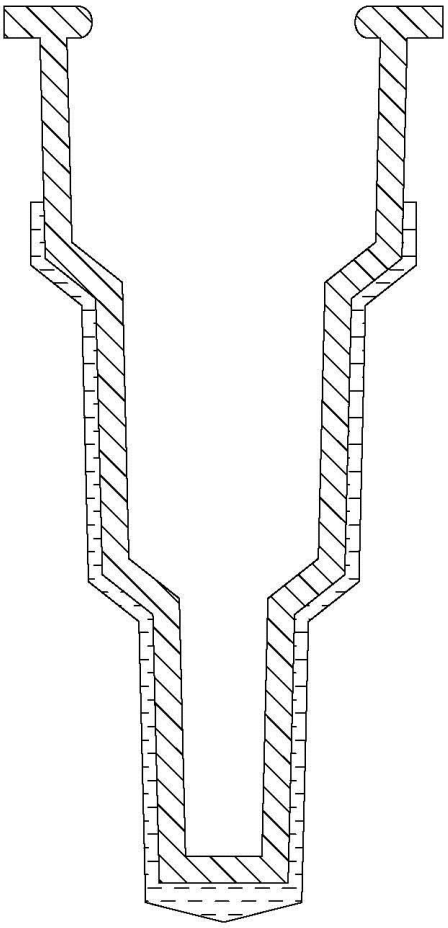
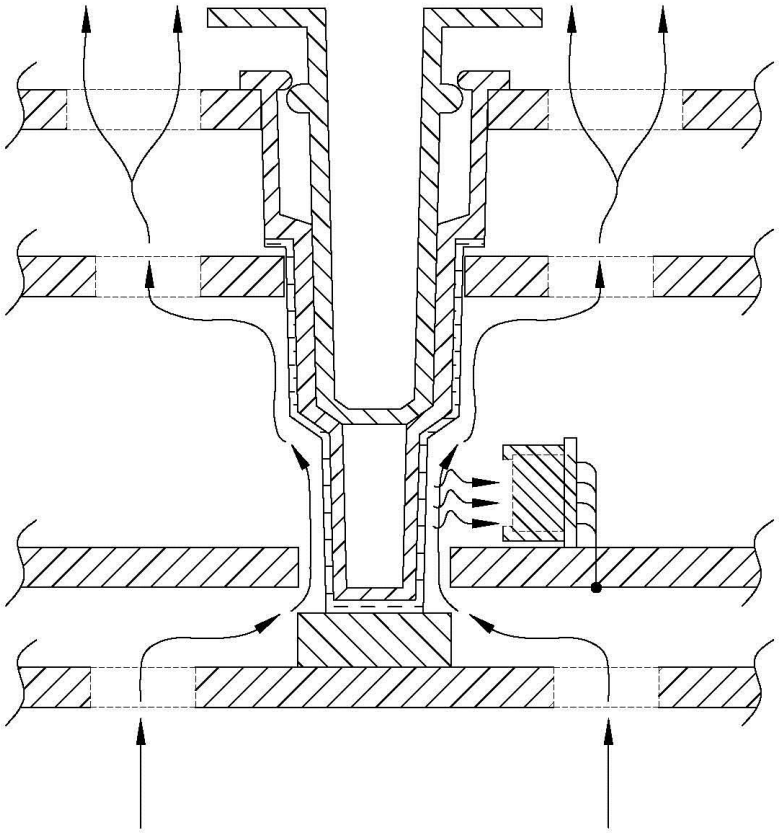

Motor
Mandrel
Incorporating
Pusher
Guard
Tube
Weir
Bath
Corona Discharge
Device
P
Reservoir

Fig. 3

Paper Ref	Question No.	Sheet	of	Your Candidate No.



Paper Ref	Question No.	Sheet	of	Your Candidate No.



Paper Ref	Question No.	Sheet	of	Your Candidate No.