



## PATENTS ACT 1977

APPLICANT Odyssey Therapeutics UK Limited

ISSUE Whether patent application GB2000552.6 complies  
with section 1(2) of the Patents Act 1977

HEARING OFFICER B Micklewright

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### DECISION

#### Introduction

- 1 Patent application number GB2000552.6 was filed on 14 January 2020 in the name of Rahko Limited, making no claim to priority. Since filing, the applicant has changed name to Odyssey Therapeutics UK Limited. The application was published as GB 2591101 A on 21 July 2021.
- 2 In their initial examination report of 20 July 2022, the examiner considered the invention to be a program for a computer as such and therefore to be excluded from patentability under section 1(2) of the Patents Act 1977 ("the Act"). The applicant disagreed and, following several rounds of correspondence, requested that a decision be made based on the papers on file. The examiner issued a pre-hearing report on 8 September 2023 and the applicant subsequently filed amendments along with further arguments on 5 October 2023.
- 3 I confirm that I have considered the arguments made in all the correspondence on file, in particular the letters from the applicant dated 15 November 2022, 27 July 2023 and 5 October 2023.

#### The invention

- 4 The invention relates to a method for identifying a valid excited energy state of a system of interacting electrons using a hybrid system of quantum and classical computers.
- 5 For materials with more than a few interacting electrons, computation of quantum mechanical models is both challenging and computationally intensive. Classical computers are not currently capable of solving the complex problems which define molecular energy structures. However, it is anticipated that quantum computers could be used to address specific computational hurdles associated with these calculations.

- 6 Some algorithms have been proposed which would provide exponential speed-up of the calculation, but which would require advanced quantum computers which are unlikely to be available for the next ten years. Current research has therefore focused on different algorithms which can make use of present quantum devices such as noisy-intermediate scale quantum devices (NISQ). However, these algorithms each have drawbacks and are not fully appropriate for implementation on present quantum processing units.
- 7 The aim of the invention, as stated on page 3 of the description, is therefore to provide a method which lowers, as much as possible, the hardware requirements on the quantum processing qubits in order to allow the method to be used with existing quantum computers, or as early as possible on future quantum computers.
- 8 In brief, the invention provides an iterative approach to optimise coupled quantum circuits, defined by a generator function and a discriminator function, in order to separately distinguish between, and generate, low-lying excited energy states of a system of interacting electrons.
- 9 More specifically, as summarised on page 5 of the description, a quantum circuit defined by a discriminator function is trained to distinguish between a ground state and a generated (or trial) state of the system. The generated (or trial) state is created by another quantum circuit defined by a generator function, which is trained to help the discriminator find a system state that is as different as possible (in other words, orthogonal to) to the ground state. At the same time, the generator is also trained conditionally to minimise the energy of the system in the generated (or trial) state. As a result, the whole network finds a valid state of the system that is different (in particular, orthogonal) to the ground state, and which at the same time minimises the energy: this state is the first excited state. This process can then be repeated in order to find further excited energy states for the system, each of which must be different (orthogonal) to the ground state and any lower excited state.
- 10 The generator and discriminator functions are applied to a system of qubits within a quantum computing system, but the iterative adjustment of the parameters of the generator and discriminator functions in order to optimise the functions takes place on a classical computer processor. As a consequence, quantum gates applied to the system of qubits may be shallow which can prevent the propagation of errors that are inevitably introduced in deeper systems of presently available qubits.

### **The claims**

- 11 Claims 1 and 10 are the only independent claims. They are corresponding method and apparatus claims respectively, which are equivalent in scope, so for the purposes of this decision it will be sufficient to consider only claim 1, which reads as follows:

1. *A method for identifying an excited energy state of a system of interacting electrons, comprising:*

*providing a first quantum circuit, the first quantum circuit defined by a generator function parameterised by a set of parameters,  $\theta$ , wherein applying the first quantum circuit to a set of qubits in an initial state generates a state of the system represented by a wavefunction,  $\Psi$ ;*

*providing  $n$  sets of values  $\theta_{n-1}$  for the set of parameters,  $\theta$ , wherein each set of values  $\theta_{n-1}$  generates an  $n$ th valid energy state of the system represented by a wavefunction,  $\Psi_{n-1}$ , wherein  $n$  is one or more;*

*providing a second quantum circuit, the second quantum circuit defined by a discriminator function parameterised by a set of parameters,  $\phi$ , wherein applying the second quantum circuit to the set of qubits in the state of the system represented by the wavefunction,  $\Psi$  provides an output representing an extent of overlap of the wavefunction  $\Psi$  with the wavefunction  $\Psi_{n-1}$  of each of the  $n$  known valid states of the system;*

*optimising the values of the set of parameters  $\theta$  to substantially minimise the energy of the state generated by the first quantum circuit represented by the wavefunction  $\Psi$ , and to substantially minimise the extent of overlap of the state generated by the first quantum circuit represented by the wavefunction  $\Psi$  and each of the  $n$  known valid states of the system represented by respective wavefunction  $\Psi_{n-1}$ , wherein optimising the value of the set of parameters  $\theta$  comprises:*

*generating, at a quantum computer, a trial energy state of the system represented by a wavefunction  $\Psi_T$  by applying, to the set of qubits in an initial state, the first quantum circuit defined by the generator function with the set of parameters  $\theta$  having trial values  $\theta_T$ ;*

*determining, at the quantum computer, an output  $\beta_T$  to the second quantum circuit by applying, to the set of qubits in the state generated by the first quantum circuit defined by the generator function with the set of parameters having trial values  $\theta_T$  and to an ancilla qubit, the second quantum circuit, and then measuring the ancilla qubit, wherein the second quantum circuit is defined by the discriminator function with the set of parameters  $\phi$  having a set of trial values  $\phi_T$ ;*

*calculating, at the quantum computer, an energy  $E_T$  of the trial energy state of the system represented by the wavefunction  $\Psi_T$ ;*

*comparing, at a classical computer, the output  $\beta_T$  of the second quantum circuit to a predefined distinctiveness threshold,  $T_d$ ;*

*wherein if the output  $\beta_T$  to the second quantum circuit is not within a predefined interval of values representing the distinctiveness threshold,  $T_d$ ; and/or*

*if the energy  $E_T$  of the trial energy state of the system represented by the wavefunction  $\Psi_T$  is not substantially at a minima;*

*then varying, at the classical computer, the set of trial values  $\theta_t$  and repeating the generating, determining, calculating and comparing steps;*

*or, if the output  $\beta_T$  to the second quantum circuit is within the predefined interval of values representing the distinctiveness threshold,  $T_d$ ; and*

*if the energy  $E_T$  of the trial energy state of the system represented by the wavefunction  $\Psi_T$  is substantially at a minima;*

*then identifying, at the classical computer, the set of values  $\theta_T$  as the set of values  $\theta_n$  parametrising the generator function defining the first quantum circuit for generating the  $n+1$ th valid energy state of the system represented by wavefunction,  $\Psi_n$ , which is the identified excited energy state of the system of interacting electrons and*

*cooperatively, training the discriminator function by optimising the value of the set of parameters  $\phi$  to train the discriminator function to discriminate between the wavefunction  $\Psi$  of the state generated by the first quantum circuit and the wavefunction  $\Psi_{n-1}$  representing each of the  $n$  valid states of the system;*

*wherein the optimised values of the set of parameters  $\theta$  correspond to a set of values  $\theta_n$  parametrising the generator function defining the first quantum circuit for generating an  $n+1$ th valid energy state of the system represented by wavefunction,  $\Psi_n$ , which is an excited energy state of the system of interacting electrons; and*

*wherein the system of interacting electrons defines a material and, after identifying the set of values  $\theta_T$  as the set of values  $\theta_n$ , determining, based on the values  $\theta_n$ , the composition of the material.*

- 12 The portion of the claim underlined was added by amendment with the agent's letter of 5 October 2023 following the pre-hearing report issued by the examiner on 8 September 2023. The amendment has therefore not been considered by the examiner. As the amendment was not in response to an examination report under section 18(3), its allowability is at my discretion under section 19(1). I am happy in principle to allow the amendment, but I will first need to consider whether it is allowable in light of section 76 before doing so.

### **The law**

- 13 Section 1(2) of the Act states:

*It is hereby declared that the following (among other things) are not inventions for the purposes of this Act, that is to say, anything which consists of—*

*...*

*(c) A scheme, rule or method for performing a mental act, playing a game or doing business, or a program for a computer;*

*...*

*but the foregoing provision shall prevent anything from being treated as an invention for the purposes of this Act only to the extent that a patent or application for a patent relates to that thing as such.*

- 14 The provisions of section 1(2) were considered by the Court of Appeal in *Aerotel*<sup>1</sup> where a four-step test was set out to decide whether a claimed invention was excluded from patent protection:

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<sup>1</sup> *Aerotel Ltd v Telco Holdings Ltd and Macrossan's Application* [2006] EWCA Civ 1371

- (1) *Properly construe the claim;*
- (2) *Identify the actual contribution;*
- (3) *Ask whether it falls solely within the excluded subject matter;*
- (4) *Check whether the actual or alleged contribution is actually technical in nature.*

15 It was stated by Jacob LJ in *Aerotel* that the test is a re-formulation of and is consistent with the previous 'technical effect approach with rider' test established in previous UK case law. Kitchin LJ noted in *HTC v Apple*<sup>2</sup> that the *Aerotel* test is followed in order to address whether the invention makes a technical contribution to the art, with the rider that novel or inventive purely excluded matter does not count as a 'technical contribution'.

16 Lewison J in *AT&T/CVON*<sup>3</sup> set out five signposts that he considered to be helpful when considering whether a computer program makes a technical contribution. Lewison LJ reformulated the signposts in *HTC v Apple* in light of the decision in *Gemstar*<sup>4</sup>. The signposts are:

*i) Whether the claimed technical effect has a technical effect on a process which is carried on outside the computer;*

*ii) Whether the claimed technical effect operates at the level of the architecture of the computer; that is to say whether the effect is produced irrespective of the data being processed or the applications being run;*

*iii) Whether the claimed technical effect results in the computer being made to operate in a new way;*

*iv) Whether the program makes the computer a better computer in the sense of running more efficiently and effectively as a computer;*

*v) Whether the perceived problem is overcome by the claimed invention as opposed to merely being circumvented.*

17 Section 76(2) of the Act states:

*No amendment of an application for a patent shall be allowed under section 15A(6), 18(3) or 19(1) if it results in the application disclosing matter extending beyond that disclosed in the application as filed.*

18 In *Bonzel v Intervention*<sup>5</sup> Aldous J described the task of determining whether an amendment to the description had the result that a patent as granted disclosed matter which extended beyond that disclosed in the application as:

*(1) to ascertain through the eyes of the skilled addressee what is disclosed, both explicitly and implicitly in the application;*

*(2) to do the same in respect of the patent as granted;*

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<sup>2</sup> *HTC Europe Co Ltd v Apple Inc* [2013] EWCA Civ 451

<sup>3</sup> *AT&T Knowledge Ventures/CVON Innovations v Comptroller General of Patents* [2009] EWHC 343 (Pat)

<sup>4</sup> *Gemstar-TV Guide International Inc v Virgin Media Ltd* [2010] RPC 10

<sup>5</sup> *Bonzel (T) v Intervention Ltd (No. 3)* [1991] RPC 553 (at 574)

(3) to compare the two disclosures and decide whether any subject matter relevant to the invention has been added whether by deletion or addition. The comparison is strict in the sense that subject matter will be added unless such matter is clearly and unambiguously disclosed in the application either explicitly or implicitly.

19 In *Richardson-Vicks Inc's Patent*<sup>6</sup> Jacob J summarised this by saying:

*“the test of added matter is whether a skilled man would, upon looking at the amended specification, learn anything about the invention which he could not learn from the unamended specification.”*

### **Assessment – Added matter**

20 The applicant points to the section on page 40 entitled “example two – materials discovery” (at lines 21-29) to support the amendment filed on 5 October 2023. The applicant also appears to reference page 1, lines 22-23 and page 22, lines 3-7 as basis for this amendment.

21 Page 1, lines 21-23, states:

*The energy absorbed to promote an electron to an excited state, or the energy emitted from a molecule upon relaxation of the electron from an excited state, is specific to the type of molecule and its complex electronic structure.*

22 Page 22, lines 3-7, states:

*Knowing this energy assists to characterise chemical reactions of the material defined by the system of interacting electrons, and so how it will interact with its environment. Accordingly, knowledge of this energy of the excited state parametrised by set of parameters  $\theta_n$  can lead to design of new materials, or modification of known materials.*

23 Page 40, lines 21-29, states:

*A researcher knows the measured spectra produced by a given material, but does not know the actual material studied. With classical computation, the researcher can only list some possible materials and calculate a crude approximation of their spectra, in order to compare with the measured spectra to determine the most likely composition of the measured material.*

*Using presently described method however, the researcher can perform more precise approximations of the energy spectra, and much faster. Therefore, the researcher can determine with more certainty the composition of the material measured.*

24 The amendment to the claim can be seen to define two features. The first of these defines that “*the system of interacting electrons defines a material*”. The quote from page 22 clearly shows that the system of interacting electrons defines a material. This is further supported by page 6, lines 7-10, which states that the system of interacting

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<sup>6</sup> *Richardson-Vicks Inc's Patent* [1995] RPC 568 (at 576)

electrons may represent a molecule or solid and may be applied to any system of interacting electrons encoded on a Hermitian matrix. I also consider it is clear from the background information, particularly on page 1 at lines 27-28, that the system of interacting electrons is a model describing the theoretical electronic structure of a material. This feature is therefore supported and does not add matter.

- 25 The second feature added by the amendment defines “*after identifying the set of values  $\theta_T$  as the set of values  $\theta_n$ , determining, based on the values  $\theta_n$ , the composition of the material*”.
- 26 The passage on page 40 is clearly the most pertinent to the question of support for this feature because it is the only one of the quoted passages which relates to the determination of a material’s composition. Indeed, it is the only mention of determining the composition of a material in the whole description. The passage on page 40 teaches that approximations of energy spectra are calculated for materials of known composition (“possible materials”). These calculated energy spectra can then be compared to measured spectra of a “given material” of unknown composition in order to determine the most likely composition of the measured given material. I note this is consistent with the applicant’s explanation of how the invention is used to determine material composition in their letter of 27 July 2023.
- 27 The amended claim specifies “the material” as that being defined by the system of interacting electrons, and that the composition of said material is determined based on the values of  $\theta_n$ . However, the passage on page 40 does not support this. The passage on page 40 teaches that the material defined by the system of interacting electrons is of a known composition. Finding the energy states of a system of interacting electrons defining a material of known composition in order to determine the composition of *said material*, as defined by the amended claim, appears somewhat redundant and is certainly not disclosed clearly and unambiguously by the disclosure of the specification as filed.
- 28 The amendment filed on 5 October 2023 therefore adds matter contrary to the requirements of section 76(2) and so is not allowable. I will proceed on the basis of the claims as amended on 15 November 2022 (that is, the claim as recited above but without the underlined portion).

#### **Assessment – Excluded matter**

- 29 To determine whether the claimed invention can be considered to be more than a program for a computer as such, I am required to follow the approach set out by the Courts in *Aerotel*.

##### *(1) Properly construe the claim*

- 30 It appears from the correspondence between the applicant and the examiner that there is a general agreement that the construction of the claim presents no particular challenges. I agree.
- 31 The claim relates to identifying a valid excited energy state of a system of interacting electrons using a hybrid system of quantum and classical computers, comprising optimisation of a generator function and a coupled discriminator function which

cooperatively generate a set of parameters representing a wavefunction of the excited state.

- 32 As touched on above, it is apparent from the description (for instance at page 1, lines 27-28, and page 6, lines 7-10) that the “*system of interacting electrons*” is a quantum mechanical model describing the electronic structure of a material. The energy state(s) identified by the method are therefore theoretical approximations for a given modelled system (as is evident from the background discussion across pages 1-3 and page 40, lines 21-29). The claim therefore does not relate to direct measurements of a physical system.

*(2) Identify the actual contribution*

- 33 In the pre-hearing report, the examiner identified the contribution as follows:

*A method of identifying an excited energy state of a system of interacting electrons, the method comprising cooperatively optimising a first quantum circuit for generating a quantum state and a second quantum circuit defined by a discriminator function;*

*the method comprising:*

*at a quantum computer, applying the generator and discriminator functions, and determining the measured output and energy;*

*at a classical computer, comparing the output and energy to relevant criteria, and then either updating parameters and causing the method to be repeated or identifying the trial (generated) state as a valid energy state.*

- 34 The applicant states in their most recent letter that this is not disputed. I am therefore happy to accept the contribution and will continue my assessment on that basis.

*(3) Ask whether it falls solely within the excluded subject matter;*

*(4) Check whether the actual or alleged contribution is actually technical in nature*

- 35 The third and fourth steps of the *Aerotel* test involve considering whether the contribution falls solely within excluded categories, and then checking whether the contribution is technical in nature. It is appropriate to consider these two steps together because whether the contribution is technical in nature will have a direct impact on whether it falls solely within excluded matter.

- 36 The examiner has identified that the contribution relates to a particular algorithm implemented in software and so in their opinion evidently relates to a computer program.

- 37 In their letter of 15 November 2022, the applicant stated that they did not necessarily agree that the contribution is evidently a computer program. They argued it was debatable whether the algorithm is wholly implemented in software because the generator and discriminator functions effect a change to the quantum state of the qubits, which is then determined by measurement.

- 38 However, the examiner argued in their report of 2 March 2023 that the change to the quantum state of the qubits does not form part of the contribution because applying a

function in the form of quantum gates acting on qubits followed by a measurement of an expectation value is the physical basis of all quantum computation. This is analogous to classical computers operating using electrical changes to transistors, the effect of which plainly does not grant all programs technical character.

39 I note the applicant did not raise this point again in their subsequent letters of 27 July 2023 and 5 October 2023, so this does not appear to be an active line of argument. Nevertheless, I note here that I agree with the examiner. The way the quantum computer physically functions is entirely conventional and not what has been invented here. It forms no part of the contribution. The contribution relates to an algorithm implemented in software and so the computer program exclusion is engaged.

40 As the examiner correctly points out, just because the contribution is implemented using a computer program it is not immediately excluded as a computer program as such. In *Symbian*<sup>7</sup>, the Court of Appeal stated that a computer program may not be excluded if it makes a technical contribution. In order to determine if the contribution is technical in nature, I will make use of the *AT&T* signposts.

*Signpost i) Whether the claimed technical effect has a technical effect on a process which is carried on outside the computer*

41 The applicant has argued that the invention allows for the possibility for the system to be realised as a chemical structure in a laboratory which is akin to the prescriptive design for a drill bit as discussed in *Halliburton*<sup>8</sup>. They also argue that the method could be used for calculation of energy spectra of a specific system of electrons, which can then be compared to measured spectra of a sample material in order to identify the composition of the sample material. In this respect it can be used as part of a determination method for a physical sample, outside of the computer.

42 In response to the first point, the examiner references my earlier decision BL O/130/22 where I found (at paragraphs 34-39) that the determination of energy levels was not analogous to designing a drill bit, and that energy levels of atoms are not in and of themselves technical in nature in the sense that drill bit design is.

43 In response to the second point, the examiner argues that the program here merely outputs determined energy levels. While a calculated energy spectrum can subsequently be compared to a measured one to assist in the determination of the composition of the measured material, the skilled person still has to determine candidate materials and appropriate wavefunctions to make use of the algorithm in this way. The examiner therefore argues that the potential technical effects are not inherently and immediately connected to the method.

44 The applicant argues that although determining the composition of a given material may involve comparing the calculated spectra to the measured spectra of the given material, it is still the case that merely knowing the energy states does enable the

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<sup>7</sup> *Symbian Ltd v Comptroller General of Patents* [2009] RPC 1

<sup>8</sup> *Halliburton Energy Services Inc's Application* [2012] RPC 12

skilled person to do so. They argue that material identification is a technical aim that the present invention enables and so this signpost is met.

- 45 They also argue that the claim (in the amended form I have found not to be allowable) recites the connection between the result of the claimed method and the technical application. The applicant argues that there is no technical gap between these steps because the skilled person would be enabled to determine the composition of a material based on the known energy states.
- 46 Having considered both positions carefully, I agree with the examiner. As I said in my earlier decision BL O/130/22 (at paragraph 36), I am not convinced that determining energy states of a system is at all analogous to designing a drill bit because it does not seem to me that the energy levels of atoms or molecules are in and of themselves technical in nature in the sense that drill bit design is. I am therefore not convinced *Halliburton* has much bearing on this application. The invention in *Halliburton* was directed to designing a drill bit, which was found to be technical. The present invention is directed to something different, namely determining energy states of a system of interacting electrons.
- 47 Even if the claim explicitly included a step of subsequently using the calculated energy states to compare with a measured material in order to assist in the determination of its composition, I do not think the potential technical effects of said step are directly connected to the method of calculating the energy states of the modelled system of electrons. There is, in my view, a broken technical chain. There is a significant cognitive effort required by a user of the method to go on and determine the composition of a material. I therefore believe the contribution is too detached from this potential effect for it to gain any technical character from it. The contribution is limited to the identification of energy states of a quantum mechanical model and thus there is no effect on a process outside the computer.

*Signpost ii) Whether the claimed technical effect operates at the level of the architecture of the computer; that is to say whether the effect is produced irrespective of the data being processed or the applications being run;*

- 48 The examiner argues that the contribution relates to a specific algorithm for solving a particular problem and therefore does not produce an effect irrespective of the data being processed. The applicant has not provided any argument in relation to this signpost.
- 49 The invention is clearly application specific with no effect at the architectural level so I agree with the examiner that this signpost is not relevant.

*Signpost iii) Whether the claimed technical effect results in the computer being made to operate in a new way;*

- 50 In their letter of 15 November 2022, the applicant argues that the technical effect of the invention results from the computer being made to operate in a new way. In particular, they argue they have developed a method that utilises a combination of a classical and quantum computer to perform different steps within the claimed method, and by so doing have arrived at a method that delivers a result that would not otherwise be possible or delivers a more accurate result.

- 51 The examiner argues that the computer operates in a normal fashion, with the algorithm being chosen to reduce noise propagation in the qubits. This represents a better program rather than a better computer.
- 52 I agree with the examiner. The present invention relates to a better program which has been designed to make best use of the strengths and weaknesses of the quantum and classical computers upon which it is run. The quantum and classical computers themselves operate in a normal and conventional fashion.

*Signpost iv) Whether the program makes the computer a better computer in the sense of running more efficiently and effectively as a computer*

- 53 The examiner argues that the benefits of reduced noise are not enjoyed by all algorithms running on the computer, but only the methods within the scope of the claims.
- 54 The applicant appears to believe the examiner's argument is that the computer does not enjoy the benefits of reduced noise when *not* implementing the particular algorithm. The applicant therefore contends that the examiner's argument contradicts the intention of the signposts, which indicate the presence of a technical effect produced by the computer program *when run*. They argue that this signpost is met because the implementation of the method provides a more efficient, accurate and realisable method for identifying a valid energy state for a system of interacting electrons.
- 55 I do not find this argument persuasive. The program may well make more efficient use of the computer to produce a more accurate result in less time, but this is merely because it is a better program. It appears to me the examiner's point is that the benefits are only enjoyed by this particular program and not any other programs. This appears to be entirely in keeping with the intention of the signposts. Other programs running on the computer will not feel any benefit because any improvement in efficiency and accuracy is specific to the particular application of identifying energy states of a system of interacting electrons. Therefore, the computer cannot be seen to run more efficiently or effectively as a computer.

*Signpost v) Whether the perceived problem is overcome by the claimed invention as opposed to merely being circumvented*

- 56 In their letter of 15 November 2022, the applicant argued that it is not the case that the inventors have merely circumvented problems arising with a classical computer – instead they have utilised the power and capabilities of a quantum computer by application of the generator and discriminator functions as quantum circuits. Furthermore, the inventors have not simply circumvented issues identified with existing quantum computers. Instead, they have identified the steps for which the strengths of each type of computer can be utilised, and in doing so have provided a method and computing apparatus that has advantages that amount to more than the particular competencies offered by each of its parts. As such, the claimed invention overcomes the particular technical problem that it sets out to achieve, rather than merely circumventing the problem.

- 57 They further argued that the present invention solves the problem of providing a more efficient, accurate and realisable method for identifying a valid energy state for a system of interacting electrons.
- 58 The examiner responded by arguing the problems set out by the application on pages 2-3 are the limited depth and high levels of noise of current quantum computers. They say that the benefits of the invention relate to carrying out certain steps at a classical computer in order to prevent noise propagation and to use simple structures and conditions in the algorithm which are tolerant to noise. The algorithm aims to get best use of current noisy quantum computers, without actually resolving the issue of noise. The examiner therefore considers the invention to merely circumvent the problem.
- 59 I note the applicant did not argue this point in their subsequent letters of 27 July 2023 and 5 October 2023.
- 60 The description clearly describes the problems being addressed by the invention in the background section (pages 1-3). It is stated that a problem with currently available noisy-intermediate scale quantum devices (NISQ) is that they are prone to errors. It is stated (on page 3) that the aim of the present invention is to provide a method which lowers, as much as possible, the hardware requirements on the qubits of a NISQ. The benefits of the invention are described as providing a method which uses shallow quantum gates applied to the system of qubits, which can prevent the propagation of errors that are introduced into deeper systems of presently-available qubits such as NISQ (page 4). I therefore agree with the examiner that the problem of currently available quantum devices being prone to errors has not been overcome. The problem has merely been circumvented by using a classical computer to optimise the generator and discriminator functions so that error propagation in the qubits can be prevented. This signpost is not satisfied.
- 61 I therefore conclude that none of the signposts point to the present invention making a technical contribution.
- 62 Taking a step back and considering the contribution more generally, it relates to a program for a hybrid quantum-classical computing system for calculating valid energy states of a modelled system of interacting electrons. I do not consider calculating energy states to be an inherently technical task. The applicant has highlighted that these calculated energy levels may be used in applications within industry, particularly to compare with measured spectra of an unknown material to assist in determining its composition. However, I believe the output from the program of the claimed invention is simply too detached from any technical application for it to be considered to have a technical effect on such an application. I therefore do not consider there is any technical effect on a process outside of the computer. The invention does not resolve or address any of the shortcomings of current generation quantum computers, but rather circumvents them through using a classical computer to perform certain aspects of the algorithm. Beyond these points, I can see nothing which leads me to believe that the contribution of the claimed invention is more than a program for a computer as such. It may well be a better computer program that better utilises the resources of a quantum computer but that in itself is not enough for the contribution to escape the exclusion.

63 Since I can find no technical effect in the contribution of claim 1, the invention is considered to fall wholly within the exclusion of a program for a computer as such. I do not find any technical effect in any of the remaining claims nor has any been brought to my attention. I have considered the examples of industrial application on page 40 of the description and do not believe any amendment to the claim reflecting these examples would bring the contribution outside of the program for a computer exclusion. The output from the current invention is simply too detached from any patentable invention for it to gain any technical character in this fashion. Accordingly, the invention is excluded from patentability under section 1(2)(c) of the Act.

### **Conclusion**

64 The invention fails to comply with section 1(2)(c) of the Act because it relates to a program for a computer as such. I therefore refuse the application under section 18(3) of the Act.

### **Appeal**

65 Any appeal must be lodged within 28 days after the date of this decision.

### **B Micklewright**

Deputy Director, acting for the Comptroller