Intellectual Property Office

BL O/112/18
20th February 2018

PATENTS ACT 1977

APPLICANT	Landmark Graphics Corporation
ISSUE	Whether patent applications GB1600694.2, GB1600696.7, GB1600703.1, GB1600704.9, GB1600705.6, GB1600706.4 and GB1600702.3 comply with section 1(2)
HEARING OFFICER	H Jones

DECISION

Introduction

1 This decision relates to a first group of seven applications out of a total of sixteen from the same applicant. All seven applications relate in general to computer-implemented methods of working with models of subterranean geology and for modifying or improving various aspects of the visual representation of subsurface formations. The sixteen applications have been examined by different examiners and all have concluded that the subject-matter of each of the applications is excluded from patentability under section 1(2) of the Patents Act 1977 ("the Act"), as either a computer program in all cases and also as a mathematical method for some. For the seven applications considered in this decision, the applications were examined by the same examiner. Despite several rounds of correspondence, in each case the applicant and the examiner have been unable to resolve matters and the issues came before me on 8 and 9 January 2018.

2 At the hearing the applicant was represented by Mr Alistair Russell and Dr Mark Jones of Hoffmann Eitle who argued that the Office approach in dealing with methods relating to geophysical modelling in these particular applications and similar applications refused previously is inconsistent with guidance from the Courts. I am extremely grateful to Mr Russell and Dr Jones for the skeleton arguments provided before the hearing and for their structured presentations on all sixteen of the applications over the course of the two days.

3 I shall deal first with the general approach to assessing patentability under section 1(2) before turning to the seven individual applications.

The Law

4 Section 1(2) of the Act lists certain categories of subject-matter which are not considered to be inventions. These categories of subject-matter are conventionally known as excluded subject-matter:

> *1(2). 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 –

(a) a discovery, scientific theory or mathematical method;
(b) a literary, dramatic, musical or artistic work or any other aesthetic creation whatsoever;
(c) a scheme, rule or method for performing a mental act, playing a game or doing business, or a program for a computer;
(d) the presentation of information;

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.

5 The Court of Appeal in *Symbian*[1] stated that the question of whether a computer-implemented invention is patentable has to be resolved by answering the question whether it reveals a technical contribution to the state of the art. It proceeded to answer the question with the aid of the four-step test set out in its earlier judgment in *Aerotel*[2], the fourth step of this test being to check whether the contribution is technical in nature. In paragraph 46 of *Aerotel* it is stated that applying this fourth step may not be necessary because the third step should have covered the question. This is because a contribution which consists solely of excluded matter will not count as being a "technical contribution" and thus will not, as the fourth step puts it, be "technical in nature".

6 Mr Russell and Dr Jones sought to persuade me how each of the seven applications before me provide the necessary technical contribution. In discussing the general approach to assessing patentability, Mr Russell and Dr Jones in essence had two points to make. The first concerned the appropriate standard of proof that an applicant should meet and the second point concerned the proper application of tests for patentability and especially the consideration of technical contribution. I shall deal with each point in turn.

<u>Standard of proof</u>

7 According to Mr Russell and Dr Jones, once an examiner has raised an objection to an application and the applicant has responded with argument and/or amendment then the examiner should give the applicant the benefit of the doubt and consider the objection overcome, unless there can be no doubt on the matter. While this is offered as a general proposition, in this decision I am particularly considering objections raised under section 1(2). In this regard Mr Russell and Dr Jones took me to a passage in *Macrossan v Comptroller-General of Patents ("Macrossan")*[3] (at paragraphs 7 and 8) in which *Fujitsu Ltd's Application*[4] is quoted by the Appellant before Mann J; the passage from *Fujitsu* is as follows (paragraph 533):

*"In coming to that conclusion [*viz a conclusion against validity*] I have borne in mind that, prima facie, a novel technical development should be patentable and that section 1(2) contains a list of exceptions to such patentability. Therefore, the onus lies on the person contesting patentability to prove that the invention falls foul of the statutory exclusions. Furthermore, at the patent office stage, benefit of the doubt should be given to the applicant. Refusal of the grant on the basis of a faulty appreciation of what is involved cannot thereafter be remedied."*

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[1] Symbian Ltd. v Comptroller-General of Patents [2008] EWCA Civ 1066
[2] Aerotel Ltd v Telco Holdings Ltd and Macrossan's Application [2006] EWCA Civ 1371
[3] Macrossan v Comptroller-General of Patents [2006] EWHC 705 (Ch)
[4] Fujitsu Ltd's Application [1996] RPC 511

8 Mann J goes on to say at paragraph 9 of *Macrossan*:

> *"Mr Birss, in his written submissions for the Comptroller, points out that Whitford J was not addressing a question of principle in what he said. I agree with that, but his statement nonetheless seems to reflect a principle or principles which are consistent with what Laddie J said in Fujitsu. That principle seems to involve the onus being on the person alleging that the alleged invention is within the exclusion. The reference to the benefit of the doubt is probably intended to signify that if there is substantial doubt then the burden has not been fulfilled. I do not consider that it means that if there is any doubt (legal or factual) then the application should succeed. It is not intended to import something like the criminal burden of proof into the proceedings. The tribunal still has to consider whether the exception applies, and it can come to the conclusion that it does without having to find that there is no doubt at all about it."*

9 The current practice of the Office in this regard is set out in paragraph 1.10 of the Manual of Patent Practice, as follows:

> *"The Court of Appeal, in paragraph 5 of Aerotel Ltd v Telco Holdings Ltd & Ors Rev 1 [2007] RPC 7 (Aerotel/Macrossan), made it clear that assessing excluded matter involves a question of law which should be decided during prosecution of the patent application. The position is therefore assessed fully by patent examiners before grant, and objections are not to be dropped simply because the applicant asserts that the invention relates to non-excluded subject matter. The question of excluded matter is decided on the balance of probabilities, taking into account all of the evidence available. However, as it is a question of law, it is not something on which applicants are entitled to the benefit of the doubt, in the way they would be in relation to questions of pure fact (such as the date of a particular disclosure, or the scope of the common general knowledge)."*

10 The original passage in question from the Court of Appeal is this:

> *"In that connection we should record also that we accept Mr Birss' submission that any pure question of law involved should be decided during prosecution. It is not enough to get a patent past the application stage to show that as a matter of law it merely arguably covers patentable subject-matter. The position is different from that under the old law. Then the rule was that patents should be refused only where on no reasonable view could the subject-matter be patentable, see Swift's & Co Application [1962] R.P.C. 37 at 46. Despite that being the rule, in the years that followed Swift, in practice a decision of the Office or on appeal to the Appeal Tribunal was taken to decide the matter once-and-for all. That itself shows there is no point doing other than deciding the question. Moreover that is what the European Patent Office (EPO) does and there is no warrant in the EPC for the "arguable" approach. Of course if a debatable question of pure fact is or may be involved at the application stage, things are different-one cannot then say that the decision at that point must be the last word on the subject. Then the applicant must be given the benefit of any reasonable doubt."*

11 From the references to prosecution and application stage I take it that the quote from the Court of Appeal is relevant to the practice of the Office.

12 It seems therefore that there is a burden upon an examiner to demonstrate that an invention falls foul of the exclusions and that to overcome such an objection an applicant must do more than "show that … it merely arguably covers patentable subject-matter". In other words, both the examiner and the applicant must do much more than simply assert that their view is correct.

13 Mr Russell and Dr Jones say in their skeleton arguments that they are not seeking to create false or spurious doubt about whether the inventions in each of the applications are excluded, since it is clear from the case law cited above that this

would not be enough to cause an application to succeed. However, they say that the arguments advanced in respect of each of the applications are sufficient to create real and substantial doubt as to whether the inventions are excluded, and they suggest that the Office should only maintain an objection when it is clear that the applicant cannot be right.

14 Crucial to the test set out in *Aerotel* is the step of identifying the contribution, and it is the position of Mr Russell and Dr Jones that examiners have assessed the contribution in the present applications (and others before them) far too narrowly and have been unprepared to question their initial assessment or to consider whether it is possible that the applicant's assessment of the contribution may indeed be right. By way of illustration they asked me to consider the general case of a method that:

> i) uses a computer to read in geological data,
> ii) carries out a sequence of mathematical operations with the computer to create a model of the geological formation, and
> iii) carries out a sequence of mathematical operations with the computer on the model of the geological formation.

15 They argue that such a method is not a mathematical method in the sense of section 1(2) because the claim is to the application of mathematical steps to geological modelling. If there is any doubt about this then they say that the benefit of such doubt has to go with the applicant. It is similarly argued that the use of real data takes the method outside the computer program exclusion and that the steps of creating and manipulating a model create and then change a tangible technical entity which also take the method outside the computer program exclusion. Again, any doubt about this should be resolved in favour of the applicant.

16 I do not think that the arguments advanced in relation to this hypothetical example help clarify the standard of proof required of examiners in objecting to inventions relating to excluded subject-matter. However, I will return to these general arguments when considering the technical contribution in each of the applications before me.

17 Mr Russell and Dr Jones suggest that an applicant should be given the benefit of the doubt unless there is no reasonable doubt to be had. Insofar as this reasonable doubt is the same as the substantial doubt to which Mann J refers, I can agree with this principle. I consider that the question for me is whether or not there is such substantial doubt regarding each of these seven applications, such that <u>where an applicant makes a reasonable case that their invention is patentable then I am bound to find in their favour</u>. I shall proceed on this basis.

<u>Assessment of the contribution</u>

18 The four steps in the *Aerotel* test which I referred to earlier are as follows:

> (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.

19 Mr Russell and Dr Jones say that the question of how to identify the contribution in the second step of this test is critical and referred me to the following paragraphs in *Aerotel* for guidance:

> *"43.The second step – identify the contribution - is said to be more problematical. How do you assess the contribution? Mr Birss submits the test is workable – it is an exercise in judgment probably involving the problem said to be solved, how the invention works, what its advantages are. What has the inventor really added to human knowledge perhaps best sums up the exercise. The formulation involves looking at substance not form – which is surely what the legislator intended.*
>
> *44. Mr Birss added the words "or alleged contribution" in his formulation of the second step. That will do at the application stage – where the Office must generally perforce accept what the inventor says is his contribution. It cannot actually be conclusive, however. If an inventor claims a computer when programmed with his new program, it will not assist him if he alleges wrongly that he has invented the computer itself, even if he specifies all the detailed elements of a computer in his claim. In the end the test must be what contribution has actually been made, not what the inventor says he has made."*

20 They referred me to paragraphs 37 and 53-54 of S*ymbian* as evidence of how the Office's approach to identifying the contribution made by inventions of the kind set out in the present applications is too narrow and is resulting in decisions by the Office to refuse applications that would otherwise be allowed by the Courts. Paragraphs 50-52 are also worth referencing as context to the subsequent paragraphs:

> *"37. The right starting point is the decision of the Board in Vicom/Computer-related invention T0208/84, [1987] 2 EPOR 74. At [3], the Board said that:*
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> *"a method for obtaining and/or reproducing an image of a physical object or even an image of a simulated object (as in computer-aided design/computer-aided manufacturing … systems) may be used e.g. in investigating properties of the object or designing an industrial article and is therefore susceptible of industrial application. Similarly a method for enhancing or restoring such an image, without adding to its informational content, has to be considered as susceptible of industrial application" and hence would not be excluded from patentability.*
>
> *At [12]:*
>
> *"a claim directed to a technical process which process is carried out under the control of a program (… in hardware or in software) cannot be regarded as relating to a computer program as such …, as it is the application of the program for determining the sequence of steps in the process for which in effect protection is sought".*
>
> *At [15]:*
>
> *"Generally claims which can be considered as being directed to a computer set up to operate in accordance with a specified program (whether by means of hardware or software) for controlling a technical process cannot be regarded as relating to a computer program as such … ."*
>
> *Finally at [16] the Board described "making a distinction between embodiments of the same invention carried out in hardware or in software" as "inappropriate", as what is "decisive" is the "technical contribution which the invention described in the claim when considered as a whole makes to the known art".*
>
> *50. The fact that "the boundary line between what is and what is not a technical [contribution]" is imprecise (as Nicholls LJ said in Gale, and as was echoed by Aldous LJ in Fujitsu) may be attributable to three causes, which are not mutually exclusive. First,*

national tribunals and the Board may still be at an intermediate stage of working out and identifying the precise location of that line; secondly, the problem may be inherent and never wholly satisfactorily soluble; thirdly, there are competing views based on different philosophies (the "open source movement represents one extreme, that of companies such as the present applicant, the other). The uncertainty is well demonstrated by the elusiveness of the meaning of "technical", the change of attitude manifested in the more recent decisions of the Board, the contrasting outcomes in Vicom and Fujitsu, and indeed the possible reconsideration of the correct view of computer program patents in the United States (see Professor John Duffy: Death of Google's Patents? Patently-O Patent Law Blog, July 21st, 2008).

51. These considerations reinforce our view that, at least in this court at this stage, we should try to follow previous authority, we should seek to steer a relatively unadventurous and uncontroversial course, and we should be particularly concerned to minimise complexity and uncertainty. These aims are not necessarily mutually consistent, but, on this occasion, we believe they are achievable, namely by following the analysis adopted by the Board in Vicom and the two IBM Corp. cases, and of the Court of Appeal in Merrill Lynch and Gale.

52. These considerations also manifest the difficulty of formulating a precise test for deciding whether a computer program is excluded from patentability, and suggest that it could be inappropriate to accept either of the rival simple propositions (summarised at [17] above) advanced by the parties here. Bearing in mind the multifarious features of computer programs and the unpredictable developments which will no doubt occur in the IT field, we believe that it would also be dangerous to suggest that there is a clear rule available to determine whether or not a program is excluded by art 52(2)(c). Each case must be determined by reference to its particular facts and features, bearing in mind the guidance given in the decisions mentioned in the previous paragraph.

53. Based on these principles, we consider that Patten J was right and that the claimed invention does make a technical contribution, and is not therefore precluded from registration by art 52(2)(c). To start with a defensive point, the program in this case does not embody any of the items specifically excluded by the other categories in art 52; thus, it is not a method of doing business (as in Merrill Lynch), or a mathematical method (as in Gale), or a method for performing mental acts (as was probably the case in Fujitsu).

54. More positively, not only will a computer containing the instructions in question "be a better computer", as in Gale, but, unlike in that case, it can also be said that the instructions "solve a 'technical' problem lying with the computer itself". Indeed, the effect of the instant alleged invention is not merely within the computer programmed with the relevant instructions. The beneficial consequences of those instructions will feed into the cameras and other devices and products, which, as mentioned at [3] above, include such computer systems. Further, the fact that the improvement may be to software programmed into the computer rather than hardware forming part of the computer cannot make a difference – see Vicom; indeed the point was also made by Fox LJ in Merrill Lynch.

21 Mr Russell and Dr Jones note that the European Patent Office Technical Board of Appeal's decision in *Vicom*[5] was approved by the Court of Appeal in *Aerotel* and *Symbian.* They suggest that it is hard to conceive of a case that could be closer to the issues under consideration in the present applications and say that *Vicom* points to the fact that the inventions in the seven applications before me are technical and do not lie in excluded subject-matter as such. They say that for the Office to find differently suggests that its approach to assessing contribution must be wrong.

22 So what then is the correct approach to assessing the contribution? In his second sentence in paragraph 44 of *Aerotel* (quoted above), Jacob LJ refers to the Office

[5] Vicom T 0208/84

accepting the word of the inventor with regard to the contribution made, however it is not clear whether the qualification that follows, i.e. “It cannot actually be conclusive”, is also intended to apply to the Office. Paragraph 1.20 of the Manual of Patent Practice appears at first glance to be helpful in this respect in that it takes me to paragraphs 23-24 in *IGT/Acres Gaming Inc*[6], where Mr Peter Prescott QC (sitting as Deputy Judge) addresses this general issue:

> *“23. After hearing argument in this case I wondered what is meant by the second paragraph I have quoted, namely paragraph 44. Does it mean that the Patent Office is bound to accept the applicant's assertion (save in blatant cases)? Or can the Patent Office do a prior art search to find out what has the inventor really added to human knowledge? I therefore invited further submissions in writing.*
>
> *24. Although there was some disagreement, both parties accepted that the Patent Office is entitled to do a prior art search and that if it turns out that the alleged contribution was already known, or was obvious, there can hardly be a contribution to human knowledge. In my judgment that is correct. And there will be no patentable contribution to human knowledge if what is new and not obvious relates solely to a business method as such.”*

23 What Mr Prescott appears to be saying here is that if the alleged contribution is either known or obvious such that the claimed invention adds nothing to human knowledge (per *Aerotel*), then the application can be refused under section 1(2). Although Mr Russell and Dr Jones did not address me directly on this case, they did address the general point that the correct basis for refusing an application in this situation would be for lack of novelty or inventive step and not under section 1(2), which is the approach, they say, that the European Patent Office takes.

24 Mr Russell and Dr Jones suggested that I need only look at how the Courts have approached the assessment of “actual contribution” to see how the Office approach is inconsistent. In the Patents Court judgment in *Halliburton Energy Services Inc. (“Halliburton”)*[7], in which HHJ Birss QC (as he then was, and sitting as a judge of the High Court) heard an appeal of an Office decision[8] to refuse various applications relating to the use of a computer simulation to improve the design of roller cone drill bits for drilling oil wells, the actual contribution made by the invention was addressed as follows (paragraphs 66 and 67 of *Halliburton*):

> *“66.Mr Thorpe identified the contribution made by this invention in paragraph 29. He said:*
>
> > *29. I will leave for a moment the issue of whether outputting the results to a resource adds to the contribution. For the moment I am happy to proceed on the basis of a slightly broader interpretation of what Mr Davis has proposed. The contribution of the claimed invention is in my view, as a matter of substance:*
> >
> > *A method of designing drill bits that includes simulation of the performance of the drill bit based on calculating a three dimensional mesh for each cutting element and for the earth formation and using that to determine the forces acting on each mesh segment of the cutting element and then the forces and stresses acting on each cutting element.*
>
> *67. I agree with that statement save that it seems to me to be important to state that the contribution is a computer implemented method of designing drill bits. Normally that emphasis would not be very important, for example if the case was concerned with the business method exclusion it would be irrelevant, but in this case, given the debate about*

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[6] IGT/Acres Gaming Inc, Re [2008] EWHC 568 (Pat)
[7] Halliburton Energy Services Inc., [2011] EWHC 2508 (Pat)
[8] BL O/080/11

the mental act exclusion, it is critical."

25 At paragraph 67, HHJ Birss agrees with the Hearing Officer's assessment of the actual contribution but considered it important to emphasise that the method of designing drill bits was limited to implementation on a computer, i.e. the contribution was a "computer-implemented method of designing drill bits". Having identified the actual contribution, the Hearing Officer went on to consider whether the contribution fell within excluded subject-matter and felt bound to follow the conclusion reached previously by Pumfrey J in *Halliburton v Smith ("Smith")*[9] given the similarity of the inventions. The Hearing Officer refused the applications on the basis that the "untethered" inventions were mental acts. However, HHJ Birss said that the Hearing Officer had taken too broad a view of the mental act exclusion and had misinterpreted the way in which Pumfrey J had applied the exclusion in *Smith* - the claims in *Smith* encompassed acts that could be performed mentally whereas the claims in *Halliburton*, which included steps of simulation and outputting, tied the method to implementation on a computer and therefore could not be performed mentally. He says at paragraph 77 of *Halliburton* that *"His concern [i.e. Pumfrey J] was not with the technical contribution as a matter of substance – which he did not doubt – but with the form of the claims."* The Hearing Officer had understood from *Smith* that a "tethering step", i.e. the subsequent manufacture of the drill bit, was needed to avoid the mental act exclusion and for a technical contribution to be made, but HHJ Birss said that this was incorrect.

26 When it came to the step of assessing whether the contribution fell solely within excluded subject matter, i.e. the third step of the *Aerotel* test, HHJ Birss says at paragraph 71 that the contribution is a method of designing a drill bit and therefore more than a computer program as such. Here he relied upon a more general description of the contribution than the narrower version formulated by the Hearing Officer. When checking whether the contribution is actually technical in nature, i.e. the fourth step of the *Aerotel* test, HHJ Birss says at paragraph 74 that *"designing drill bits is obviously a highly technical process, capable of being applied industrially……The detailed problems to be solved with wear and ability to cut rock and so on are technical problems with technical solutions"*, concluding that the applications did satisfy the requirements of section 1(2). Here again he relies upon a more general description of the contribution, his conclusion on whether the more general description of the contribution is actually technical in nature echoing his comments earlier in the judgment (at paragraphs 29-38) after reviewing the judgments in *Merrill Lynch*[10], *Gale*[11], *Macrossan*, *Aerotel*, S*ymbian*, etc.. Paragraph 38 says:

> *"38. What if the task performed by the program represents something specific and external to the computer and does not fall within one of the excluded areas? Although it is clear that that is not the end of the enquiry, in my judgment that circumstance is likely to indicate that the invention is patentable. Put in other language, when the task carried out by the computer program is not itself something within the excluded categories then it is likely that the technical contribution has been revealed and thus the invention is patentable. I emphasise the word "likely" rather than "necessarily" because there are no doubt cases in which the task carried out is not within the excluded areas but nevertheless there is no technical contribution at all."*

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[9] Halliburton Energy Services, Inc. v Smith International (North Sea) Ltd & Ors [2005] EWHC 1623 (Pat) (21 July 2005)
[10] Merrill Lynch's Application, [1989] RPC 561
[11] Gale's Application [1991] RPC 305

27 Even though it seems that the applicant, Halliburton, may not have been the first to invent a computer-implemented method for designing drill bits *per se*, it seems from this judgment that one can take a step back from the actual advance over the state of the art when assessing the contribution for the purpose of section 1(2) and simply identify the field of endeavour in which the method is applied. In other words, it might not be necessary to conduct a forensic analysis of the difference between the invention and the prior art in order to assess what the inventor has really added to human knowledge when it is clear that the invention is limited to a very specific task or application that is not itself excluded. The fact that one can specify precisely the difference between the invention and the state of the art within a description of the actual contribution does not alter the fact that a contribution is also made within a general field of endeavour if the invention is claimed and limited in such a way. If that field of endeavour is a technical one then, according to *Halliburton,* there is a reasonable chance of it being a patentable invention under section 1(2). For computer-implemented inventions such as the ones in *Halliburton* and *Vicom*, it can be sufficient to determine whether the general task performed by the computer program is external to the computer and does not fall within one of the excluded areas in order to conclude that a technical contribution has been revealed. For other computer-implemented inventions, where the task performed by the program is limited entirely to what is going on inside the computer, an invention can be patentable if it solves a technical problem relating to the running of computers generally.

28 This poses an interesting question in respect of the assessment of contribution as determined in *Halliburton.* Given that HHJ Birss agreed with the narrow description of the contribution identified by the Hearing Officer but then relied upon a more general description of it when assessing steps 3 and 4, would HHJ Birss have come to a different conclusion on the question of patentability had he proceeded on the same narrow basis as the Hearing Officer? In other words, was the reason that a different conclusion was reached by the Hearing Officer a direct consequence of having taken a narrower view of the contribution, which Mr Russell and Dr Jones suggest is the practice of the Office, or simply because he came to a different view of what is technical.

29 On reading the Hearing Officer's decision it seems clear that the latter was the case, However, I shall first set our Mr Russell and Dr Jones' argument as to how a narrow view of the contribution can lead to inconsistencies in deciding what is and isn't a patentable invention before I explain my reasons why. They sought to illustrate their argument by way of example. In an invention where the only difference between a known method of processing particular data sets, e.g. a method for enhancing/modelling image or geophysical data, is the use of a Fast Fourier Transform (FFT) instead of a Fourier Transform (FT), the benefits of doing so being to reduce the processing load of the computer, a narrow assessment of the contribution could lead to a conclusion that what has been added to human knowledge is the mere replacement of a FT with a FFT, and a mistaken assessment that this is nothing more than a mathematical or computational advance. They say that such a narrow approach would be wrong, because the invention remains a method for enhancing/modelling image or geophysical data, which is inherently patentable (per *Vicom*). Once past the hurdle of section 1(2), they say that the act of replacing the FT with an FFT should then be assessed against the requirement for inventive step, this being the proper place for doing so and not confused with any

consideration of whether the invention is within the list of exclusions set out in section 1(2)

30 I accept Mr Russell's and Dr Jones' point that there is a risk of reaching the wrong conclusion on section 1(2) if the contribution is not properly framed. However, as I have said, I do not believe that the reason the Hearing Officer came to a different conclusion to that of the Court in *Halliburton* was a consequence of having relied upon a much narrower description of the contribution in assessing steps 3 and 4 – the Hearing Officer had simply applied the mental act exclusion on too broad a basis.

31 So where does this leave me with regard to the correct approach to assessing the contribution? It seems to me from *Halliburton* that it is quite possible to arrive at either a narrow or a broad view of the actual contribution made by the invention and still be able to come to the same conclusion as to whether the contribution falls solely within excluded subject-matter. I have already noted that HHJ Birss agreed with the narrow form of the contribution set out by the Hearing Officer in *Halliburton* while also relying on a broader description when assessing whether the contribution was technical. The reason for doing so seems clear, in that it allowed him to quickly highlight the nature of the task performed by the computer program as representing something specific and external to the computer, i.e. designing drill bits. This task was included in both the narrow and broad descriptions of the contribution, and illustrated how the computer program was tied to a specific field of endeavour. He then goes on to consider whether the contribution is technical, saying that when the task is not something within the excluded categories then it is likely that that the technical contribution has been revealed and that the invention is patentable. He emphasises the word "likely" rather than "necessarily" because there would no doubt be cases in which the task carried out is not within the excluded areas but nevertheless there is no technical contribution at all.

32 It is precisely this approach I intend taking in this decision: when assessing the actual contribution in a computer-implemented invention, I shall take proper account of the task performed by the computer and determine whether the task falls outside the excluded categories. I shall also take account of Mr Russell and Dr Jones' argument that such cases, i.e. the cases in which the task carried out is outside the excluded areas but nevertheless there is no technical contribution at all, would be the exception rather than the norm. If the task carried out is within an excluded area, e.g. a computer program, then HHJ Birss explains at paragraph 37 of *Halliburton* that this is not necessarily the end of the matter because a program that solves a technical problem relating to the running of computers generally is not excluded by section 1(2). The oft-quoted signposts in *AT&T/CVON*[12] provide a useful summary of where the Courts have identified a technical contribution in computer-implemented inventions when the task carried out falls within an excluded category, but there are likely to be other areas where a technical contribution is found that have not yet been considered by the Courts.

The applications in suit

33 Before addressing each application in turn, Mr Russell and Dr Jones made some general comments regarding the set of applications I am to consider and the field of endeavour in which they lie.

[12] AT&T Knowledge Ventures LP, Re [2009] EWHC 343 (Pat)

34 A parallel is drawn between the geological models in these applications and an image that is manipulated as in *Vicom,* and a quote is taken from the Reasons for the Decision in *Vicom*:

> *5. There can be little doubt that any processing operation on an electric signal can be described in mathematical terms. The characteristic of a filter, for example, can be expressed in terms of a mathematical formula. A basic difference between a mathematical method and a technical process can be seen, however, in the fact that a mathematical method or a mathematical algorithm is carried out on numbers (whatever these numbers may represent) and provides a result also in numerical form, the mathematical method or algorithm being only an abstract concept prescribing how to operate on the numbers. No direct technical result is produced by the method as such. In contrast thereto, if a mathematical method is used in a technical process, that process is carried out on a physical entity (which may be a material object but equally an image stored as an electric signal) by some technical means implementing the method and provides as its result a certain change in that entity. The technical means might include a computer comprising suitable hardware or an appropriately programmed general purpose computer.*

35 Mr Russell and Dr Jones reminded me that a similar point was put to me in a previous hearing concerning a method of processing seismic or other geophysical data, namely *WesternGeco Ltd's Application*[13]*.* In that case I agreed that "*Vicom was particularly relevant to the present application because of the similarity in the subject matter of the two inventions*" and I agree that the same is true with the present applications. In *WesternGeco* my decision was that some, but not all, of the claims related to subject-matter excluded from patentability under section 1(2), namely the "untethered" claims that did not include a step of determining one or more parameters relating to physical properties of the earth's interior from the processed geophysical data. I came to the same conclusion as the Hearing Officer in *Halliburton* that a tethering step was necessary to make a method of processing seismic data patentable, i.e. technical, which the Court has since found to be incorrect. To the extent that Mr Russell and Dr Jones wish me to draw general conclusions regarding patent applications relating to methods involving geological models, all that I can say is that such methods are not inherently excluded from patentability and that such an invention must be considered upon its own merits.

36 This group of applications were all filed as PCT applications on 15 August 2014 and share a single priority application dated 16 August 2013. The disclosure in each application is essentially the same, since each relates to a particular part within a larger overall method, as shown in figures 2A and 2B of the specifications, reproduced at Annex 1. Consequently I have arranged them in what seems to me to be a sensible order based upon where they lie within the larger method. I will deal with the applications in turn.

<u>i) GB1600696.7</u>

37 GB1600696.7, published as GB2530953 and corresponding to PCT publication WO 2015/023942, relates to step 206 in figure 2A. This is expanded in figure 3 and paragraphs [0054] to [0059] of the description, reproduced at Annex 2.

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[13] BL O/135/07

38 Claim 1 as currently amended reads as follows:

> 1. A method for generating a representation of a geological structure, which comprises: mapping a plurality of source data points to a common point cloud; creating a sorted point cloud collection with a footprint representing a boundary by sorting points in the common point cloud according to a distance of each of the plurality of source data points from an origin; creating a new point cloud by reducing the footprint of the sorted point cloud collection; and creating a representation of a geological structure by gridding points in the new point cloud using a computer processor.

39 Independent claims 8 and 15 are directed to program carrier devices, but relate to the same inventive concept as claim 1 and so I will consider only claim 1. I note there are two omnibus claims which are generally no longer allowed before the Intellectual Property Office following an amendment to the Patent Rules 2007.

40 Turning to the four steps in the *Aerotel* test I must first properly construe the claim. It seems to me that the claim is clear as it stands and needs no interpretation. I am reassured in this regard that neither the examiner nor Mr Russell and Dr Jones saw any need to dwell on the construction of claim 1. It is worth considering one point. The method takes in "*source data points*". The application does not discuss the nature of these data points in any great detail although "*hand digitized polylines*" are given as one example of such data points (see e.g. paragraph [0054], Annex 2). Nevertheless it seems to me that the source data is necessarily data relating to or derived from a physical object in the form of a geological structure. It is thus real data of the kind to which Mr Russell and Dr Jones drew my attention and not arbitrary data.

41 Next I must identify the actual contribution. According to the examiner the contribution is "*a computer program for implementing the mathematical method of gridding a point cloud*". By contrast Mr Russell and Dr Jones saw the contribution as "*a better computer-implemented process for geological modelling by virtue of which gas and oil filled reservoirs may be interpreted with a higher degree of accuracy*". This is in part a quote from paragraph [0054] of the description, as quoted in Annex 2. It seems to be common ground that the invention is limited to implementation on a computer and indeed this is explicit in the claim. It is true that the method grids points in a point cloud, as the examiner says. However, I think that there is more going on in the method than just this and it would be wrong for me to say that what the inventor has really added to human knowledge is no more than a computer program for implementing a mathematical method of gridding a point cloud. To my mind the contribution is a computer-implemented method for creating a representation of a geological structure which relies upon a particular method of gridding a point cloud. This seems to me to be very much akin to "*a method for obtaining and/or reproducing an image of a physical object or even an image of a simulated object*" as referred to in *Vicom*. Such a contribution is neither a computer program as such nor a mathematical method as such, and hence does not fall <u>solely</u> within the excluded subject matter.

42 As a final check, the contribution I have identified seems to me to be technical in nature and, to borrow the words of HHJ Birss in *Halliburton*, is "*a highly technical process, capable of being applied industrially……The detailed problems to be solved … are technical problems with technical solutions"*.

ii) GB1600694.2

43 The next application is GB1600694.2, which was published as GB2530463 and corresponds to PCT publication WO 2015/023944. This application is concerned with the stratigraphic analysis of step 214 in figure 2A, described in more detail in paragraphs [0078] to [0087] on pages 16 and 17 of the description and figures 10A and 10B, reproduced at Annex 3.

44 Independent claims 1, 8 and 15 relate to method and program carrier aspects of the same inventive concept. Consequently I will consider claim 1. I note that claims 21 and 22 are omnibus claims. Claim 1 as amended reads as follows:

> 1. A method for identifying and extracting stratigraphic layers in one or more bodies representing a geological structure, which comprises:
>
> a) loading a plurality of bodies, wherein each body includes a top patch, a center of mass and a volume;
> b) assigning a surface flag to each respective body, wherein each surface flag is designated as empty;
> c) selecting a surface flag that is assigned to one of the plurality of bodies with a top patch that is a surface;
> d) converting the selected surface flag from empty to a top surface representing a top surface flagged body;
> e) selecting each one of the plurality of bodies that is below the top-surface flagged body;
> f) identifying each body selected below the top-surface flagged body that is a continuation of the top-surface flagged body using a computer processor;
> g) repeating steps c) - f) for each surface flag assigned to one of the plurality of bodies with a top patch that is a surface; and
> h) separating each top-surface flagged body and each body identified as a respective continuation of the top-surface flagged body from the plurality of bodies into a group of bodies, and returning the group of bodies as an output.

45 Turning now to the *Aerotel* test, neither the examiner nor Mr Russell and Dr Jones saw any need to construe the claim and I am content that the claim needs little interpretation. I will say however that it strikes me that the bodies representing a geological structure upon which the method is performed necessarily relate to a physical object and are thus real data and not arbitrary data. It is common ground that the method is implemented using a computer.

46 As for the contribution, the examiner determines it as being "*a computer program for implementing the extraction of bodies*", whereas Mr Russell and Dr Jones see the contribution as "*a better computer-implemented process for geological modelling in which source data is analysed to identify stratigraphic layers and in which the method automatically extracts stratigraphic layers and groups them without seams or intrusions for simple identification*", quoting in part paragraph [0078] of the description (see Annex 3). For my part the method seems to be a computer-

implemented method for modifying a model of a geological structure by identifying stratigraphic layers in the bodies representing the geological structure.

47 While the method is implemented using a computer, I do not believe that it is merely a computer program as such and nor is it a mathematical method. It seems very much that the method "*may be used e.g. in investigating properties of the object*" along the lines described in *Vicom*, the object in question being the modelled geological structure. As with the previous application, the contribution is technical in nature, tied to a very specific technical field of endeavour or task.

iii) GB1600702.3

48 The next application is GB1600702.3, published in the UK as GB2531197 and before that in the PCT international phase as WO 2015/023947. This application relates to the fault block analysis of step 218 in figure 2. This is further described in figures 13A and 13B and paragraphs [0088] to [0097] on pages 17 to 19, which are reproduced at Annex 4.

49 Independent claims 1, 10 and 19 share an inventive concept, claim 1 being directed to a method and claims 10 and 19 to a program carrier. I will consider claim 1, which reads as follows:

> 1. A method for identifying and extracting fault blocks in one or more bodies representing a geological structure, which comprises:
>
> a) loading a plurality of bodies, wherein each body includes a side patch, a center of mass and a volume;
> b) assigning a fault flag to each respective body, wherein each fault flag is designated as empty;
> c) selecting a fault flag that is assigned to one of the plurality of bodies with a side patch that is a fault;
> d) converting the selected fault flag from empty to a fault representing a fault-flagged body;
> e) selecting each one of the plurality of bodies that is below the fault- flagged body;
> f) identifying each body selected below the fault-flagged body that is a continuation of the fault-flagged body using a computer processor;
> g) repeating steps c) - f) for each fault flag assigned to one of the plurality of bodies with a side patch that is a fault; and
> h) separating each fault-flagged body and each body identified as a respective continuation of the fault- flagged body from the plurality of bodies into a group of bodies, and returning the group of bodies as an output.

50 First I must construe the claim. Again, neither the examiner nor Mr Russell and Dr Jones mention this step, from which I take it that they find the claim to be clearly understood. Once again the bodies specified in the claim are bodies representing a geological structure related to a physical object and thus represent real data. Both the examiner and the attorneys agree that the method is implemented using a computer. While the claim is concerned with bodies having a side patch that is a fault (see steps a), c) and g)), I note that the detailed description of fault block analysis discusses bodies having a top patch that is a fault (see paragraphs [0091] and [0096]). I cannot readily resolve this inconsistency, but I do not believe that it affects

my construction of the claim, which clearly refers to side patches, nor the question of excluded subject matter.

51 The examiner identifies the contribution as a computer program for implementing the extraction of fault blocks and does not require any physical or external use for such extraction. Mr Russell and Dr Jones see the contribution as a better computer-implemented process for geological modelling in which fault blocks are identified and extracted based on geological source data and returned as one or more bodies representing the geological structure facilitating real-time modelling with higher accuracy. In a similar manner to the previous application, I see the contribution as a computer-implemented method for modifying a model of a geological structure by identifying and extracting fault blocks from the bodies representing the geological structure. Once again, I do not believe that it is merely a computer program as such, but rather the method "*may be used e.g. in investigating properties of the object*" as in *Vicom*, with the object being the modelled geological structure. As with the previous applications, the contribution is technical in nature.

<u>iv) GB1600704.9</u>

52 GB1600704.9, published as GB2531199 and WO 2015/023950, concerns the fluid fill analysis of step 224 in figure 2, as elaborated in paragraphs [0098] to [0116] and figures 20A to 20D, which I include at Annex 5.

53 Claims 1, 8 and 15 share an inventive concept and method claim 1 reads as follows:

> 1. A method for identifying and extracting fluid layers and fluid reservoirs in one or more bodies representing a geological structure, which comprises:
>
> a) loading a plurality of bodies extrapolated from source geological data, wherein each body includes a top patch, a center of mass and a volume;
> b) assigning a fluid contact flag to each respective body, wherein each fluid contact flag is designated as empty;
> c) selecting a fluid contact flag that is assigned to one of the plurality of bodies with a top patch that is a fluid contact;
> d) converting the selected fluid contact flag from empty to a fluid contact representing a top-fluid contact flagged body;
> e) selecting each one of the plurality of bodies that is one of in a same fault block and in a same stratigraphic layer as the top-fluid contact flagged body;
> f) identifying each body selected as one of in the same fault block and in the same stratigraphic layer as the top-fluid contact flagged body, which is a continuation of the top-fluid contact flagged body, using a computer processor;
> g) repeating steps c) - f) for each fluid contact flag assigned to one of the plurality of bodies with a top patch that is a fluid contact; and
> h) separating each top-fluid contact flagged body and each body identified as a respective continuation of the top-fluid contact flagged body from the plurality of bodies into a group of fluid-layer bodies; and
>
> wherein the method further comprises performing property matching on the group of fluid-layer bodies to convert each body of the group of fluid-layer bodies to a respective compartment; and returning the compartments as an output.

54 I have no great difficulty construing the claim, although I note that at step a), the bodies are explicitly extrapolated from source geological data, i.e. real data. Once again it seems to be common ground between the examiner and the applicant that the method is implemented by computer. In his pre-hearing report, the examiner assesses the contribution as a computer program for implementing a mathematical method of the extraction of fault blocks. I assume the examiner means extraction of fluid layers and fluid reservoirs rather than extraction of fault blocks. In their skeleton arguments, Mr Russell and Dr Jones tell me that the contribution is a better computer-implemented process for geological modelling in which source data is analysed to identify stratigraphic layers and in which the method automatically extracts stratigraphic layers and groups them without seams or intrusions for simple identification, rather than handling groups of structures that create challenges to recognition. I do not think this can be right - the method of claim 1 does not identify stratigraphic layers because this has already been done at step 214 in figure 2 and is the subject of GB1600694.2. Mr Russell and Dr Jones acknowledged this point at the hearing. To my mind the contribution should be characterised as a computer-implemented method for modifying a model of a geological structure by identifying and extracting fluid layers and reservoirs from the bodies representing the geological structure.

55 While acknowledging that some of the steps in claim 1 could be characterised as data processing steps, Mr Russell and Dr Jones were keen to point out that none of the steps in the method can be properly characterised as a generic mathematical method. I feel I must agree with this proposition. So is the method a computer program as such? I consider the answer must be no, since the inventor has not simply added a computer program as such to human knowledge: once again the method "*may be used e.g. in investigating properties of the object*" as in *Vicom*, with the object being the modelled geological structure. As with the previous applications, the contribution is technical in nature.

v) GB1600703.1

56 GB1600703.1 was published as GB2531198 and WO 2015/023954. It mainly concerns the property matching at step 238 in figure 2 (although see below regarding steps 202 and 208), which is described in more detail in paragraphs [00117] to [00129] on pages 23 to 26 of the description (as published), reproduced at Annex 6.

57 Claims 1, 9 and 17 relate to method and program carrier aspects of the same inventive concept and claim 1 reads as follows:

> 1. A method for identifying matching properties between a group of bodies representing a geological structure and a table of properties, which comprises:
> loading, from a database, current data comprising a plurality of source data points in a current coordinate system, with predefined units, into a 3D modelling engine, operating in a system with predefined units;
> producing the bodies by extrapolating the current data;
> identifying each inherent property in the table with a value that is identical to a value for an inherent property of one of the bodies in the group of bodies using a computer processor, wherein each body with an inherent property

value that is identical to an inherent property value in the table represents a matching body;
identifying each inherent property in the table with a value that is within a predefined tolerance of a value for an inherent property of one of the bodies in the group of bodies that is not a matching body using the computer processor, wherein each body with an inherent property value that is within the predefined tolerance of an inherent property value in the table and is not a matching body represents a related body;
associating each inherent property value in the table that is identical to an inherent property value of one of the bodies in the group of bodies with the respective body representing a matching body; and
associating each inherent property value in the table that is within the predefined tolerance of an inherent property value of one of the bodies in the group of bodies with the respective body representing a related body.

58 I note that the initial loading and producing steps in the method have been added during prosecution and relate to steps 202 and 208 in the overall method shown in figure 2. Once again neither the examiner nor Mr Russell and Dr Jones see any need to discuss the construction of the claim. For my part I noted in the previous applications that I took the bodies in question to relate to real data and in this case this seems abundantly clear from the loading and producing steps.

59 Turning to the contribution, the examiner has this as a computer program for implementing the process of comparing one set of data with another to determine a match. By contrast Mr Russell and Dr Jones prefer to say that the contribution is a better computer-implemented process for geological modelling in which an association is created between geological properties and bodies identifiable within the geological structure to allow compartments to be identified and providing increased speed of scanning and filtering. I agree with the examiner that on one level there is a step of matching properties within the method and that this is performed using a computer processor. However, I consider that there is more to the contribution than just this. I also agree with Mr Russell and Dr Jones that the method allows compartments to be identified, although actually producing the compartments seems to come in dependent claim 4. Nevertheless the method takes in data representing a geological structure and modifies that data in several ways, first by producing the bodies and then by identifying and associating bodies that match or are related to one another. I think the contribution can be expressed as a computer-implemented method for modifying a model of a geological structure by identifying bodies representing the geological structure that match or relate to one another. I do not consider that this should reasonably be described as a computer program as such and, given the field of endeavour within which the invention lies, I believe that the contribution is technical in nature.

<u>vi) GB1600705.6</u>

60 This application was published as GB2540447 and WO 2015/023956 and concerns the custom reservoir generation of step 240 in figure 2, described in more detail in paragraphs [00130] to [00138] on pages 26 and 27 of the description and figures 23A and 23B, which can be found at Annex 7.

61 There are independent claims to a method and to a program carrier, but claims 1 and 9 share an inventive concept. Claim 1 as amended reads thus:

1. A method for generating a custom reservoir from multiple compartments representing one or more geological structures, which comprises:
selecting two or more compartments from the multiple compartments;
selecting, as a combination type, one of union, intersect some and intersect all;
combining the two or more compartments based on the selected combination type into a combined compartment representing a custom reservoir using a computer processor, wherein union is a combination of the selected compartments, intersect some is a combination of a section of each selected compartment that intersects another selected compartment, and intersect all is a combination of only a section of each selected compartment that intersects each of the other selected compartments; and
returning the combined compartment for display.

62 In construing the claim is seems clear to me that the compartments must relate to real data by virtue of their representing geological structures. Once again the method does not operate on arbitrary data.

63 The examiner says that the contribution is simply a computer program for implementing the mathematical method of generating a model by combining sets of data. I am by no means confident that the method represents a mathematical method as such and, while data is combined using a computer processor, I think a reasonable assessment of the contribution finds there is something more going on. Mr Russell and Dr Jones propose that the contribution is a better computer-implemented process for geological modelling in which compartments representing the geological structure are combined or separated to identify a coherent reservoir system, in turn serving as a basis for highly accurate property and volumetric analysis. I think this goes a little further than the contribution of the invention claimed. To my mind the contribution can be seen as a computer-implemented method for modifying a model of a geological structure by combining previously identified compartments within the modelled structure to form a custom reservoir. I cannot say that this is simply a computer program as such and, when set in its proper context, the contribution strikes me as technical, i.e. it is tied to a very specific technical field of endeavour or task.

vii) GB1600706.4

64 The last application in this group, GB1600706.4, was published as GB2533057 and WO 2015/023960. The application as filed concerned dynamically updating compartments and related to step 244 in figure 2, described in more detail at paragraphs [00139] to [00143] on pages 27 to 29 and figure 24, reproduced at Annex 8.

65 As in previous applications, claim 1 is directed to a method and shares an inventive concept with independent claim 9, which is directed to a program carrier. Unlike the applications discussed earlier, there is also an independent claim to a computer system, claim 17. However, this too shares an inventive concept with claim 1 and I will consider claim 1 only.

66 During prosecution the invention claimed has changed somewhat and there is a question of added subject matter for me to decide, along with excluded subject matter. As filed, claim 1 read as follows:

> 1. A method for dynamically updating compartments representing one or more geological structures, which comprises:
> loading current data;
> extrapolating the current data against a volume of interest to produce one or more bodies;
> extracting at least one of a stratigraphic layer and a fault block from the one or more bodies to produce at least one group of bodies with at least one of the stratigraphic layer and the fault block;
> extracting a fluid reservoir from each group of bodies to produce a group of fluid reservoir bodies;
> converting each body in at least one of the at least one group of bodies to a respective compartment;
> generating one or more combined compartments representing a custom reservoir using each compartment; and
> automatically updating at least one of each compartment and each combined compartment using a computer processor.

67 As currently amended, claim 1 reads as follows:

> 1. A computer-implemented method for identifying, from data relating to one or more geological structures, one or more compartments of the geological structure which is a fluid reservoir, using a three-dimensional model of the one or more geological structures by dynamically updating compartments representing the one or more geological structures which comprises:
> loading current data relating to the one or more geological structures;
> extrapolating the current data against a volume of interest to produce one or more bodies;
> extracting at least one of a stratigraphic layer and a fault block from the one or more bodies to produce at least one group of bodies with at least one of the stratigraphic layer and the fault block;
> extracting a fluid reservoir from each group of bodies to produce a group of fluid reservoir bodies each associated with a common fluid type;
> converting each body in at least one of the at least one group of fluid reservoir bodies to a respective compartment;
> generating one or more combined compartments representing a custom reservoir using each compartment; and
> automatically updating at least one of each compartment and each combined compartment using a computer processor.

68 The examiner objected that there was added matter in identifying one or more compartments that is a fluid reservoir using a three dimensional model of one or more geological structures. In response, in their skeleton arguments, Mr Russell and Dr Jones state that claim 1 as filed specified a 3D modelling process and included the step of “extracting a fluid reservoir from each group of bodies to produce a group of fluid reservoir bodies”. The attorney letter dated 26 October 2016 accompanying the latest amended claims points to paragraphs [0036], [0037], [0049], [0050], [0098] to [00116] and [00121] as providing support for the amendments to claim 1, also explaining that “the final two integers of method claim 1 previously presented are reserved to a new dependent claim 2, since these steps are not specifically necessary (however advantageous) for identifying a compartment of the geological structure which is a fluid reservoir”.

69 I have some difficulty with the claim as currently amended. It is directed to a method for identifying compartments by dynamically updating compartments. I am not clear whether the compartments which are identified are the same as the compartments which are updated, but in any event the method of claim 1 ends by converting bodies to compartments, but before any compartments are updated. So on the face of it the claim is incomplete, and I shall need to refer this application back to the examiner to consider further the amended claims both with regard to their acceptability and their impact upon the searching that has been performed.

70 On the question of whether the reference to a three-dimensional model is added subject matter I am less concerned, and I said as much at the hearing. From the disclosure as a whole I am content that the current data and the bodies subsequently produced from that data and then further manipulated could reasonably be described as a three-dimensional model.

71 In their skeleton arguments, Mr Russell and Dr Jones, provided an auxiliary claim which would largely revert to the claim as filed, albeit directed to a method of generating a three-dimensional model by dynamically updating compartments rather than simply dynamically updating compartments. I would have no concerns with the form and scope of such a claim.

72 I am also called upon to consider whether the invention in this application is excluded as a computer program as such. In view of the issues with the claim as amended I do not feel that I can properly construe that claim at the first step in the *Aerotel* test. Consequently I must have some difficulty with the remaining steps. Since I am referring the application back for further examination there is also the possibility that the claim will be amended which might render my efforts with the *Aerotel* test null and void. I will not therefore decide the question of excluded matter in the claims as currently amended.

73 Regarding the auxiliary claim I note that many of my comments regarding the previous applications could well apply here. As far as construing the auxiliary claim goes, the method claimed operates on real data relating to a geological structure. According to Mr Russell and Dr Jones the contribution for the inventions of both the claim as currently amended and the auxiliary claim is a better computer-implemented process for identifying and analysing a reservoir in a geological structure in the sense of being more accurate and reliable. I think that I would go further regarding the auxiliary claim and say that the contribution is a computer-implemented method of generating and updating a model of a geological structure, which model comprises a number of custom reservoirs. I note that activities such as generating models of geological structures and updating compartments representing such structures might well be described as technical activities which “may be used e.g. in investigating properties of the object” as in *Vicom*.

Conclusion

74 I find that the inventions in these seven applications apart from GB1600706.4 are not excluded by section 1(2) either as a program for a computer as such or a mathematical method as such. In view of issues with the invention as presently claimed, I reach no conclusion on whether the invention in GB1600706.4 is excluded.

I find that the invention set out in the auxiliary claim of GB1600706.4 is not excluded by section 1(2)(c) as a computer program as such.

75 I refer all of the applications back to the examiner for a number of reasons. I believe that the searches in some or all of the applications need to be updated, the omnibus claims found in some of the applications will need to be deleted in line with current practice, there is a matter of consistency between the claims and the description in 1600702.3 and finally further consideration of the amended and auxiliary claims in GB1600706.4 is required.

H JONES
Deputy Director, acting for the Comptroller

Annex 1 - flow diagram and description illustrating an embodiment of the invention

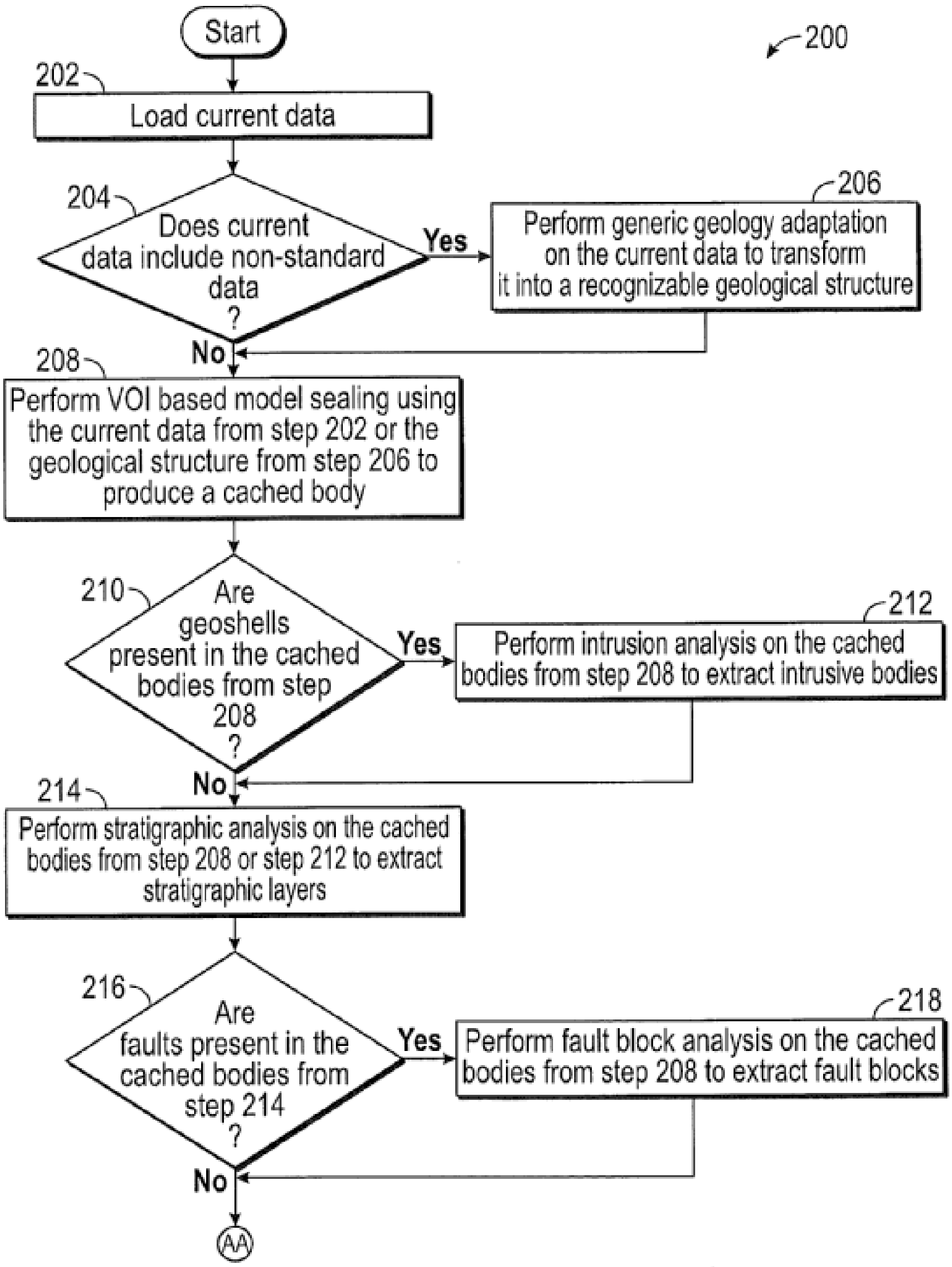

FIG. 2A

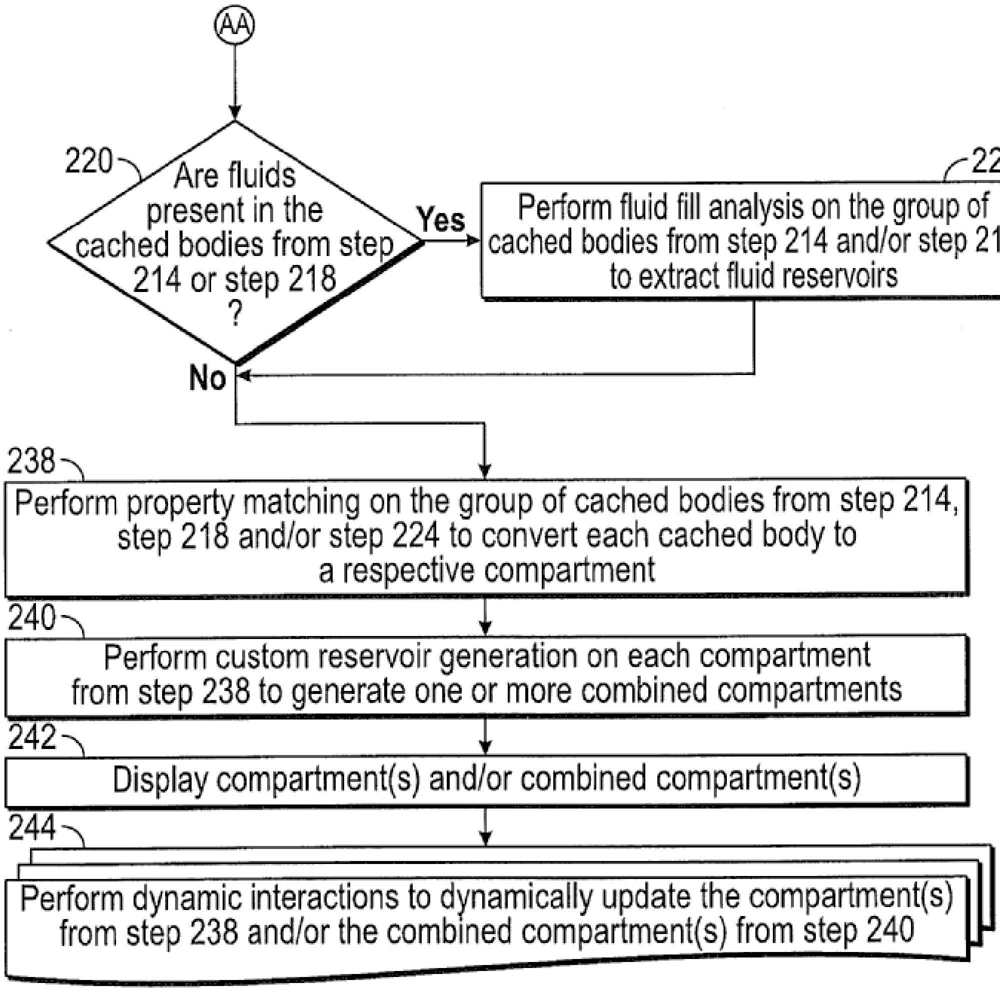

FIG. 2B

[0038] Referring now to FIGS. 2A-2B, a flow diagram of one embodiment of a method 200 for implementing the present disclosure is illustrated.

[0039] In step 202, current data comprising a plurality of source data points in a common coordinate system with predefined units is loaded into a conventional 3D modeling engine, operating in a system with predefined units, from a database.

[0040] In step 204, the method 200 determines if the current data loaded in step 202 includes non-standard data. If the current data does not include non-standard data, then the method 200 proceeds to step 208. Otherwise, the method 200 proceeds to step 206.

[0041] In step 206, generic geology adaptation is performed on the current data from step 202 to transform it into a recognizable geological structure such as, for example, a gridded surface. One embodiment of a method for performing this step is described further in reference to FIG. 3.

[0042] In step 208, Volume of Interest (VOI) based model sealing is performed using the current data from step 202 or the geological structure from step 206 to extrapolate the current data or the geological structure against the VOI to produce a cached body. In this manner arbitrary extents may be used within the model. Each cached body includes a top patch, a side patch and bottom patch, (each of which may be associated with a surface, a fault or a fluid contact), a center of mass and a volume. One embodiment of a method for performing this step is described further in reference to FIGS. 4A-4B.

[0043] In step 210, the method 200 determines if geoshells are present in the cached bodies from step 208. If geoshells are not present, then the method 200 proceeds to step 214. Otherwise, the method 200 proceeds to step 212.

[0044] In step 212, an intrusion analysis is performed on the cached bodies from step 208 to isolate and extract any intrusive bodies. One embodiment of a method for performing this step is described further in reference to FIG. 7.

[0045] In step 214, a stratigraphic analysis is performed on the cached bodies from step 208 or step 212 to extract stratigraphic layers from the cached bodies. One embodiment of a method for performing this step is described further in reference to FIGS. 10A-10B.

[0046] In step 216, the method 200 determines if faults are present in the cached bodies from step 214. If faults are not present, then the method 200 proceeds to step 220. Otherwise, the method 200 proceeds to step 218.

[0047] In step 218, a fault block analysis is performed on the cached bodies from step 208 to extract fault blocks from the cached bodies. One embodiment of a method for performing this step is described further in reference to FIGS. 13A-13B.

[0048] In step 220, the method 200 determines if fluids are present in the cached bodies from step 214 or step 218. If fluids are not present, then the method 200 proceeds to step 238. Otherwise, the method 200 proceeds to step 224.

[0049] In step 224, a fluid fill analysis is performed on the group of cached bodies from step 214 and/or step 218 using advanced fluid fill analysis algorithms to extract fluid reservoirs from the geological structure represented by the group of cached bodies. One embodiment of a method for performing this step is described further in reference to FIGS. 20A-20D.

[0050] In step 238, property matching is performed on the group of cached bodies from step 214, step 218 and/or step 224 to convert each cached body to a respective compartment represented by a triangulated mesh of the bounding cached body with properties such as color and lithology. One embodiment of a method for performing this step is described further in reference to FIGS. 21A-21C.

[0051] In step 240, custom reservoir generation is performed on each compartment from step 238 to generate one or more combined compartments. This allows intersection and union algorithms to sit on top of other compartments, which allows combined compartments to be generated automatically. One embodiment of a method for performing this step is described further in reference to FIGS. 23A-23B.

[0052] In step 242, the compartments from step 238 and/or the combined compartments from step 240 may be displayed. In FIGS. 6, 9, 12 and 15, various exemplary displays illustrate the different compartments that may be displayed. In FIG. 6, the display 600 illustrates an exemplary three-dimensional geoshell volume compartment. In FIG. 9, the display 900 illustrates an exemplary three-dimensional stratigraphic layer compartment, In FIG. 12, the display 1200 illustrates an exemplary three-dimensional fault block compartment. In FIG. 15, the display 1500 illustrates an exemplary three-dimensional fluid layer compartment.

[0053] In step 244, one or more dynamic interactions are performed on the current data loaded in step 202, the predefined polygon AOI and the predefined minimum/maximum depths from the VOI based model sealing performed in step 208 and/or the fluid contact flag and the sealing state from the fluid fill analysis performed in step 224 to dynamically update the compartments from step 238 and/or the combined compartments from step 240. One embodiment of a method for performing this step is described further in reference to FIG. 24.

Annex 2 - Detail of the Generic Geology Adaptation of step 206 and GB1600696.7

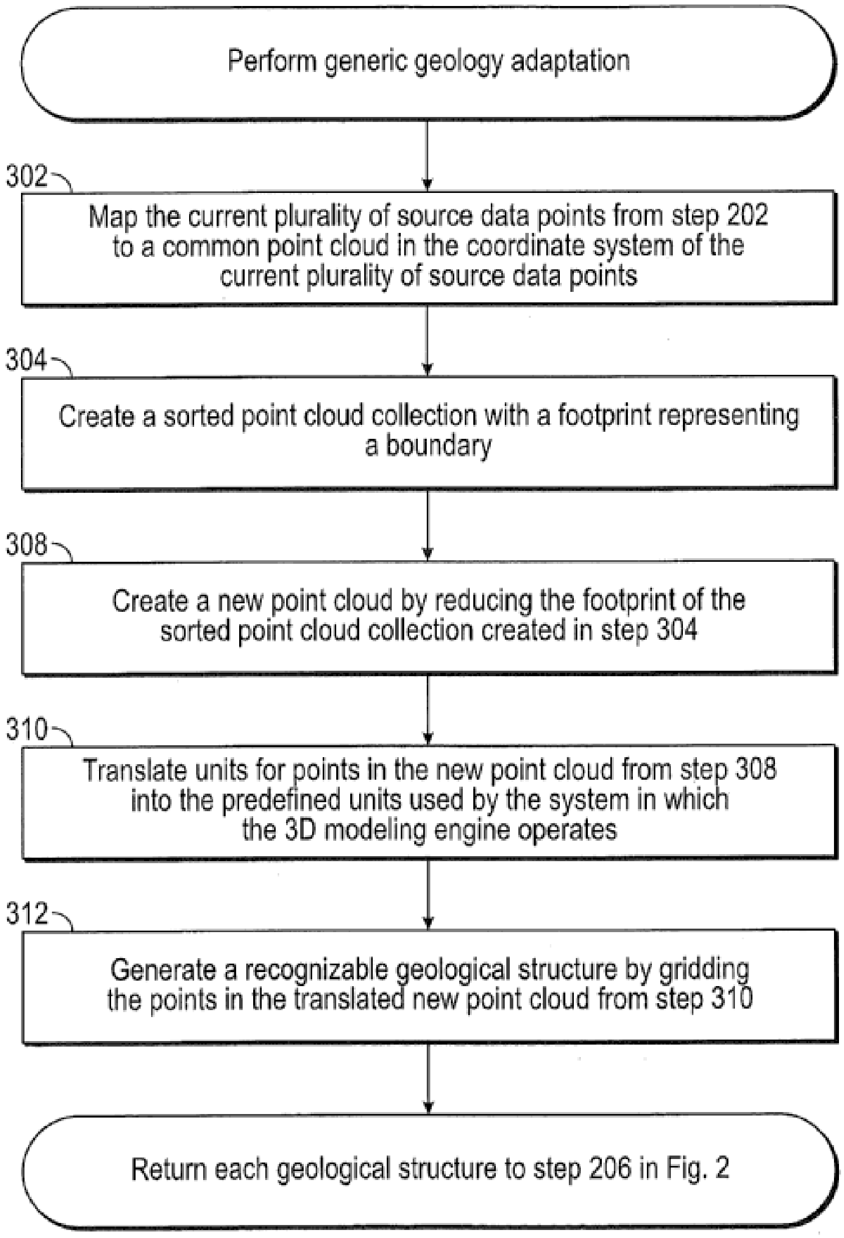

FIG. 3

[0054] Referring now to FIG. 3, a flow diagram of one embodiment of a method 300 for implementing step 206 in FIG. 2 is illustrated. The method 300 performs a generic geology adaptation on the current data from step 202 to transform it into a recognizable geological structure such as, for example, a gridded surface. When combined with the fluid fill analysis from step 224, gas and oil filled reservoirs may be interpreted with a higher degree of accuracy. When combined with the fluid fill analysis from step 224 and the custom reservoir generation from step 240, the differences between measurement techniques, min and max cases, or fluid level variation through time may be evaluated. Typically, fluid contacts can only be represented as a flat plane or a predefined grid. The method 300, however, allows any current data source such as, for example, hand digitized polylines to be transformed into fluid contacts in the 3D modeling engine as one example of a recognizable geological structure.

[0055] In step 302, the current plurality of source data points loaded in step 202 is mapped to a common point cloud in the coordinate system of the current plurality of source data points using the 3D modeling engine and techniques well known in the art. In this manner, a common point collection is mapped to a common point cloud.

[0056] In step 304, a sorted point cloud collection with a footprint representing a boundary is created by sorting points in the common point cloud from step 302 according to a distance of each of the current plurality of source data points from an origin, first by a length of a z-vector in the z-axis and then by a length of an x-y vector across the x and y axes, using techniques well known in the art.

[0057] In step 308, a new point cloud is created by reducing the footprint of the sorted point cloud collection created in step 304 using the 3D modeling engine and techniques well known in the art.

[0058] In step 310, units for points in the new point cloud from step 308 are translated into the predefined units used by the system in which the 3D modeling engine operates using techniques well known in the art.

[0059] In step 312, a recognizable geological structure is generated such as, for example, a gridded surface by gridding the points in the translated new point cloud from step 310 using the 3D modeling engine and techniques well known in the art. Each geological structure is returned to step 206 in FIG. 2.

Annex 3 - Detail of the stratigraphic analysis of step 214 and GB1600694.2

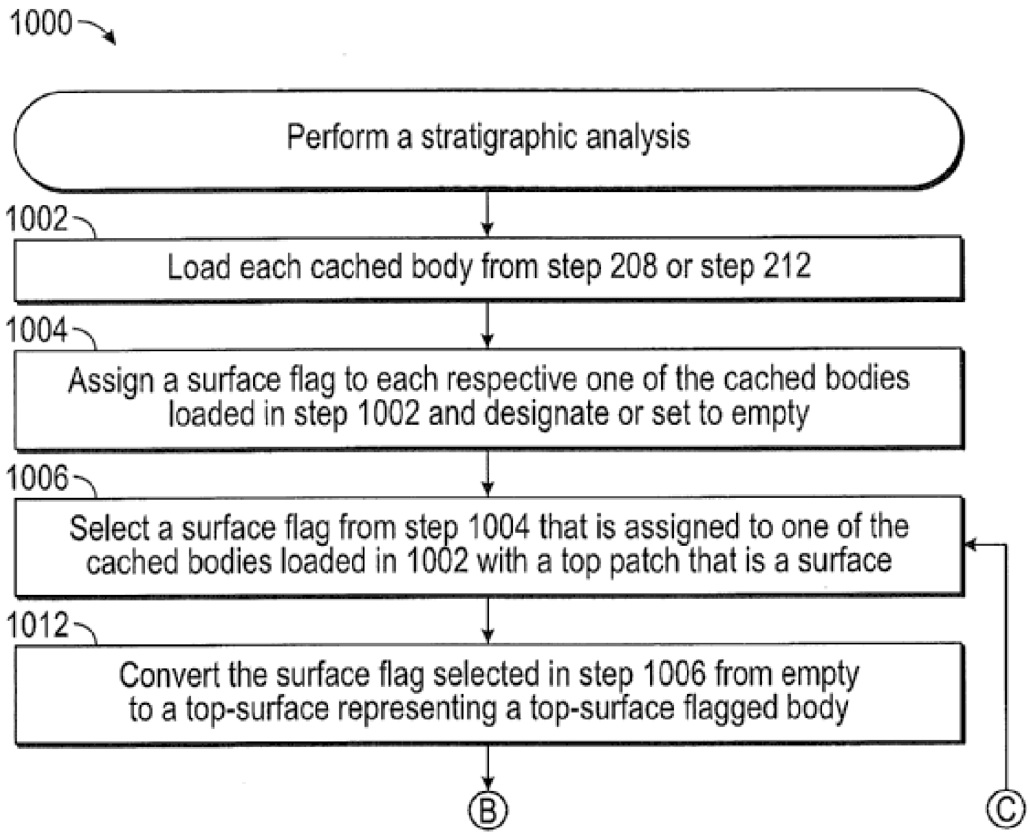

FIG. 10A

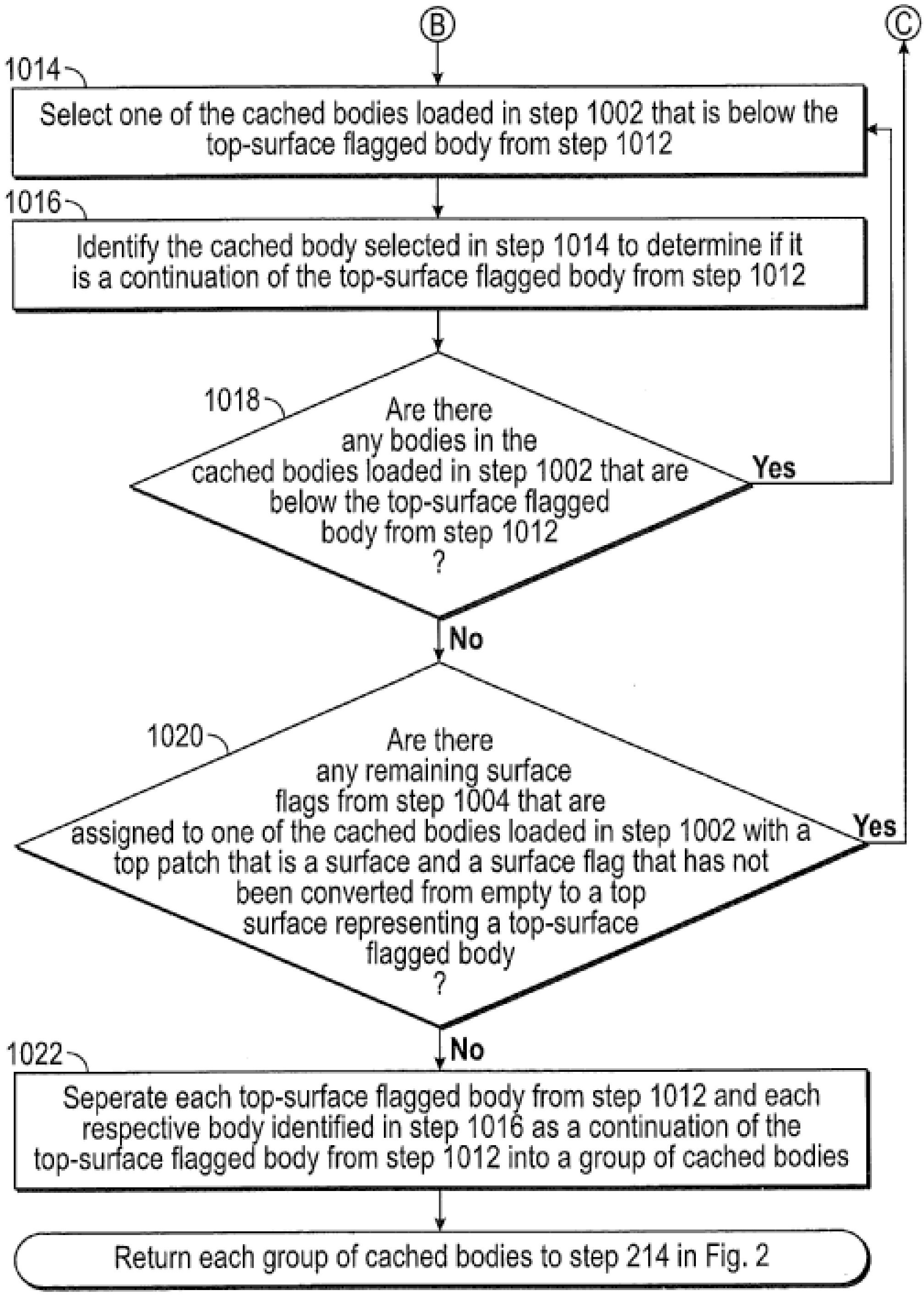

FIG. 10B

[0078] Referring now to FIGS. 10A-10B, a flow diagram of one embodiment of a method 1000 for implementing step 214 in FIG. 2 is illustrated. The method 1000 performs a stratigraphic analysis on the cached bodies from step 208 or step 212 to extract stratigraphic layers from the cached bodies. In case of surfaces with different areal extents, the compartment boundaries are extrapolated to the extents of the largest surface. A stratigraphic layer is always created above the topmost surface and below the bottommost surface, which represent arbitrary extensions into unknown rock layers. Stratigraphic layers automatically adjust to changes of the surface sources (e.g. horizons, picks) and changes to the framework model (e.g. surface AOI, algorithms etc.). In conventional applications, all stratigraphic layers are seamed of several bodies sorted by all bounding structure names and are auto-grouped in a system that creates challenges to recognition. The method 1000, however, automatically extracts stratigraphic layers and groups them without seams or intrusions for simple identification.

[0079] In step 1002, each cached body from step 208 or step 212 is loaded. Thus, each cached body includes a top patch, a center of mass and a volume.

[0080] In step 1004, a surface flag is assigned to each respective one of the cached bodies loaded in step 1002. Each surface flag is designated or set to empty. [0081] In step 1006, a surface flag is selected from step 1004 that is assigned to one of the cached bodies loaded in 1002 with a top patch that is a surface.

[0082] In step 1012, the surface flag selected in step 1006 is converted from empty to a top-surface representing a top-surface flagged body.

[0083] In step 1014, one of the cached bodies loaded in step 1002 that is below the top- surface flagged body from step 1012 is selected.

[0084] In step 1016, the cached body selected in step 1014 is identified to determine if it is a continuation of the top-surface flagged body from step 1012.

[0085] In step 1018, the method 1000 determines if there are any bodies in the cached bodies loaded in step 1002 that are below the top-surface flagged body from step 1012, If there are bodies in the cached bodies loaded in step 1002 that are below the top-surface flagged body from step 1012, then the method 1000 returns to step 1014. Otherwise, the method 1000 proceeds to step 1020.

[0086] In step 1020, the method 1000 determines if there are any remaining surface flags from step 1004 that are assigned to one of the cached bodies loaded in step 1002 with a top patch that is a surface and a surface flag that has not been converted from empty to a top surface representing a top-surface flagged body. If there are any surface flags from step 1004 that are assigned to one of the cached bodies loaded in step 1002 with a top patch that is a surface and a surface flag that has not been converted from empty to a top surface representing a top-surface flagged body, then the method 1000 returns to step 1006. Otherwise, the method 1000 proceeds to step 1022.

[0087] In step 1022, each top-surface flagged body from step 1012 and each respective body identified in step 1016 as a continuation of the top-surface flagged body from step 1012 are separated into a group of cached bodies. The group of cached bodies is returned to step 214 in FIG. 2. In FIG. 8, a schematic diagram 800 illustrates a group of cached bodies for a stratigraphic layer 802 in relation to the geoshell body 502 in FIG. 5.

Annex 4 - Detail of the fault block analysis of step 218 and GB1600702.3

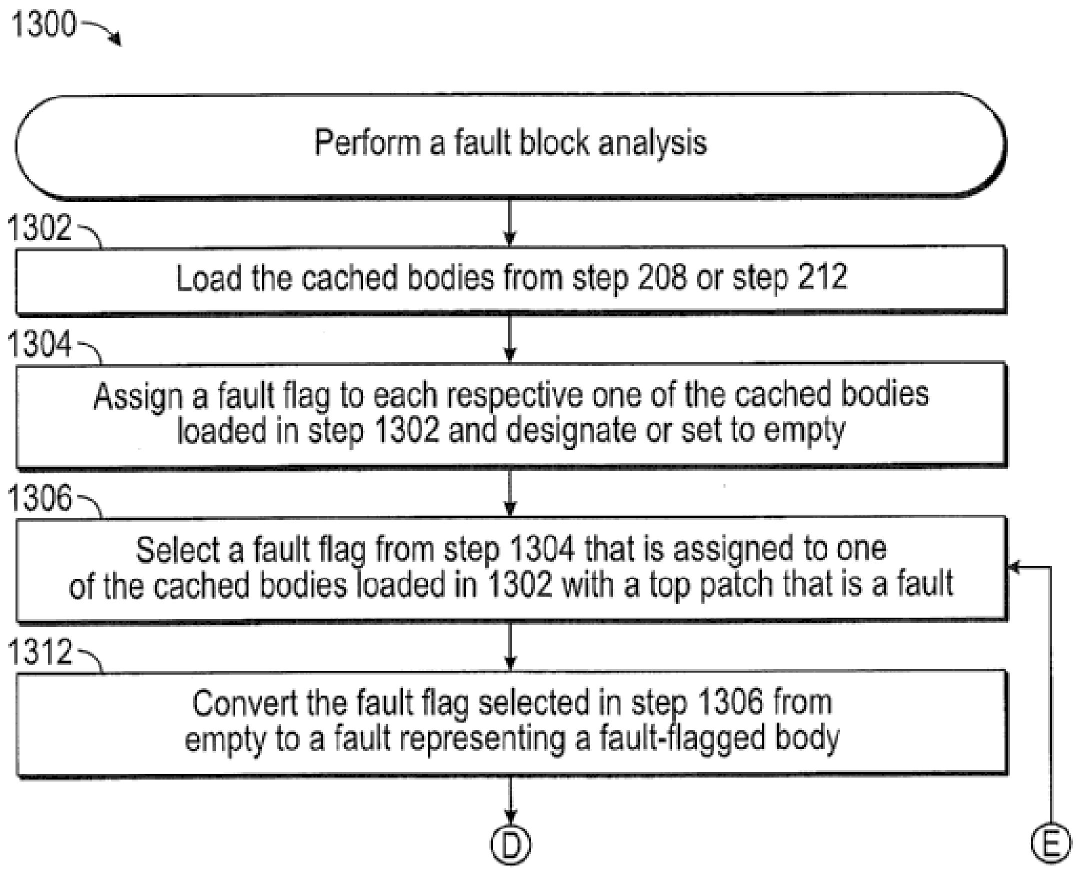

FIG. 13A

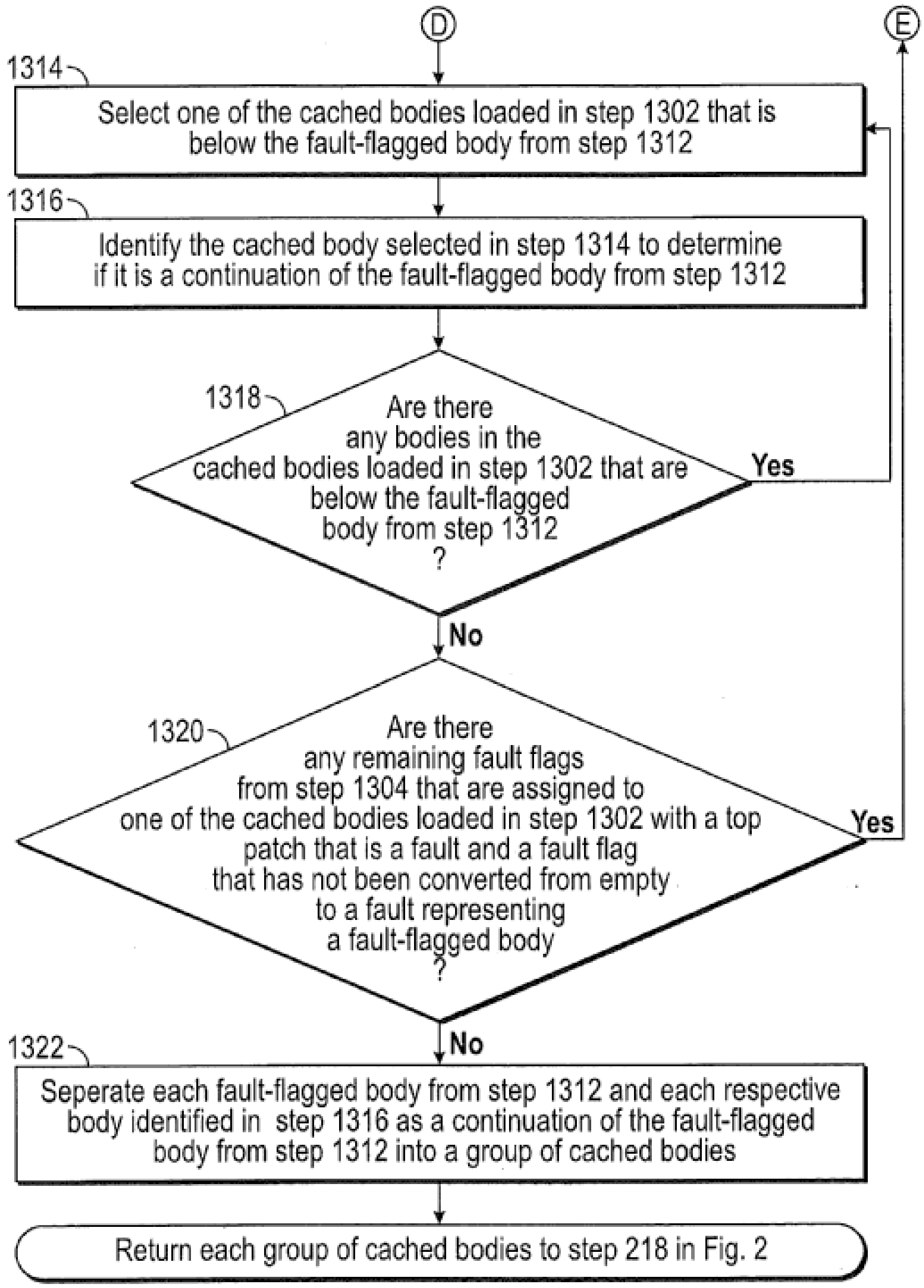

FIG. 13B

[0088] Referring now to FIGS. 13A-13B, a flow diagram of one embodiment of a method 1300 for implementing step 218 in FIG. 2 is illustrated. The method 1300 performs a fault block analysis on the cached bodies from step 208 or step 212 to extract fault blocks from the cached bodies. In many models, surfaces may be much larger than faults. Faults can be extrapolated using fault networking and a smaller compartment attribute-of-interest polygon can be specified to ensure faults can seal enough of the solid model to properly detect fault blocks. Fault blocks automatically adjust to changes of the fault sources (e.g. seismic faults, fault picks) and changes to the framework model (e.g. fault networking, fault sealing). In conventional applications, fault blocks cannot be generated due to the limitations resolved by volume-of- interest model sealing. The method 1300, however, enables fault blocks to be automatically extracted and grouped without seams.The faults may be structurally sealing and completely isolate a 3D space within two surfaces in order to be extracted. The resulting collection of individual compartments becomes a fault block. Geoshell volumes are removed against the fault blocks for the purpose of volumetric calculations.

[0089] In step 1302, the cached bodies from step 208 or step 212 are loaded. Thus, each cached body includes a side patch, a center of mass and a volume.

[0090] In step 1304, a fault flag is assigned to each respective one of the cached bodies loaded in step 1302. Each fault flag is designated or set to empty.

[0091] In step 1306, a fault flag is selected from step 1304 that is assigned to one of the cached bodies loaded in 1302 with a top patch that is a fault.

[0092] In step 1312, the fault flag selected in step 1306 is converted from empty to a fault representing a fault-flagged body.

[0093] In step 1314, one of the cached bodies loaded in step 1302 that is below the fault- flagged body from step 1312 is selected.

[0094] In step 1316, the cached body selected in step 1314 is identified to determine if it is a continuation of the fault-flagged body from step 1312.

[0095] In step 1318, the method 1300 determines if there are any bodies in the cached bodies loaded in step 1302 that are below the fault-flagged body from step 1312. If there are bodies in the cached bodies loaded in step 1302 that are below the fault- flagged body from step 1312, then the method 1300 returns to step 1314. Otherwise, the method 1300 proceeds to step 1320.

[0096] In step 1320, the method 1300 determines if there are any remaining fault flags from step 1304 that are assigned to one of the cached bodies loaded in step 1302 with a top patch that is a fault and a fault flag that has not been converted from empty to a fault representing a fault-flagged body. If there are any fault flags from step 1304 that are assigned to one of the cached bodies loaded in step 1302 with a top patch that is a fault and a fault flag that has not been converted from empty to a fault representing a fault-flagged body, then the method 1300 returns to step 1306. Otherwise, the method 1300 proceeds to step 1322.

[0097] In step 1322, each fault-flagged body from step 1312 and each respective body identified in step 1316 as a continuation of the fault-flagged body from step 1312 are separated into a group of cached bodies. The group of cached bodies is returned to step 218 in FIG. 2. In FIG. 11, a schematic diagram 1100 illustrates three groups of cached bodies for three respective fault blocks 1104, 1106, and 1008 in relation to the geoshell body 502 in FIG. 5.

Annex 5 - Detail of the fluid fill analysis of step 224 and GB1600704.9

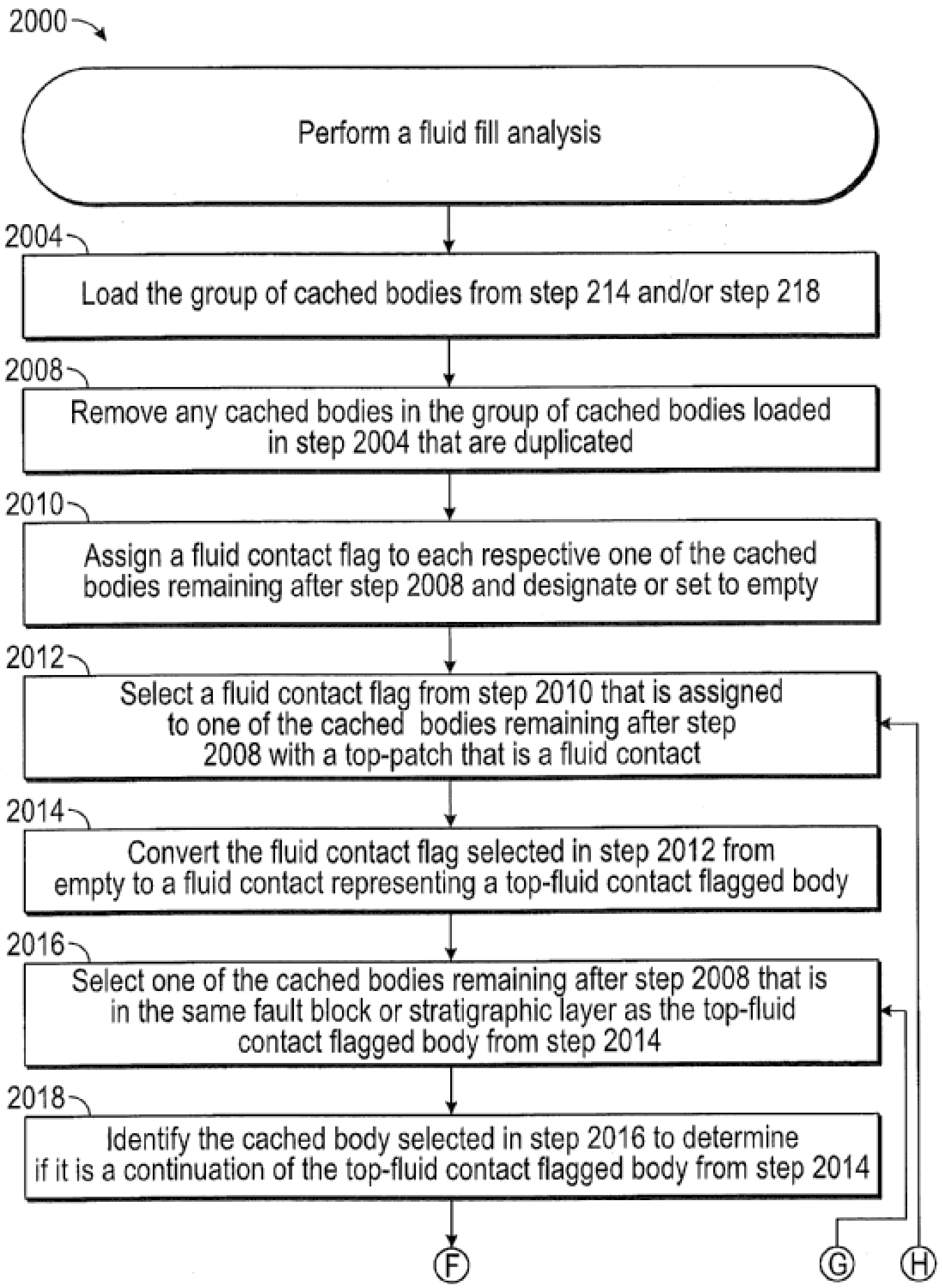

FIG. 20A

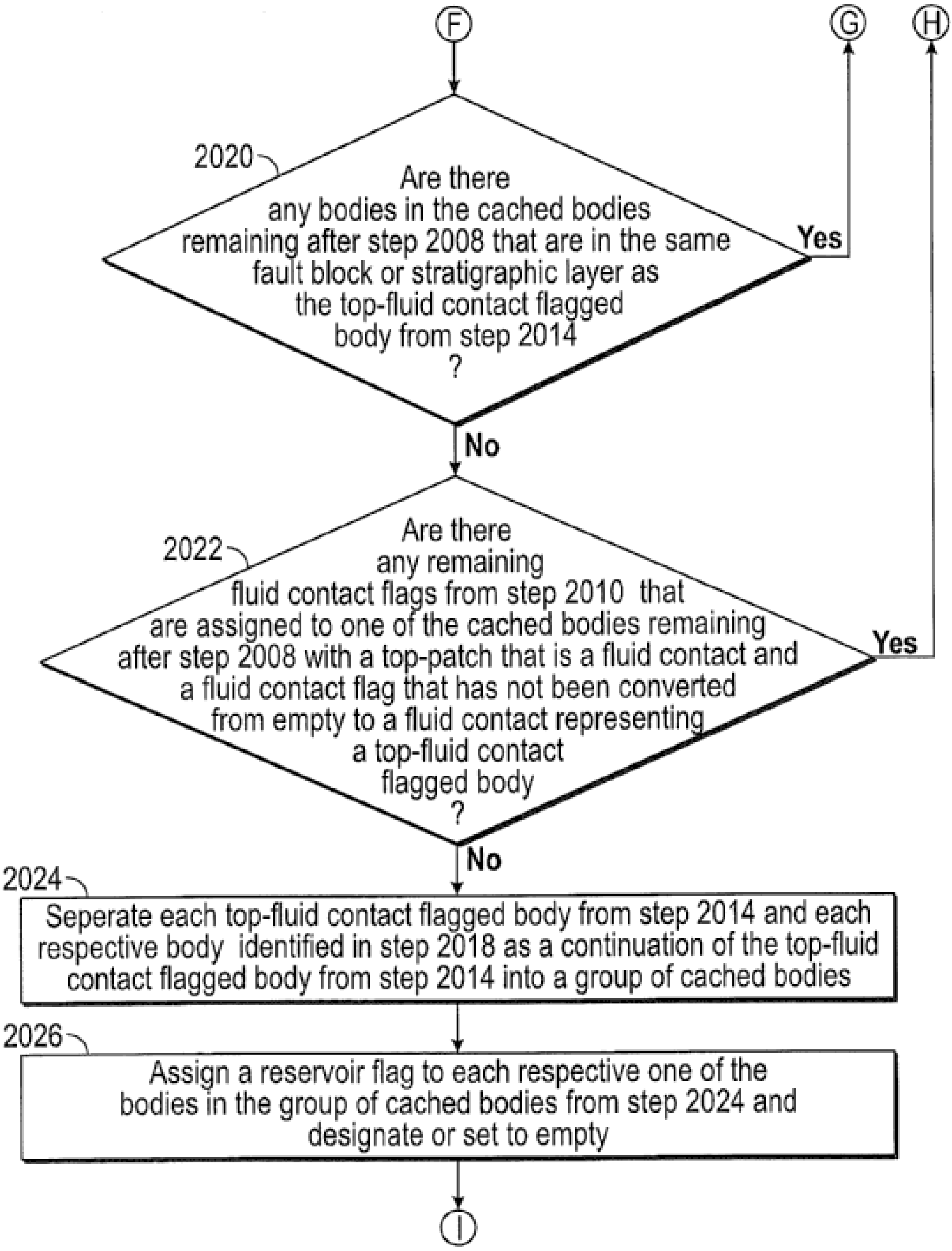
F
G
H
2020
Are there any bodies in the cached bodies remaining after step 2008 that are in the same fault block or stratigraphic layer as the top-fluid contact flagged body from step 2014 ?
Yes
No
2022
Are there any remaining fluid contact flags from step 2010 that are assigned to one of the cached bodies remaining after step 2008 with a top-patch that is a fluid contact and a fluid contact flag that has not been converted from empty to a fluid contact representing a top-fluid contact flagged body ?
Yes
No
2024
Seperate each top-fluid contact flagged body from step 2014 and each respective body identified in step 2018 as a continuation of the top-fluid contact flagged body from step 2014 into a group of cached bodies
2026
Assign a reservoir flag to each respective one of the bodies in the group of cached bodies from step 2024 and designate or set to empty
I

FIG. 20B

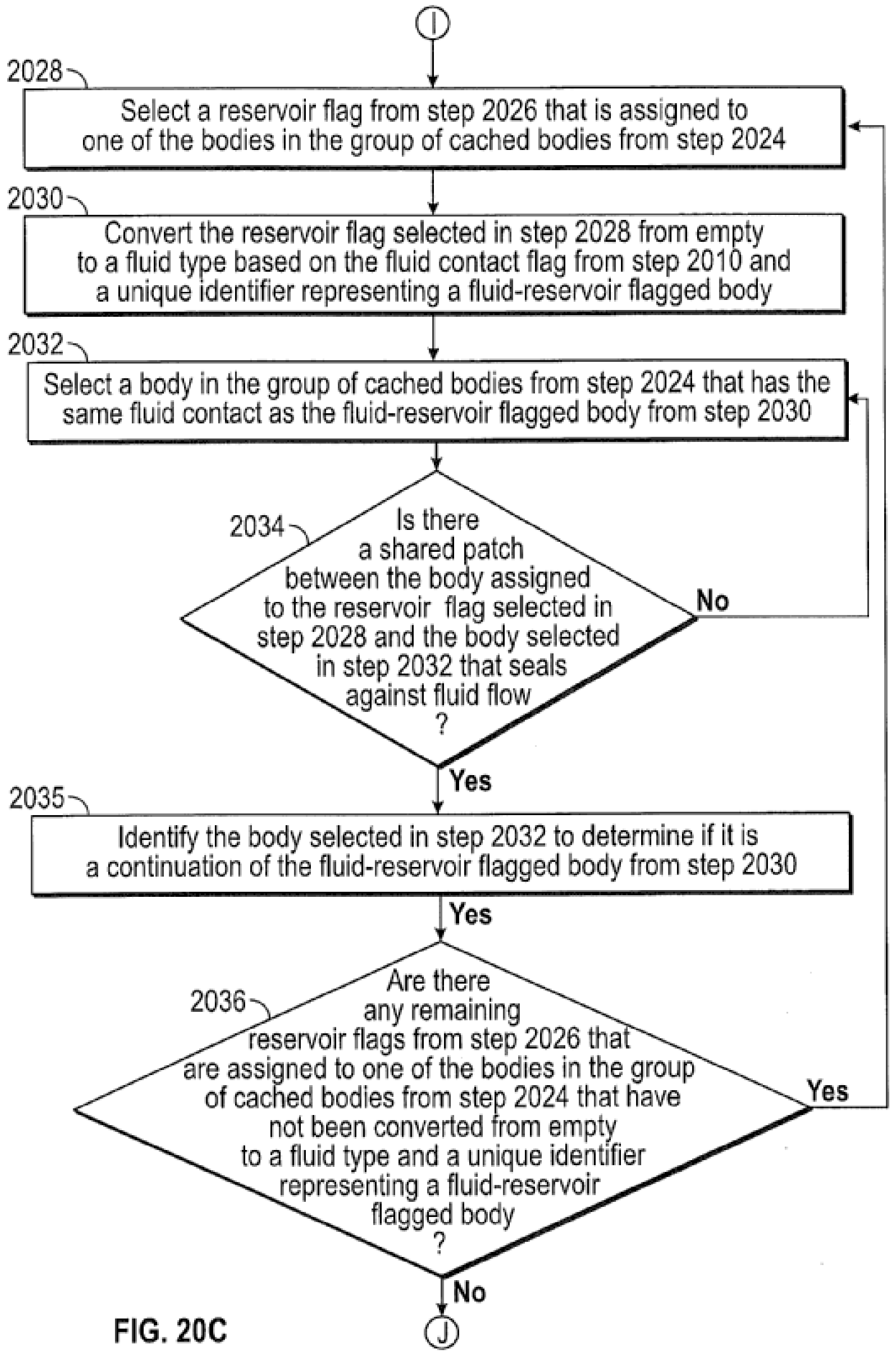
I
2028
Select a reservoir flag from step 2026 that is assigned to one of the bodies in the group of cached bodies from step 2024
2030
Convert the reservoir flag selected in step 2028 from empty to a fluid type based on the fluid contact flag from step 2010 and a unique identifier representing a fluid-reservoir flagged body
2032
Select a body in the group of cached bodies from step 2024 that has the same fluid contact as the fluid-reservoir flagged body from step 2030
2034
Is there a shared patch between the body assigned to the reservoir flag selected in step 2028 and the body selected in step 2032 that seals against fluid flow ?
No
Yes
2035
Identify the body selected in step 2032 to determine if it is a continuation of the fluid-reservoir flagged body from step 2030
Yes
2036
Are there any remaining reservoir flags from step 2026 that are assigned to one of the bodies in the group of cached bodies from step 2024 that have not been converted from empty to a fluid type and a unique identifier representing a fluid-reservoir flagged body ?
Yes
No
J

FIG. 20C

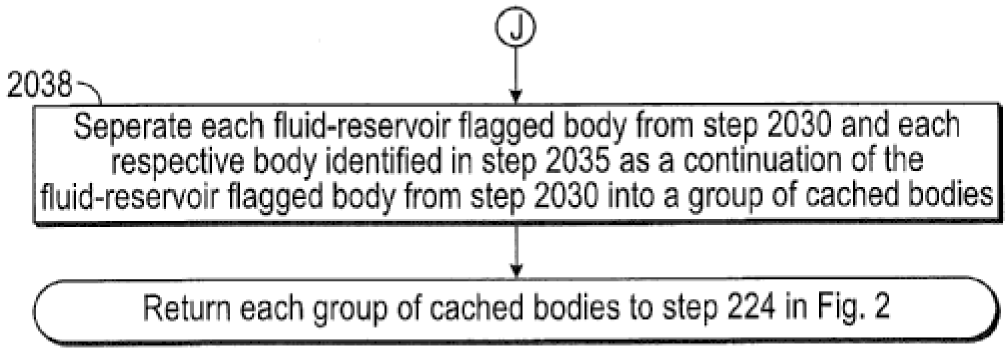

FIG. 20D

[0098] Referring now to FIGS. 20A-20D, a flow diagram of one embodiment of a method 2000 for implementing step 224 in FIG. 2 is illustrated. The method 2000 performs a fluid fill analysis on the group of cached bodies from step 214 and/or step 218 using advanced fluid fill analysis algorithms to extract fluid reservoirs from the geological structure represented by the cached bodies. Fluid Layers are created between fluid contacts and other fluid contacts or framework surfaces. Fluid layers are a particular compartment type defined by a fluid property such as oil, gas, water or a generic fluid. They may also be subdivided by sealing faults. In conventional applications, fluid compartments are manually grouped by individually turning them on in a view and then dragging and dropping them into a new grouping. This creates a slow, frustrating, seamed grouping with no fluid properties. The method 2000, however, enables fluid layers to be automatically detected, filled, and grouped by fluid type.

[0099] In step 2004, the group of cached bodies from step 214 and/or step 218 is loaded. Thus, each cached body in either group includes a top patch, a center of mass and a volume.

[00100] In step 2008, any cached bodies in the group of cached bodies loaded in step 2004 that are duplicated are removed.

[00101] In step 2010, a fluid contact flag is assigned to each respective one of the cached bodies remaining after step 2008. Each fluid contact flag is designated or set to empty.

[00102] In step 2012, a fluid contact flag is selected from step 2010 that is assigned to one of the cached bodies remaining after step 2008 with a top-patch that is a fluid contact.

[00103] In step 2014, the fluid contact flag selected in step 2012 is converted from empty to a fluid contact representing a top-fluid contact flagged body.

[00104] In step 2016, one of the cached bodies remaining after step 2008 that is in the same fault block or stratigraphic layer as the top-fluid contact flagged body from step 2014 is selected.

[00105] In step 2018, the cached body selected in step 2016 is identified to

determine if it is a continuation of the top-fluid contact flagged body from step 2014.

[00106] In step 2020, the method 2000 determines if there are any bodies in the cached bodies remaining after step 2008 that are in the same fault block or stratigraphic layer as the top- fluid contact flagged body from step 2014. If there are bodies in the cached bodies remaining after step 2008 that are in the same fault block or stratigraphic layer as the top-fluid contact flagged body from step 2014, then the method 2000 returns to step 2016, Otherwise, the method 2000 proceeds to step 2022.

[00107] In step 2022, the method 2000 determines if there are any remaining fluid contact flags from step 2010 that are assigned to one of the cached bodies remaining after step 2008 with a top-patch that is a fluid contact and a fluid contact flag that has not been converted from empty to a fluid contact representing a top-fluid contact flagged body. If there are any fluid contact flags from step 2010 that are assigned to one of the cached bodies remaining after step 2008 with a top-patch that is a fluid contact and a fluid contact flag that has not been converted from empty to a fluid contact representing a top-fluid contact flagged body, then the method 2000 returns to step 2012. Otherwise, the method 2000 proceeds to step 2024.

[00108] In step 2024, each top-fluid contact flagged body from step 2014 and each respective body identified in step 2018 as a continuation of the top-fluid contact flagged body from step 2014 are separated into a group of cached bodies. In FIG. 14, a schematic diagram 1400 illustrates two groups of cached bodies for respective fluid layers 1404 and 1406 in relation to the geoshell body 502 in FIG. 5.

[00109] In step 2026, a reservoir flag is assigned to each respective one of the bodies in the group of cached bodies from step 2024. Each reservoir flag is designated or set to empty.

[00110] In step 2028, a reservoir flag is selected from step 2026 that is assigned to one of the bodies in the group of cached bodies from step 2024.

[00111] In step 2030, the reservoir flag selected in step 2028 is converted from empty to a fluid type based on the fluid contact flag from step 2010 and a unique identifier (e.g. oil 17) representing a fluid-reservoir flagged body.

[00112] In step 2032, a body in the group of cached bodies from step 2024 that has the same fluid contact as the fluid-reservoir flagged body from step 2030 is selected.

[00113] In step 2034, the method 2000 determines if there is a shared patch between the body assigned to the reservoir flag selected in step 2028 and the body selected in step 2032 that seals against fluid flow using the client interface and/or the video interface described in reference to FIG. 25. If there is not a shared patch between the body assigned to the reservoir flag selected in step 2028 and the body selected in step 2032 that seals against fluid flow, then the method 2000 returns to step 2032. Otherwise, the method 2000 proceeds to step 2035.

[00114] In step 2035, the body selected in step 2032 is identified to determine if it is a continuation of the fluid-reservoir flagged body from step 2030.

[00115] In step 2036, the method 2000 determines if there are any remaining reservoir flags from step 2026 that are assigned to one of the bodies in the group of cached bodies from step 2024 that have not been converted from empty to a fluid type and a unique identifier representing a fluid-reservoir flagged body. If there are any reservoir flags from step 2026 that are assigned to one of the bodies in the group of cached bodies from step 2024 that have not been converted from empty to a fluid type and a unique identifier representing a fluid-reservoir flagged body, then the method 2000 returns to step 2028. Otherwise, the method proceeds to step 2038.

[00116] In step 2038, each fluid-reservoir flagged body from step 2030 and each respective body identified in step 2035 as a continuation of the fluid-reservoir flagged body from step 2030 are separated into a group of cached bodies. The group of cached bodies is returned to step 224 in FIG. 2. In FIGS. 16-19, various exemplary displays 1600, 1700, 1800 and 1900 illustrate multiple groups of cached bodies for respective fluid reservoirs with different sealing states.

Annex 6 - Detail of the property matching of step 238 and GB1600703.1

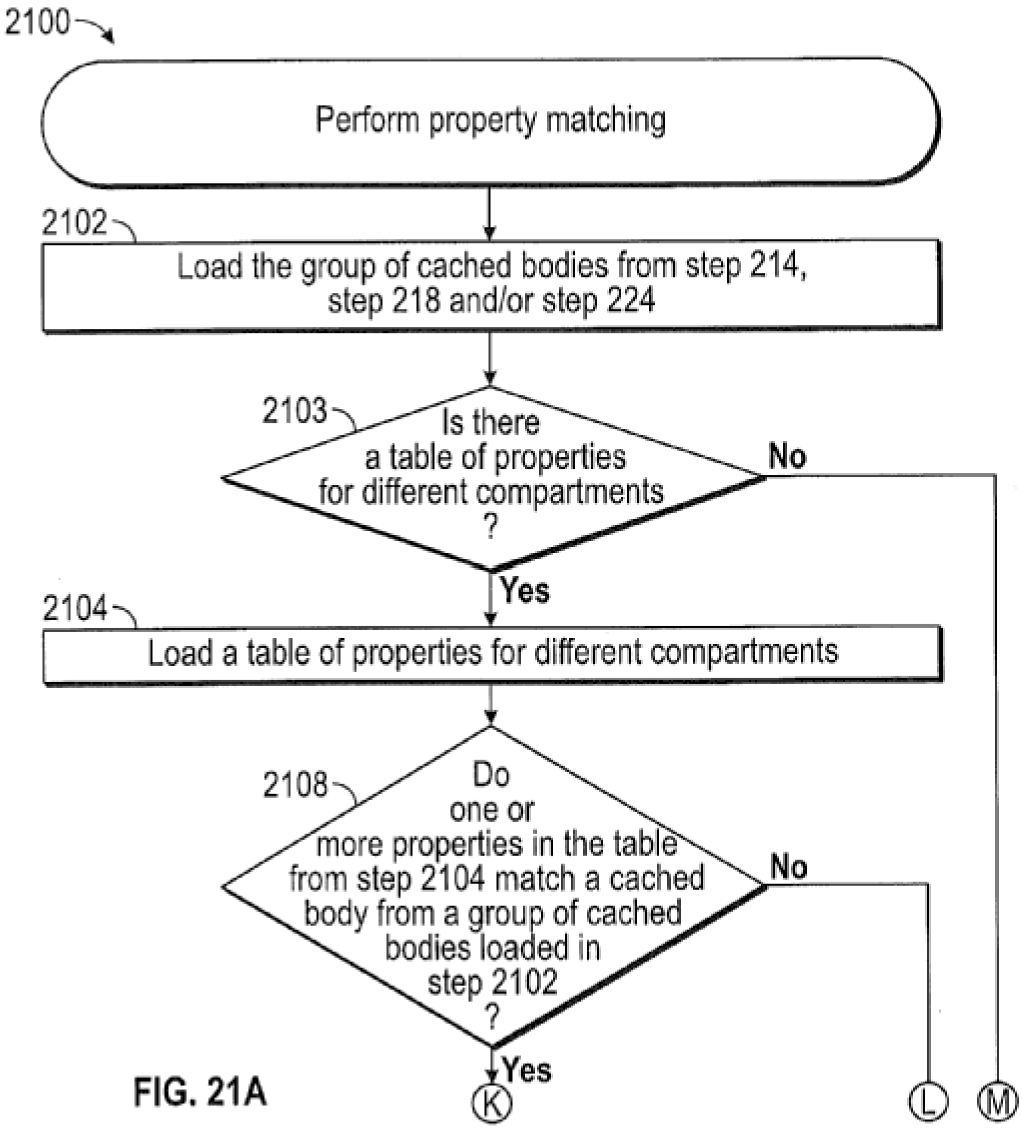

FIG. 21A

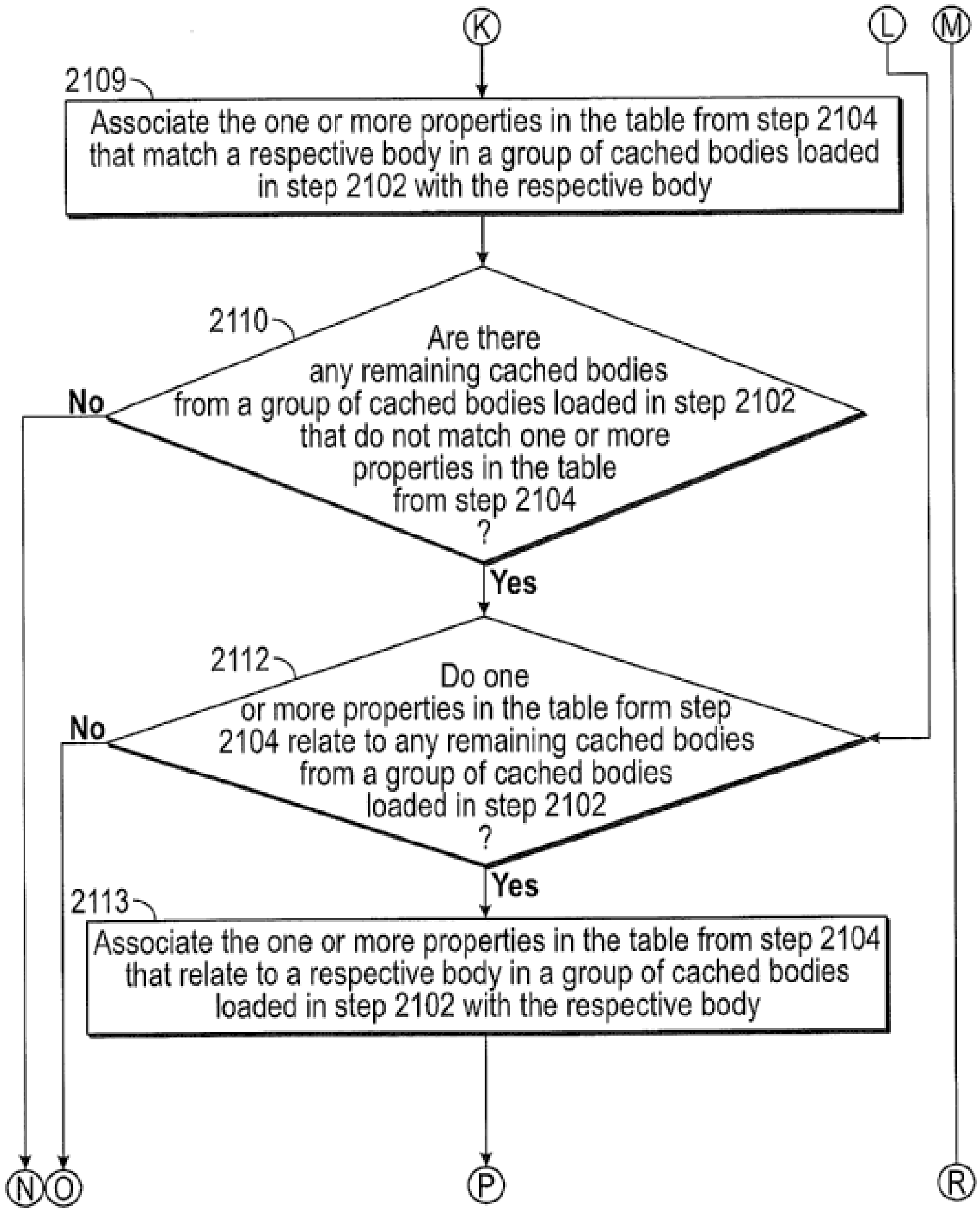
K
L
M
2109
Associate the one or more properties in the table from step 2104 that match a respective body in a group of cached bodies loaded in step 2102 with the respective body
2110
Are there any remaining cached bodies from a group of cached bodies loaded in step 2102 that do not match one or more properties in the table from step 2104 ?
No
Yes
2112
Do one or more properties in the table form step 2104 relate to any remaining cached bodies from a group of cached bodies loaded in step 2102 ?
No
Yes
2113
Associate the one or more properties in the table from step 2104 that relate to a respective body in a group of cached bodies loaded in step 2102 with the respective body
N
O
P
R

FIG. 21B

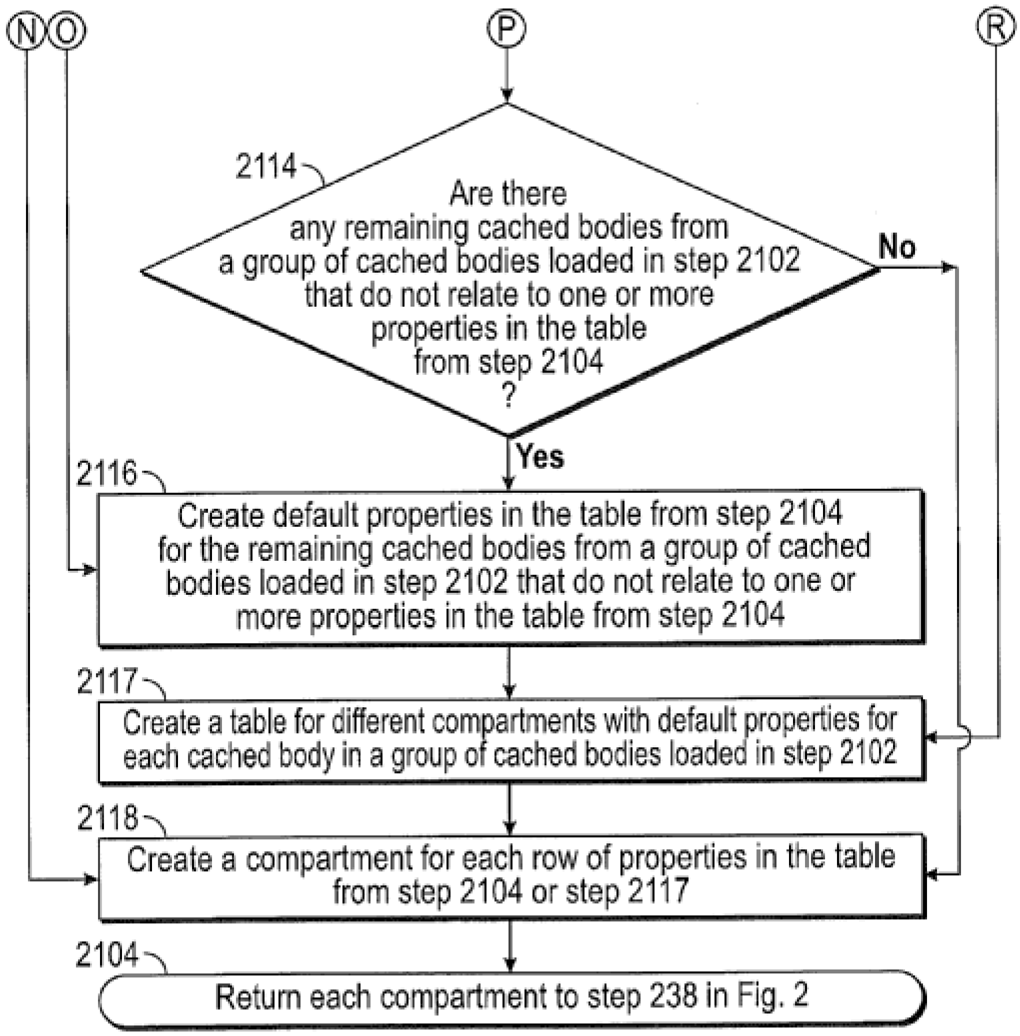
N
O
P
R
2114
Are there any remaining cached bodies from a group of cached bodies loaded in step 2102 that do not relate to one or more properties in the table from step 2104 ?
No
Yes
2116
Create default properties in the table from step 2104 for the remaining cached bodies from a group of cached bodies loaded in step 2102 that do not relate to one or more properties in the table from step 2104
2117
Create a table for different compartments with default properties for each cached body in a group of cached bodies loaded in step 2102
2118
Create a compartment for each row of properties in the table from step 2104 or step 2117
2104
Return each compartment to step 238 in Fig. 2

FIG. 21C

[00117] Referring now to FIGS. 21A-21C, a flow diagram of one embodiment of a method 2100 for implementing step 238 in FIG. 2 is illustrated. The method 2100 performs property matching on the group of cached bodies from step 214, step 218 and/or step 224 to convert each cached body to a respective compartment represented by a triangulated mesh of the bounding cached body with properties such as color and lithology. This facilitates finding specific compartments when a large number of compartments are present. One or more boundary objects such as surfaces, faults, fluid contacts and geoshells may be selected and all compartments that share those objects as boundaries are identified. Multiple selections mean that any of the selected boundaries may be matched. Since all compartments are a combination of patches from the framework structure, any compartment can be quickly scanned for common structural boundaries.This provides a near instant filtering method even with thousands of compartments in complex frameworks. In conventional applications, all compartments are generated with a random color and names that represent a string amalgamation of all the structural boundaries surrounding the compartment that can change each model build or new session load. The method 2100, however, provides the ability to set custom names and properties such as color or lithology, and provides that compartments return with the same properties each time the model is loaded to a new session.

[00118] In step 2102, the group of cached bodies from step 214, step 218 and/or step 224 is loaded.

[00119] In step 2103, the method 2100 determines if there is a table of properties for different compartments. If there is no table of properties for different compartments, then the method 2100 proceeds to step 2117. Otherwise, the method 2100 proceeds to step 2104.

[00120] In step 2104, a table of properties for different compartments is loaded. The table includes user specified properties like color, name or lithology and inherent properties like patches, center of mass and volume for each compartment. In FIG. 1, a graphical user interface 100 illustrates various different compartments (strati graphic layer, fault block, fluid layer, combined), user specified properties and inherent properties in an exemplary table.

[00121] In step 2108, the method 2100 determines if one or more properties in the table from step 2104 match a cached body from a group of cached bodies loaded in step 2102. If one or more properties in the table from step 2104 do not match a cached body from a group of cached bodies loaded in step 2102, them the method 2100 proceeds to step 2112. Otherwise, the method 2100 proceeds to step 2109. A match is determined by comparing the inherent properties (e.g. patches, center of mass, volume) in the table and the inherent properties of each cached body from a group of cached bodies loaded in step 2102 for identical values (i.e. an exact match).

[00122] In step 2109, the one or more properties in the table from step 2104 that match (i.e. have identical inherent properties) a respective body in a group of cached bodies loaded in step 2102 are associated with the respective body.

[00123] In step 2110, the method 2100 determines if there are any remaining cached bodies from a group of cached bodies loaded in step 2102 that do not match one or more properties in the table from step 2104. If there are cached bodies from a group of cached bodies loaded in step 2102 that do not match one or more properties in

the table from step 2104, then the method 2100 proceeds to step 2112. Otherwise, the method 2100 proceeds to step 2118. A match is determined by comparing the inherent properties (e.g. patches, center of mass, volume) in the table and the inherent properties of each cached body from a group of cached bodies loaded in step 2102 for identical values (i.e. an exact match).

[00124] In step 2112, the method 2100 determines if one or more properties in the table form step 2104 relate to any remaining cached bodies from a group of cached bodies loaded in step 2102. If one or more properties in the table form step 2104 do not relate to any remaining cached bodies from a group of cached bodies loaded in step 2102, then the method 2100 proceeds to step 2116. Otherwise, the method 2100 proceeds to step 2113. One or more properties in the table from step 2104 relate to a respective cached body from a group of cached bodies loaded in step 2102 if the inherent properties (e.g. patches, center of mass, volume) in the table and the inherent properties of a respective cached body have corresponding values within a predefined tolerance.

[00125] In step 2113, the one or more properties in the table from step 2104 that relate to a respective body in a group of cached bodies loaded in step 2102 are associated with the respective body.

[00126] In step 2114, the method 2100 determines if there are any remaining cached bodies from a group of cached bodies loaded in step 2102 that do not relate to one or more properties in the table from step 2104. If there are cached bodies from a group of cached bodies loaded in step 2102 that do not relate to one or more properties in the table from step 2104, then the method proceeds to step 2116. Otherwise, the method 2100 proceeds to step 2118.

[00127] In step 2116, default properties are created in the table from step 2104 for the remaining cached bodies from a group of cached bodies loaded in step 2102 that do not relate to one or more properties in the table from step 2104. The method 2100 then proceeds to step 2118.

[00128] In step 2117, a table is created for different compartments with default properties for each cached body in a group of cached bodies loaded in step 2102. The default properties include user specified properties like color, name or lithology and inherent properties like patches, center of mass and volume for each compartment.

[00129] In step 2118, a compartment is created for each row of properties in the table from step 2104 or step 2117, wherein each row of properties represents one or more continuous bodies. Each compartment is returned to step 238 in FIG. 2.

Annex 7 - Detail of the Custom Reservoir Generation of step 240 and GB1600705.6

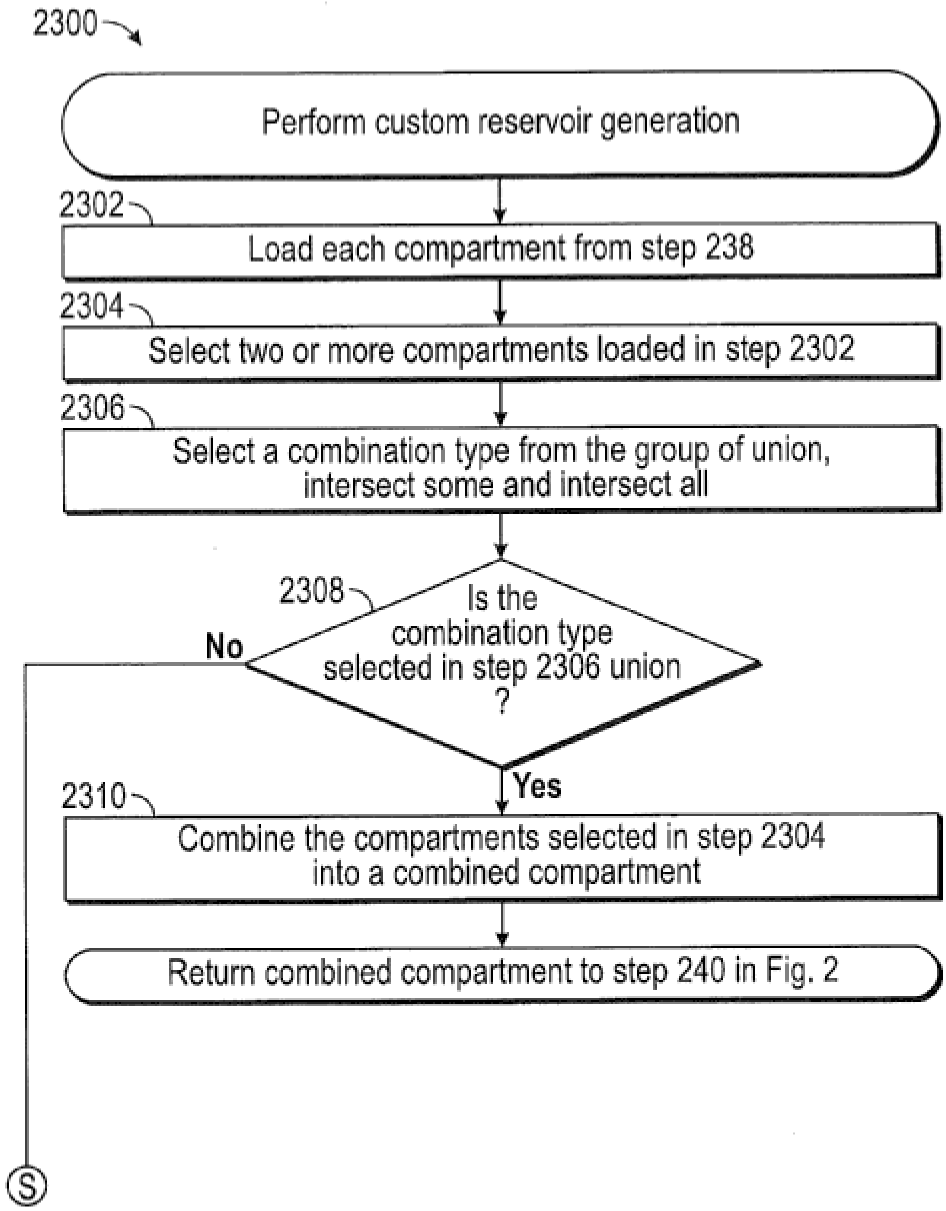

FIG. 23A

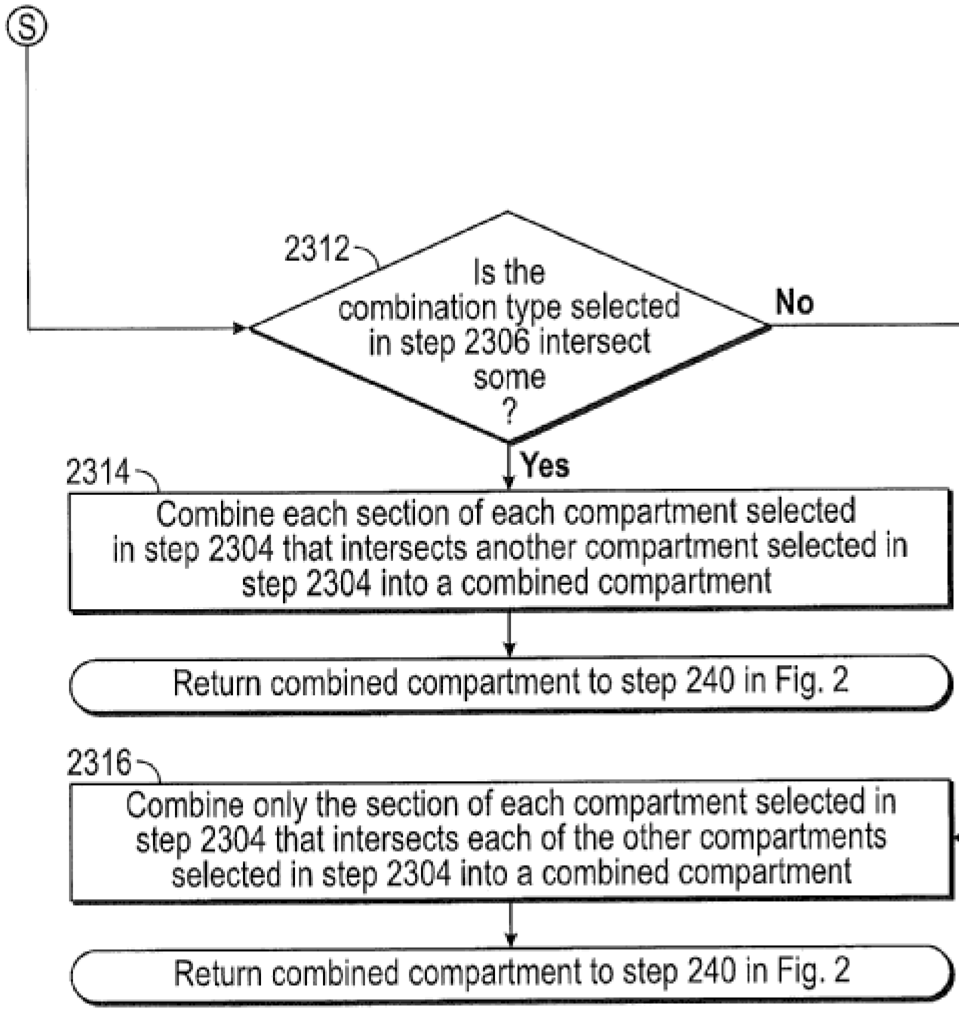

FIG. 23B

[00130] Referring now to FIGS. 23A-23B, a flow diagram of one embodiment of a method 2300 for implementing step 240 in FIG. 2 is illustrated. The method 2300 performs custom reservoir generation on each compartment from step 238 to generate one or more combined compartments, Since each compartment is composed of patches, those patches can be reassembled into new compartments on the fly. By analyzing the interior of bounding patches, connected compartments may be either grouped or isolated. Once a new set of sealed patches is assembled, the interior seams will be removed. The final result is a merge or intersection between any set of compartments, which forms a combined compartment. All volumes and properties will honor the new bounding edges. In conventional applications, all compartments are isolated as individual bodies that are manually assembled into meaningful geological units. The method 2300, however, automatically generates most standard geological units.This automatic generation provides an advantage, even in those situations where a subset or merging of these units may be more useful.

[00131] In step 2302, each compartment from step 238 is loaded.

[00132] In step 2304, two or more compartments loaded in step 2302 are selected.

[00133] In step 2306, a combination type from the group of union, intersect some, intersect all is selected. A union is the combination of all selected compartments. Intersect some is the combination of the section of each selected compartment that intersects another selected compartment. Intersect all is the combination of only the section of each selected compartment that intersects each of the other selected compartments. In FIG. 22, a Venn Diagram illustrates the various combinations from the group of union (2202), intersect some (2204) and intersect all (2206). [00134] In step 2308, the method 2300 determines if the combination type selected in step 2306 is union using the client interface and/or the video interface described in reference to FIG. 25. If the combination type selected in step 2306 is not a union, then the method 2300 proceeds to step 2312. Otherwise, the method 2300 proceeds to step 2310.

[00135] In step 2310, the compartments selected in step 2304 are combined into a combined compartment that is returned to step 240 in FIG. 2.

[00136] In step 2312, the method 2300 determines if the combination type selected in step 2306 is intersect some using the client interface and/or the video interface described in reference to FIG. 25. If the combination type selected in step 2306 is not intersect some, then the method 2300 proceeds to step 2316. Otherwise, the method 2300 proceeds to step 2314.

[00137] In step 2314, each section of each compartment selected in step 2304 that intersects another compartment selected in step 2304 is combined into a combined compartment that is returned to step 240 in FIG. 2. Unlike the example in FIG. 22, multiple intersections may be non-contiguous depending on the position of the selected compartments.

[00138] In step 2316, only the section of each compartment selected in step 2304 that intersects each of the other compartments selected in step 2304 is combined into a combined compartment that is returned to step 240 in FIG. 2.

Annex 8 - Detail of the dynamic interactions of step 244 and GB1600706.4

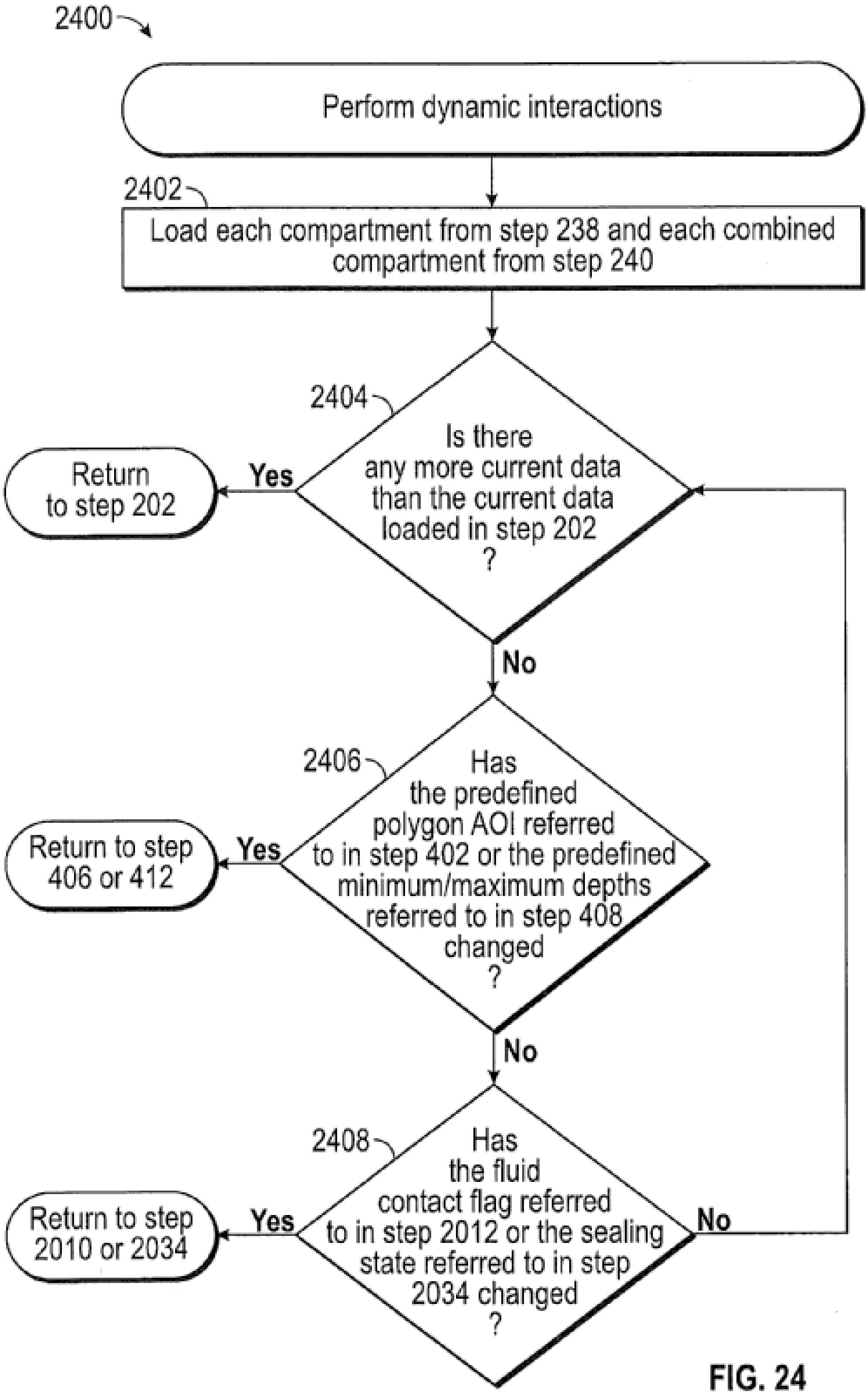

FIG. 24

[00139] Referring now to FIG. 24, a flow diagram of one embodiment of a method 2400 for implementing step 244 in FIG. 2 is illustrated. The method 2400 performs one or more dynamic interactions on the current data loaded in step 202, the predefined polygon AOI and the predefined minimum/maximum depths from the VOI based model sealing performed in step 208 and/or the fluid contact flag and the sealing state from the fluid fill analysis performed in step 224 to dynamically update the compartments from step 238 and/or the combined compartments from step 240. Compartments are automatically synchronized with updates and there is no need to redetect compartments after framework changes. Since the compartments can now incrementally update, performance is improved. Even disabling compartments will keep the state preserved so enabling compartments will still only need an incremental update. As a result, compartments may be active more frequently and more analysis tools may be used.In conventional applications, compartments are often required to be manually redetected any time they updated the model, changed properties, or grouped compartments. In addition, visibility states are often required to be constantly toggled to parse names and figure out which compartment is needed. The method 2400, however, enables all aspects of dynamic updatability for compartments. In other words, sealed geological units are always visible that update with each change to the model. There is no additional interaction required and the compartments can be used for quality control and better comprehend the complex, three-dimensional structure of a geological model.

[00140] In step 2402, each compartment from step 238 and each combined compartment from step 240 is loaded.

[00141] In step 2404, the method 2400 determines if the there is any more current data than the current data loaded in step 202. If the there is more current data than the current data loaded in step 202, then the method 2400 returns to step 202 to load the more current data. Otherwise, the method 2400 proceeds to step 2406.

[00142] In step 2406, the method 2400 determines if the predefined polygon AOI referred to in step 402 or the predefined minimum/maximum depths referred to in step 408 have changed. If the predefined polygon AOI referred to in step 402 or the predefined minimum/maximum depths referred to in step 408 have changed, then the method 2400 returns to step 406 to set the polygon AOI using a new predefined polygon AOI or step 412 to set the minimum/maximum depths using new predefined minimum/maximum depths. Otherwise, the method 2400 proceeds to step 2408,

[00143] In step 2408, the method 2400 determines if the fluid contact flag referred to in step 2012 or the sealing state referred to in step 2034 have changed. If the fluid contact flag referred to in step 2012 or the sealing state referred to in step 2034 have changed, then the method 2400 returns to step 2010 to select a fluid contact flag using a new fluid contact flag or step 2034 to determine if there is a shared patch using a new sealing state. Otherwise, the method 2400 returns to step 2404.