Patents Act 1977 **Opinion Number** **25/14**

OPINION UNDER SECTION 74A

Patent	GB 2497956
Proprietor(s)	J. C. Bamford Excavators Limited
Exclusive Licensee	
Requester	Abel & Imray
Observer(s)	
Date Opinion issued	11 February 2015

The request

1. The comptroller has been requested to issue an opinion as to whether GB2497956 ("the patent") is valid in light of a number of prior art patent documents and alleged common general knowledge.

Observations

2. Observations were received from Withers & Rogers LLP on behalf of the patentee and observations in reply were received from Abel & Imray.

The patent

3. The patent was filed on 23 December 2011, making no claim to an earlier priority date. It was granted with effect from 1 January 2014 and remains in force.

4. The patent is entitled Energy Recovery System and is concerned with hydraulic systems used particularly with load handling machines such as back hoe loaders, excavators and telehandlers.

5. An embodiment of the invention is illustrated schematically in figure 3, below, which shows a system in which an engine 112 drives ground engaging means 122B such as wheels via transmission 140 and also drives a hydraulic pump 142 and a flywheel 150, the flywheel 150 being connected to the engine via a clutch 152 and a gearbox 148. The hydraulic pump 142 is used to power hydraulic services 103A, 103B which may be actuator rams. The flywheel 150 is also connected to hydraulic pump 142 via a further gearbox 149 and a further clutch 153. The flywheel 152 is used as a kinetic energy storage device, from and to which energy can be transferred to or

from either the engine 12 or the hydraulic pump 142. With clutches 152 or 153 engaged the system is arranged such that the flywheel 150 rotates faster than the engine 112 or the hydraulic pump 142, by means of gearboxes 148 and 149.

6. Upon initially starting the engine 112 it may drive the flywheel 150 from rest, thus storing energy in the flywheel 150. In subsequent use clutch 153 may be engaged allowing the flywheel 150 to transfer energy to the hydraulic pump 142.

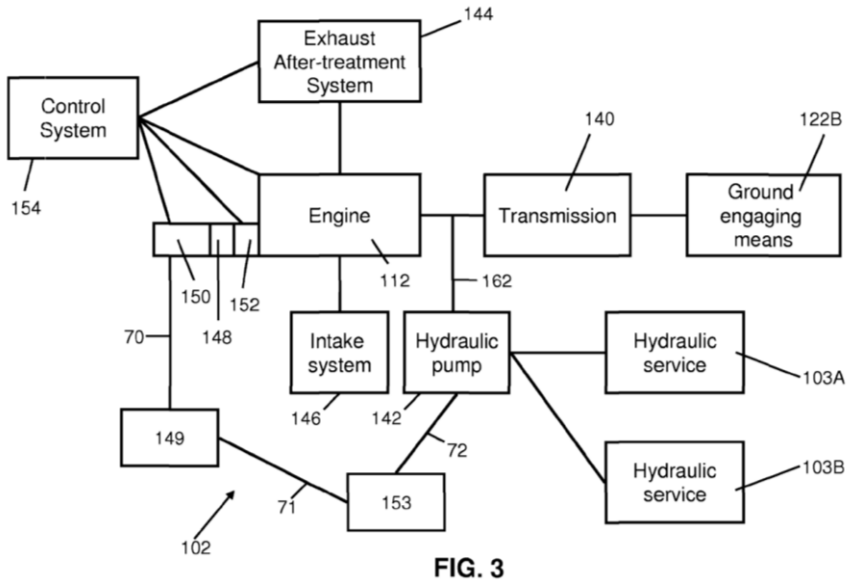


FIG. 3

7. Figure 4, below, shows an embodiment of the invention in which engine 212 drives a hydraulic pump 242A which may be used to power one or more services 203B such as actuators. A flywheel 250 may be used to store kinetic energy which may be used to drive hydraulic motor 242B and then to provide energy to power the service 203B, the service 203B being powered either solely from energy stored in the flywheel 250 or along with power from hydraulic pump 242A driven by the engine 212.

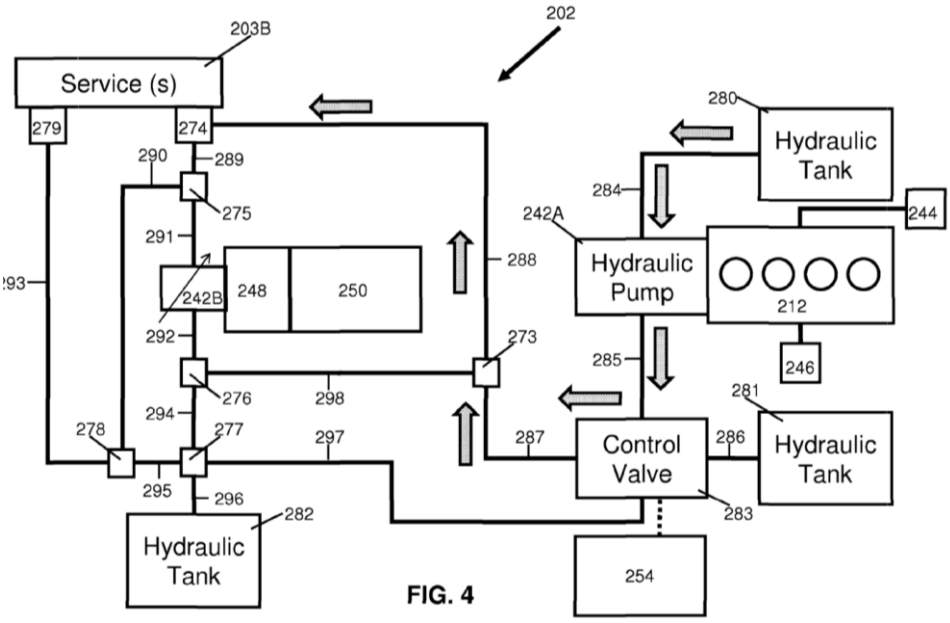


FIG. 4

8. The arrangement of figure 4 may also be used to transfer energy from the service 203B to the flywheel 250. For example when lowering a loading arm that has been raised by service 203B, hydraulic fluid may be used to drive pump 242B which then acts as a motor and drives the flywheel 250 via the gearbox 248.

9. The granted patent includes 33 claims directed variously to a hydraulic system, a vehicle including a hydraulic system, a method of operating a vehicle including a hydraulic system or a method of operating an internal combustion engine. Of those claims only claims 1 and 20 are truly independent, by which I mean that they make no reference to other claims. Claims 1 and 20 are as follows:

> 1. *A hydraulic system including hydraulic fluid, a hydraulic machine for pressuring the hydraulic fluid, a hydraulic circuit for delivering the hydraulic fluid to a hydraulic actuator, the hydraulic machine being configured to receive the hydraulic fluid from the hydraulic actuator and a kinetic energy storage device for storing energy in a kinetic form, wherein the kinetic energy storage device is a flywheel, the flywheel being operably coupled to the hydraulic machine such that the flywheel rotates faster than the hydraulic machine, the system being configured such that the hydraulic machine is operable to transfer energy from the hydraulic fluid received from the hydraulic actuator to the flywheel.*
>
> 20. *A method of operating an internal combustion engine including the steps of:*
> *providing an internal combustion engine having an exhaust after treatment system,*
> *providing a hydraulic system including hydraulic fluid, a hydraulic machine for pressuring the hydraulic fluid, a hydraulic circuit for delivering the hydraulic fluid to a hydraulic actuator, the hydraulic machine being configured to receive the hydraulic fluid from the hydraulic actuator and a kinetic energy storage device for storing energy in a kinetic form, the kinetic energy storage device being operably connected to the hydraulic machine, the system being configured such that the hydraulic machine is operable to transfer energy from the hydraulic fluid received from the hydraulic actuator to the kinetic energy storage device; and,*
> *starting with the exhaust after treatment system at a temperature below a normal working temperature, starting the internal combustion engine and using the kinetic energy storage device to apply a load to the engine so as to store energy in the kinetic energy storage device and increase the temperature of the exhaust after treatment system.*

Claim construction

10. Before considering the documents put forward in the request I will need to construe the claims of the patent following the well known authority on claim construction which is *Kirin-Amgen and others v Hoechst Marion Roussel Limited and others* [2005] RPC 9. This requires that I put a purposive construction on the claims, interpret it in the light of the description and drawings as instructed by Section 125(1) and take account of the Protocol to Article 69 of the EPC. Simply put, I must decide what a person skilled in the art would have understood the patentee to have used the language of the claim to mean.

11. Section 125(1) of the Act states that:

> *For the purposes of this Act an invention for a patent for which an application has been made or for which a patent has been granted shall, unless the context otherwise requires, be taken to be that specified in a claim of the specification of the application or patent, as the case may be, as interpreted by the description and any drawings contained in that specification, and the extent of the protection conferred by a patent or application for a patent shall be determined accordingly.*

12. And the Protocol on the Interpretation of Article 69 of the EPC (which corresponds to section 125(1)) states that:

> *Article 69 should not be interpreted in the sense that the extent of the protection conferred by a European patent is to be understood as that defined by the strict, literal meaning of the wording used in the claims, the description and drawings being employed only for the purpose of resolving an ambiguity found in the claims. Neither should it be interpreted in the sense that the claims serve only as a guideline and that the actual protection conferred may extend to what, from a consideration of the description and drawings by a person skilled in the art, the patentee has contemplated. On the contrary, it is to be interpreted as defining a position between these extremes which combines a fair protection for the patentee with a reasonable degree of certainty for third parties.*

13. It is clear from the embodiments that the "*hydraulic machine for pressuring the hydraulic fluid*" of claims 1 and 20 may be a hydraulic pump. From claim 9 it is clear that the hydraulic machine may be formed from more than one machine, potentially one for pressuring fluid and another one for receiving fluid from the actuator.

14. The hydraulic actuator of the independent claims may be a hydraulic ram as described in relation to the embodiments (see page 4), whilst claim 6 makes it clear that the actuator may be a linear actuator or a rotary actuator and claim 14 requires that the actuator should be operable to drive ground engaging means for propelling the vehicle.

15. The request points out that claim 1 requires "*the flywheel being operably coupled to the hydraulic machine such that the flywheel rotates faster than the hydraulic machine*" and that this condition need not be satisfied by the system at all times. Such times are indeed described in the specification and I am minded to agree with the requester's construction of this passage to mean "*the flywheel being operably coupled to the hydraulic machine such that the flywheel is capable of rotating faster than the hydraulic machine*". I note that the observations in reply make no reference to this point.

16. In their observations in relation to one of the prior art documents (US2011/180287) the patentee raises a question of the construction of the phrase "operably coupled", claiming that this requires a direct mechanical or hydraulic connection between the flywheel and the hydraulic machine. They refer to a passage on page 12 of the patent describing the embodiments of figures 3 and 4 in which the flywheel is indeed hydraulically coupled to the hydraulic pump. In their observations in reply the

requester does not accept this construction and maintains that the words are general and are not limited to hydraulic or mechanical coupling, although such coupling is clearly included in the scope of the phrase. I can find nothing explicit in the specification to assist me in construing this phrase. Although all of the embodiments shown include only hydraulic or mechanical connections between the components, such embodiments are said to be by way of example only (see page 2 lines 17 and 18) and I do not believe that a person skilled in the art would have understood the patentee to have meant the phrase "operably coupled" to mean only hydraulically or mechanically connected.

Common general knowledge

17. The request makes reference to several non-patent documents described under a heading of technical background. These are said to demonstrate that various things were "well known" at the priority date. The patentee takes issue with the dates at which several of these documents were publically available and indeed if at least one of the documents was publically available. Whilst the point about dates is strictly correct, as the observations in reply suggest, the documents are being used to illustrate what was already known before those documents were produced.

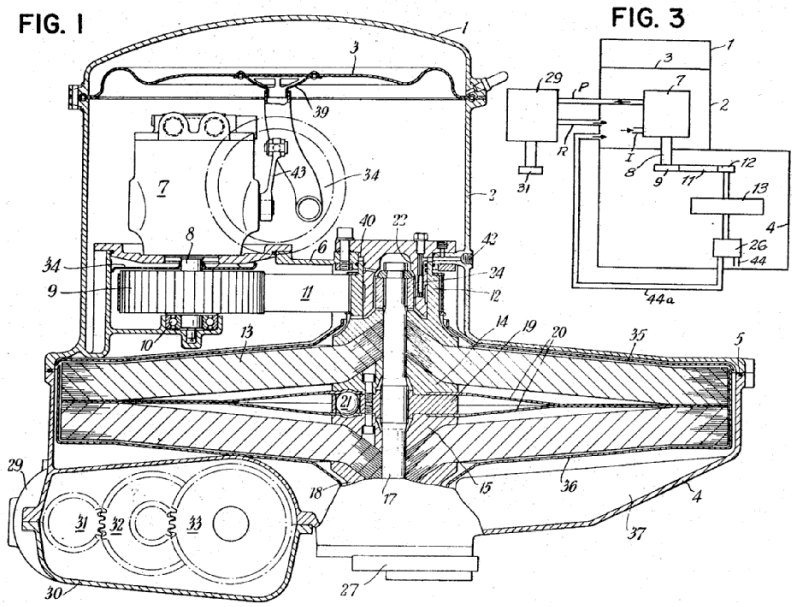
18. It seems to me reasonable to accept that these documents serve to illustrate that a number of things were commonly known. These include:

    - the use of flywheels as energy storage devices in road vehicles;
    - the use of high rotational speeds in such flywheels, such as speeds between 7500 rpm and 50000 rpm;
    - hydraulic pump maximum rotational speeds could be less than 4000 rpm;
    - the use of exhaust treatment systems for non-road vehicles.

Prior art

19. The request refers to five prior art patent documents, all of which were published before the priority date of the patent.

20. The first of the prior art patent documents is US3485037. It shows a hydraulic power system that may be used to power equipment such as fork lift trucks or the like. Figures 1 and 3, below, show a power unit used to power the half shafts of a vehicle connected to a differential 33. A flywheel 13 is initially rotated using a motorable variable stroke pump 7 and belt 11, the motor being pressurised from an external pressure source that is disconnected once the flywheel is brought up to speed. Pump/motor 7 is housed within an air-free oil reservoir 2 which is pressurised by means of compressed air in the space above flexible diaphragm 3.



21. The operation of the system is described between lines 40 to 52 of column 4 as follows:

> *To put the vehicle in motion the function of the motorable pump 7 is changed by its control lever 43 to cause it to act as a pump driven by the flywheel through the belt 11 and toothed drum 9. The output of the pump 7 is led to the hydraulic motor/pump 29 from whence it is returned to the inlet of pump 7. Speed of the vehicle is controlled in accordance with the stroke of the pump 7.*
>
> *When the vehicle is on overrun, for example descending a hill, the motor/pump 29 is caused to act as a pump and the motorable pump 7 is adjusted to act as a motor.*

22. The second prior art document referred to is US2011/0180287, the disclosure of which is concerned with "*mobile implements such as loaders, telehandlers, baggers, and dumpers.*" (paragraph 0004). The invention is illustrated schematically in figure 1, below.

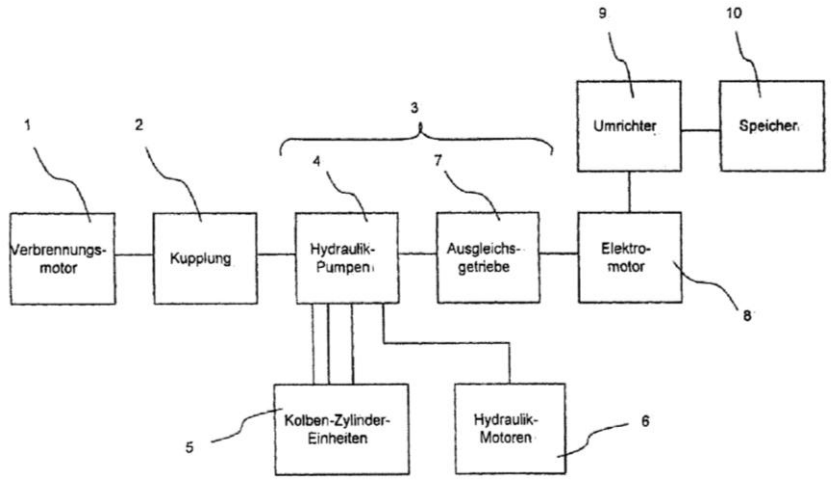


Fig. 1

23. The following paragraphs quoted from the specification describe the operation of the invention and provide translations for the German language annotations in figure 1:

[0063] An internal combustion engine 1 is coupled, via a clutch 2, to a main drivetrain 3 that constitutes an operative connection. With the aid of a clutch 2 that can be controlled by a control device (not shown), it is possible to connect internal combustion engine 1 to main drivetrain 3 or separate it therefrom as needed. This is explained in more detail below. In main drivetrain 3, one or more hydraulic pumps 4 are provided that in normal operation are driven by internal combustion engine 1 in order to convey hydraulic fluid (hydraulic oil) and to place it under pressure in a hydraulic system in a known manner. Correspondingly, hydraulic pumps 4 are connected to one or more piston-cylinder units 5. Piston-cylinder units 5 are used for example to raise and lower the arm of a bagger or loader or to cause a shovel movement.

[0064] Likewise, it is possible for hydraulic pumps 4 to be coupled to one or more hydraulic motors 6 in order for example to rotate a revolving superstructure of a bagger relative to its chassis, or in order to provide a travel drive to cause the bagger or a loader to travel in a known manner.

[0065] In addition to piston-cylinder units 5 and hydraulic motors 6, suitable valves are provided for controlling the hydraulic flows; however, these valves are not shown in the schematic Figure. These hydraulic valves are preferably seat valves and check valves, or unlockable check valves. Proportional control valves and throttle valves are to be avoided in order to reduce flow losses.

[0066] Hydraulic pumps 4, piston-cylinder units 5, hydraulic motors 6, and the hydraulic valves form in this respect a working mechanism of the implement.

[0067] Moreover, in main drivetrain 3 there is situated a differential mechanism 7 that connects main drivetrain 3 to an electric motor 8. Electric motor 8 can be operated both as a motor and as a generator. Differential mechanism 7 acts to increase the rotational speed of main drivetrain 3 and to achieve a higher rotational speed suitable for electric motor 8.

[0068] Electric motor 8 is connected to an energy accumulator 10 via a converter 9.

[0069] Energy accumulator 10 is an electromechanical kinetic accumulator in which there is provided, inter alia, an electric motor (accumulator motor) having a stator and a rotor. The energy that is to be absorbed by energy accumulator 10 is stored in the form of kinetic energy, i.e. rotational energy of the rotor, which also acts as a flywheel mass. The higher the energy content of energy accumulator 10, the higher the rotational speed of the rotor provided therein. Conversely, the energy content of energy accumulator 10 decreases when the rotational speed of the rotor decreases.

[0070] The energy accumulator DYNASTORE(R), made by the company Compact Dynamics, is an example of a suitable energy accumulator 10.

[0071] In addition, a power and control electronics system (not shown in the

Figure) is provided that monitors and controls all parameters of the system that are relevant to the method. These include, for example, the rotational speed of internal combustion engine 1, the switching state of clutch 2, the power consumption of hydraulic pumps 4 due to a power requirement on the part of piston and cylinder units 5 and hydraulic motors 6, the position of the hydraulic valves, an excitation at electric motor 8, the behavior of converter 9, and the controlling of energy accumulator 10.

[0072] The power and control electronics system adjusts the rotational speed of internal combustion engine 1 to a preset optimal value at which the efficiency of internal combustion engine 1 is particularly high. Depending on the working process currently being executed, this can have the result that excess energy is present that does not have to be introduced into the hydraulic system via hydraulic pumps 4, because the current working process does not require this energy. In this case, the power and control electronics system causes a corresponding excitation of electric motor 8 in order to operate it as a generator. The resulting electrical energy is adapted in its frequency and voltage by the converter and is supplied to energy accumulator 10. The electric motor provided in energy accumulator 10, e.g. a magnetic motor or a reluctance motor, is correspondingly excited so that the rotational speed of the rotor in energy accumulator 10 increases. In this way, energy is stored.

[0073] If in a subsequent work process, e.g. the raising of a filled shovel, it is determined that an increased power requirement exists, and the average output of internal combustion engine 1 is not sufficient to cover this power requirement, the power and control electronics system causes additional energy to be fed back from energy accumulator 10.

[0074] For this purpose, the electric motor in energy accumulator 10 is operated as a generator, so that the rotating rotor produces an electric current that is supplied to electric motor 8 via converter 9. In this case, electric motor 8 is operated as a motor, and transmits drive power into the main drivetrain via differential mechanism 7. This power is used to support the average power output provided by internal combustion engine 1. In this way, the currently required working cycle can be carried out without having to increase the output power of the internal combustion engine.

[0075] In the case of a power excess, e.g. during the lowering of a filled shovel or braking of the chassis, it is also possible to briefly separate internal combustion engine 1 from main drivetrain 3 using clutch 2. At the same time, the rotational speed of internal combustion engine 1 should be regulated so that it does not increase unnecessarily. The power fed back into main drivetrain 3 via the hydraulic system and hydraulic pumps 4 is then fed directly to energy accumulator 10, via differential mechanism 7, electric motor 8, and converter 9. In a following work cycle, it can then again be fed back in the reverse direction in order to support internal combustion engine 1.

24. The third prior art document is US2007/175209. This is concerned with work machines such as, for example, dozers, loaders, excavators, motor graders, and other types of heavy machinery and a hydraulic system having an energy recovery device locatable within a low pressure sump. Figure 1, below, illustrates the system:

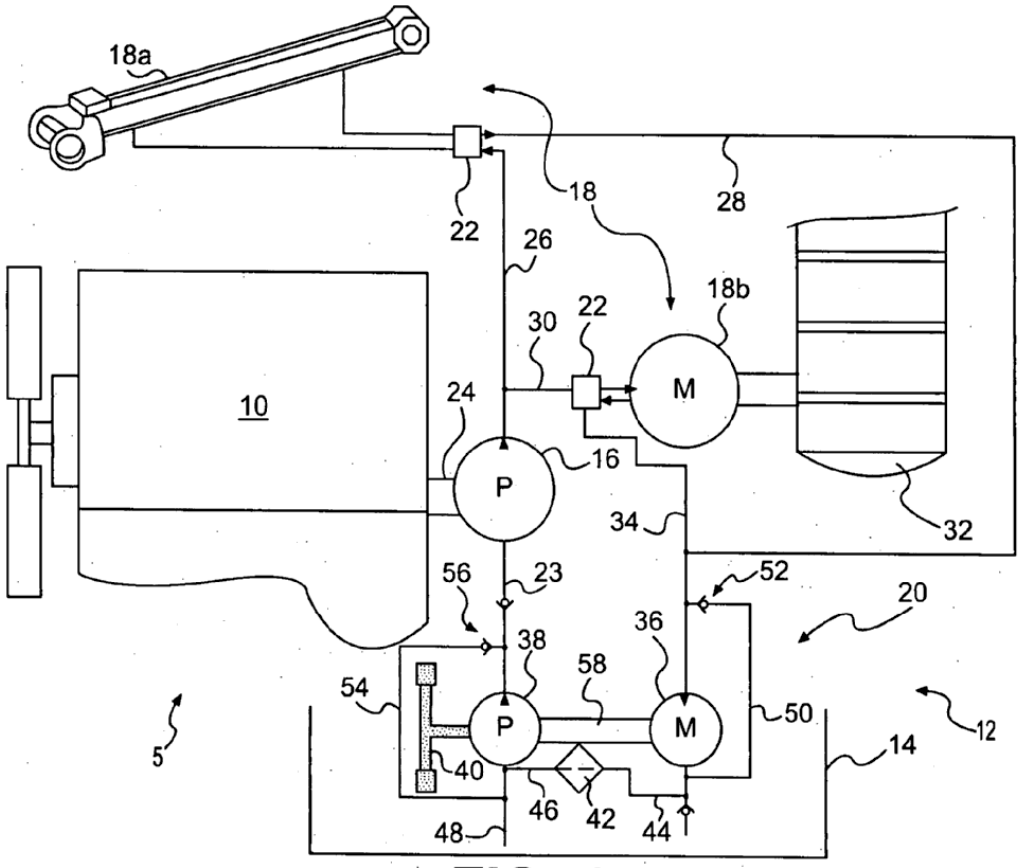


FIG. 1

25. The system is further described in the following quoted paragraphs:

[0015] Hydraulic system 12 may include a plurality of components that cooperate together with power source 10 to perform a task. Specifically, hydraulic system 12 may include a low pressure sump 14, a primary source 16 of pressurized liquid, one or more actuators 18, and an energy recovery device 20. Low pressure sump 14, primary source 16, actuators 18, and energy recovery device 20 may form a circuit that assists in moving a work tool or propelling a work machine to accomplish the task. Hydraulic system 12 may also include one or more valve mechanisms 22 associated with each actuator 18 to control the operation thereof. It is contemplated that hydraulic system 12 may include additional and/or different components such as, for example, pressure compensators, accumulators, restrictive orifices, pressure relief valves, makeup valves, pressure-balancing passageways, temperature sensors, position sensors, controllers, and other such components known in the art.

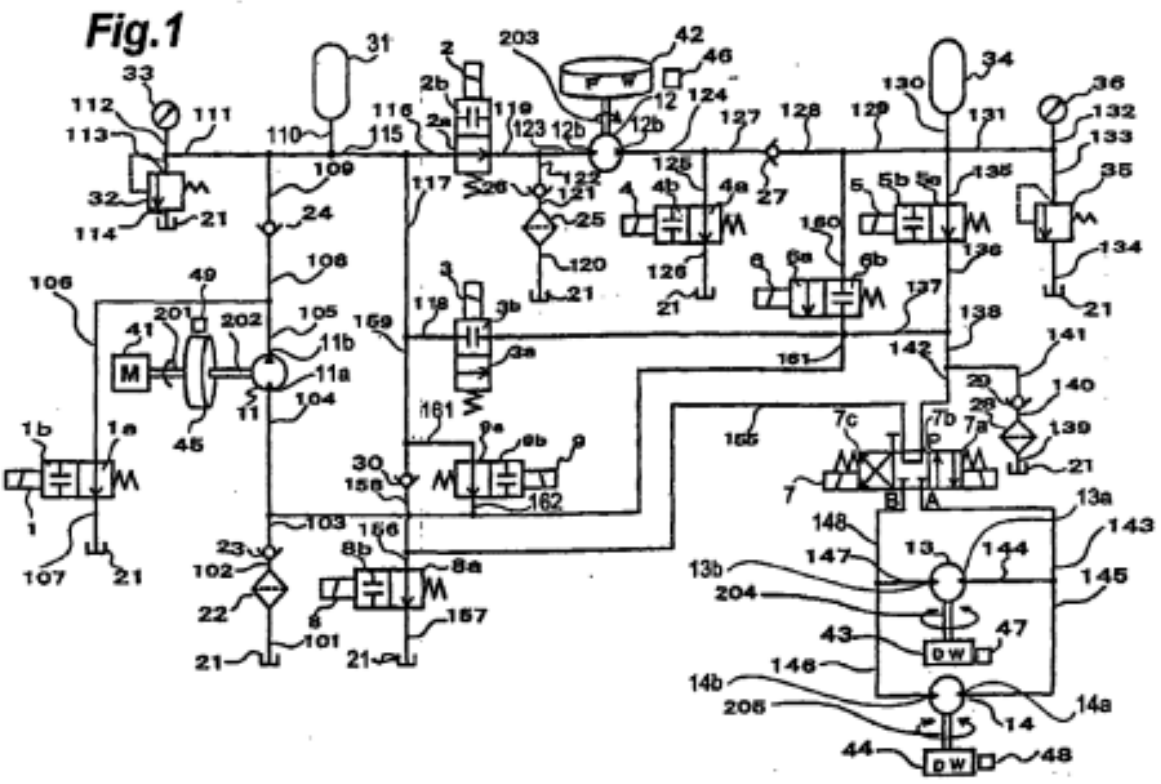
[0021] Energy recovery device 20 may include multiple components fluidly interconnected to recover energy from and condition liquid draining from actuators 18 to low pressure sump 14. Specifically, energy recovery device 20 may include a driving element 36, a driven element 38, a means for storing energy 40, and a means for conditioning liquid 42. Driving element 36 may be connected to receive waste liquid from actuators 18 via drain passageways 28 and 34, and to direct the liquid to driven element 38 via the means for conditioning liquid 42 and fluid passageways 44 and 46. Driven element 38 may receive the waste liquid from

driving element 36 and draw additional liquid from low pressure sump 14 by way of a suction line 48. A first bypass circuit 50 having a check valve 52 may regulate the pressure and/or rate of the waste liquid flowing through driving element 36, while a second bypass circuit 54 having a check valve 56 may regulate the pressure and/or rate of the liquid flowing through driven element 38. Driving element 36 may be connected to drive each of driven element 38, the means for storing energy 40, and the means for conditioning liquid 42 by way of, for example, a common shaft 58, a gear train (not shown), a cam mechanism (not shown), a linkage system (not shown), or in any other appropriate manner such that a rotation of driving element 36 results in an actuating motion of the connected components. It is contemplated that any one or all of the components of energy recovery device 20 may be located within or in close proximity to low pressure sump 14, if desired. It is further contemplated that the means for conditioning liquid could alternatively be located upstream of driving element 36 or downstream of driven element 38, if desired.

[0024] The means for storing energy 40 may function to remove excess energy from the waste liquid for later use by hydraulic system 12. For example, the means for storing energy 40 could embody a flywheel device configured to store excess energy kinetically, an accumulating device, or any other means known in the art. The flywheel device may be any type of device for storing and releasing rotational energy recovered by driving element 36. For example, the flywheel may embody a fixed inertia flywheel, a variable inertia flywheel, an electric flywheel (e.g., an electric power generating device such as a motor/generator), or any other type of flywheel known in the art. The accumulating device may embody a hydraulic accumulator configured to store and release pressurized fluid, or an electrical accumulator such as a battery or capacity associated with an electric flywheel and configured to store and release electrical power. It is contemplated that the means for storing energy 40 may be connected to common shaft 58 at any suitable location along its length such as, for example, between driving and driven elements 36 and 38, or toward one end of common shaft 58. It is further contemplated that a clutch device may be associated with means 40 to selectively engage and disengage means 40 with common shaft 58, if desired. It is also contemplated that the means for storing energy 40 may be omitted, if desired.

[0030] As common shaft 58 is rotated by driving element 36, driven element 38 and the means for storing energy 40 may be actuated to pressurize liquid and store energy. In particular, as impeller 66 (referring to FIGS. 2A and 2B) of driven element 38 is rotated, the liquid from driving element 36 and low pressure sump 14 may be drawn into volute housing 60, pressurized, and directed to primary source 16 via suction line 23. During situations in which the recovered energy is not immediately demanded, the pressurized fluid may be recirculated from outlet 70 to inlet 68 by way of check valve 56 and second bypass circuit 54.In these situations, the energy may be stored for later use by the means for storing energy 40.

26. EP1439310 shows a hydraulic system for a vehicle, illustrated in figure 1 and described in the paragraphs quoted below.



[0015] Fig. 1 is a hydraulic circuit diagram showing a hydraulic apparatus in accordance with the present invention employed in a driving system for a vehicle. In Fig. 1, number 41 refers to a driving source, which is preferably a heat engine in the vehicle, though other types of driving sources such as an electric motor may be used. An inertial element, which is specifically a flywheel 45, is attached to a shaft 201 of the driving source 41. The flywheel 45 is also known as a balance wheel, and accumulates a rotational energy when driven by the driving source 41 to rotate. A shaft 202 is connected to the center of the flywheel 45. By way of the shaft 201, the driving force from the driving source 41 is transmitted to a hydraulic pump ("third pump motor" in claims) 11 and drives the latter. When the driving source 41 has a large moment of inertia, i.e., when the driving source 41 is inherently provided with inertia, the flywheel 45 can be omitted. Fig. 1 shows the whole system of the hydraulic apparatus, organically combining a plurality of parts in charge of different functions and operations. In this embodiment, a hydraulic pump motor also functioning as a motor is used as the hydraulic pump 11.

[0020] A pipeline 115 branches off from between the pipelines 109 and 110, and is connected to a pipeline 116. By way of a control valve ("second control valve" in claims) 2, a pipeline 119 is connected to the pipeline 116. A pipeline 123 extends from the pipeline 119, and is connected to an inlet port 12a of a hydraulic motor ("second pump motor" in claims) 12. The hydraulic motor 12 functions as a load driven in response to the operating fluid discharged from the hydraulic pump 11. In this embodiment, a hydraulic pump motor also functioning as a pump is used as the hydraulic motor 12. A flywheel ("second energy accumulating device" in claims) 42 is attached to the rotary shaft of the hydraulic motor 12.

[0058] A case where the vehicle is decelerated while in an advancing state will now

be explained. The deceleration includes two patterns, i.e., a decelerating operation accompanying regeneration and a decelerating operation without regeneration. First, the decelerating operation with regeneration will be explained. When the vehicle advances, the ports 13b, 14b of the pump motors 13, 14 become the discharge side. The pipeline 158 on the input side of the check valve 30 is connected to the pipeline 155 connected to the ports 13b, 14b by way of the control valve 7 at the position 7a, whereas the output side of the check valve 30 is connected to the input side of the control valve 2.In this configuration, in a state where the pump motors 13, 14 continue their revolutions because of the inertia of the vehicle, the pump motors 13, 14 become the driving side, whereas the driven side is the hydraulic motor 12 to which the flywheel 42 is connected. When accelerated, the flywheel 42 becomes a load, thereby decelerating the vehicle. The control operation can be explained as in the case of accelerating the vehicle with the flywheel 42, in which actions similar thereto are carried out while the control valves 5 and 4 to switch their positions act as the control valves (second and third control valves) 2 and 8, respectively.

27. In JP2011-127534 engine apparatus for a working machine such as a back hoe is disclosed. The system is shown in figure 2 below and includes an internal combustion engine 7, an exhaust after treatment system 150, a hydraulic circuit 40 including hydraulic pumps 48, 51, hydraulic actuators 9, 16, 20, 23, 26, 27, 29, generator/motor 64 and accumulating means 66. There are several references to using the generator 64 as a load upon the engine in order to increase operating temperatures (see paragraphs 0037 and 0044), the generator being connected to battery 66 acting as an energy storage means.

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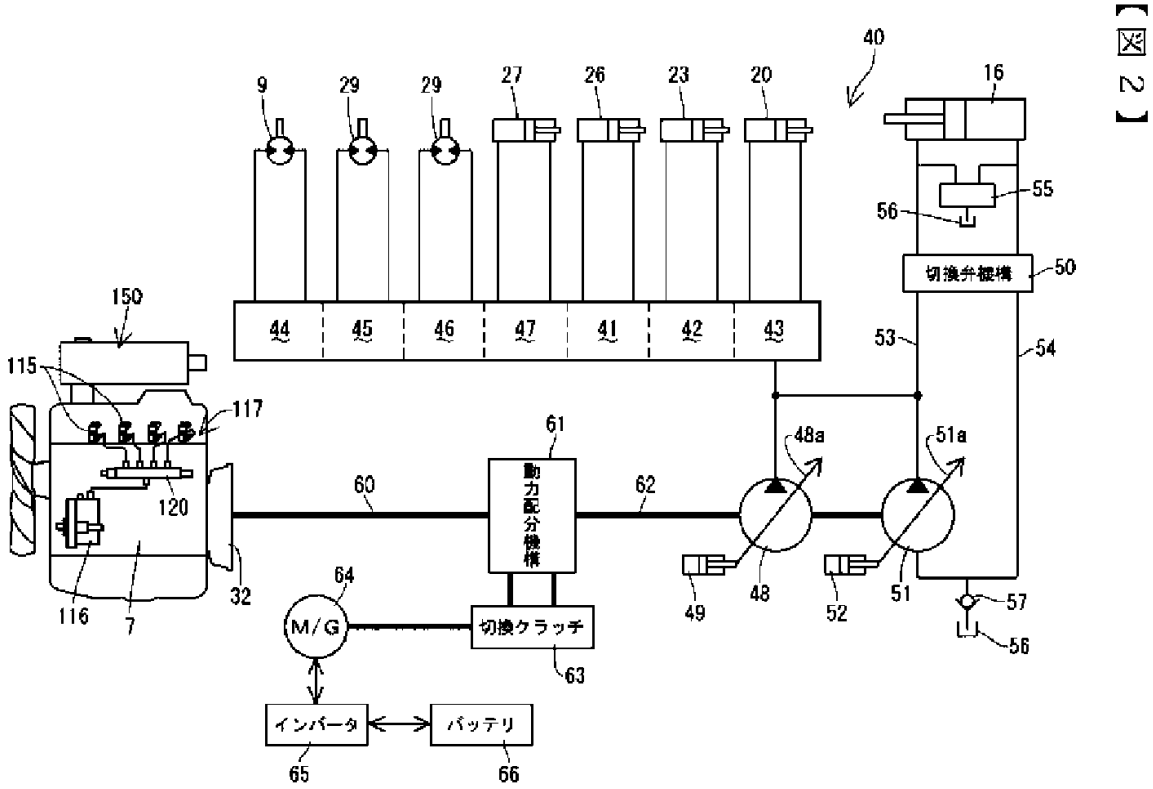

Novelty of claim 1

28. Taking the integers of claim 1 in turn, in US3485037 there is clearly disclosed a hydraulic system including hydraulic fluid, motor/pump 7 forms a hydraulic machine for pressuring the hydraulic fluid and lines P and R in figure 3 form a hydraulic circuit for delivering the hydraulic fluid to a hydraulic actuator in the form of high pressure motor/pump 29 acting as a rotary actuator which drives differential 33 through gears 31 and 32. With the vehicle on overrun descending a hill, the hydraulic machine or pump 7 is described as being configured to receive the hydraulic fluid from the hydraulic actuator or high pressure motor 29. Flywheel 13 forms a kinetic energy storage device, the flywheel 13 being operably coupled to the hydraulic machine or pump 7 such that the flywheel is capable of rotating faster than the hydraulic machine, given that respective speeds of 6450rpm and 10200 rpm for the motor 7 and flywheel 13 are described between lines 15 and 18 of column 4. It is clear from the description of motor/pump 29 being caused to act as a pump and the motorable pump 7 being adjusted to act as a motor when the vehicle is on overrun that the hydraulic machine or pump 7 is operable to transfer energy from the hydraulic fluid received from the hydraulic actuator or pump 29 to the flywheel 13.

29. In response to the request the observations filed on behalf of the patentee address the disclosure of US3485037 and conclude that “there is no enabling disclosure in Clark (sic) of the method of transferring energy from pump 29 to flywheel 13.”. In my view this conclusion is not supported. Admittedly there is little in US3485037 describing the energy recovery mode of operation, essentially just the short passage about overrun quoted earlier. However, I believe that this does describe a system of the kind required by claim 1 and that the skilled addressee would be able to perform the invention based upon the disclosure in US3485037.

30. Moving on to US2011/180287 and the integers of claim 1, this document shows a hydraulic system with hydraulic pumps 4, piston and cylinder units 5 and hydraulic motors 6, that system including hydraulic fluid (see paragraph 0063), a hydraulic machine for pressuring the hydraulic fluid in the form of hydraulic pump 4, a hydraulic circuit for delivering the hydraulic fluid to a hydraulic actuator 5, the hydraulic machine being configured to receive the hydraulic fluid from the hydraulic actuator (see paragraph 0075) and a kinetic energy storage device in the form of a flywheel accumulator (see paragraph 0069). The system is configured such that the hydraulic machine or pump 4 is operable to transfer energy from the hydraulic fluid received from the hydraulic actuator 5 to the flywheel accumulator 10 (see paragraph 0075). Although there is discussion of the relative speeds of the main drivetrain 3 and electric motor 8, there is little in the disclosure regarding the relative speeds of hydraulic pump 4 and flywheel accumulator 10. I have construed the speed requirement of claim 1 to mean that the flywheel is to be capable of rotating faster than the hydraulic machine. Whilst it is quite likely that flywheel accumulator 10 in US2011/180287 would be capable of rotating faster than hydraulic pump 4, there is no definite disclosure of this. For example there is no description of the pump 4 being stopped whilst the flywheel accumulator 10 is spinning.

31. In their observations the patentee states their belief that the flywheel and hydraulic machine in US2011/180287 are not “operably coupled” in the manner required by claim 1, since there is direct hydraulic or mechanical connection. As I noted above, I

do not accept this construction of the claim.

32. In terms of the requirements of claim 1, US2007/175209 shows a hydraulic system including hydraulic fluid, a hydraulic machine formed from pumps 16, 38 and motor 36 for pressuring the hydraulic fluid, a hydraulic circuit for delivering the hydraulic fluid to a hydraulic actuator 18, the hydraulic machine 16, 38, 36 being configured to receive the hydraulic fluid from the hydraulic actuator 18 and a kinetic energy storage device in the form of flywheel 40, the system being configured such that the hydraulic machine is operable to transfer energy from the hydraulic fluid received from the hydraulic actuator 18 to the flywheel 40 (see paragraph 0030). However, there is no explicit reference to the flywheel being operably coupled to the hydraulic machine such that the flywheel is capable of rotating faster than the hydraulic machine.

33. Although in their observations the patentee suggests that there is no enabling disclosure for the invention in US2007/175209, I agree with the observations in reply from the requester and in my view the invention is described clearly and completely enough. The observations from the patentee suggest that there is some difficulty with the arrangements of inlets and outlets for the pump 38 and motor 36 shown in figure 2A (not shown here). In fact, as the observations in reply note, the inlets and outlets are positioned as one would expect for a motor and a pump.

34. In EP1439310 there is shown a hydraulic system including hydraulic fluid, a hydraulic machine or pump 11 for pressuring the hydraulic fluid, a hydraulic circuit for delivering the hydraulic fluid to a hydraulic actuator, the hydraulic machine or motor 12 being configured to receive the hydraulic fluid from the hydraulic actuator and a kinetic energy storage device for storing energy in a kinetic form, wherein the kinetic energy storage device is a flywheel 42, the system being configured such that the hydraulic machine is operable to transfer energy from the hydraulic fluid received from the hydraulic actuator to the flywheel (see paragraph 0058). Once again there is no explicit reference to the flywheel being operably coupled to the hydraulic machine such that the flywheel is capable of rotating faster than the hydraulic machine, as I have construed claim 1 to require.

Inventive step of the independent claims

35. To determine whether or not an invention defined in a particular claim is inventive over the prior art, I will rely on the principles established in Pozzoli SPA v BDMO SA [2007] EWCA Civ 588, in which the well known Windsurfing steps were reformulated:

> *(1)(a) Identify the notional "person skilled in the art";*
> *(1)(b) Identify the relevant common general knowledge of that person;*
> *(2) Identify the inventive concept of the claim in question or if that cannot readily be done, construe it;*
> *(3) Identify what, if any, differences exist between the matter cited as forming part of the "state of the art" and the inventive concept of the claim or the claim as construed;*
> *(4) Viewed without any knowledge of the alleged invention as claimed, determine whether those differences constitute steps which would have been obvious to the person skilled in the art.*

36. The request suggests that claim 1 would be obvious in light of US2011/180287 since there would be nothing inventive in a flywheel being capable of rotating faster than a hydraulic pump. I am inclined to agree with this. Whilst the request does not deal with the notional person skilled in the art, to my mind he or she would be a person or a team knowledgeable in a number of fields relating to load handling machines, such as the power and control requirements of such macines, their mechanical and hydraulic design and also the design of energy recovery systems In the terms of Pozzoli the flywheel being capable of rotating faster than the hydraulic pump is the difference between claim 1 and US2011/180287. As construed, the requirement is merely one of capability and I see no invention in the skilled man arranging the motor 4 and flywheel accumulator 10 such that the latter is capable of a higher speed than the former. Indeed I believe that the common general knowledge of such a skilled person would be that energy storage flywheels typically rotate at higher speeds than hydraulic pumps.

37. For similar reasons, to my mind it would be obvious to arrange the system in US2007/175209 or EP1439310 such that the flywheel is capable of rotating faster than the hydraulic machine.

38. In the request independent claim 20 is said to be obvious in view of any of the prior art documents and common general knowledge. The request separates claim 20 into three parts as follows:

20. (a) A method of operating an internal combustion engine including the steps of: providing an internal combustion engine having an exhaust after treatment system;

(b) providing a hydraulic system including hydraulic fluid, a hydraulic machine for pressuring the hydraulic fluid, a hydraulic circuit for delivering the hydraulic fluid to a hydraulic actuator, the hydraulic machine being configured to receive the hydraulic fluid from the hydraulic actuator and a kinetic energy storage device for storing energy in a kinetic form, the kinetic energy storage device being operably connected to the hydraulic machine, the system being configured such that the hydraulic machine is operable to transfer energy from the hydraulic fluid received from the hydraulic actuator to the kinetic energy storage device; and,

(c) starting with the exhaust after treatment system at a temperature below a normal working temperature, starting the internal combustion engine and using the kinetic energy storage device to apply a load to the engine so as to store energy in the kinetic energy storage device and increase the temperature of the exhaust after treatment system.

39. The request considers US3485037, US2011/180287 and US2007/175209 separately from JP2011-127534 and I shall do the same. Part (b) of the claim is very similar to the requirements of claim 1 considered above, except that the kinetic energy storage device in claim 20 need not be a flywheel and there is no requirement for that flywheel to rotate, or be capable or rotating, faster than the hydraulic machine. US3485037, US2011/180287 and US2007/175209 all disclose hydraulic systems meeting the requirements of part (b). None of them explicitly disclose parts (a) or (c), which are therefore the differences between the matter cited and the claim.

40. That leaves the question of whether it would have been obvious to the person skilled

in the art to provide an internal combustion engine having an exhaust after treatment system and to operate it in the manner of part (c).

41. US3485037, US2011/180287 and US2007/175209 all disclose diesel or other internal combustion engines. None of them refer explicitly to exhaust after treatment systems, nor to other details of the engines. The request argues that such systems were common general knowledge at the priority date and that their inclusion in the systems shown in US3485037, US2011/180287 and US2007/175209 would have been obvious to the skilled person. I agree with this contention.

42. None of the three documents discusses the method of operating the systems disclosed starting with the exhaust after treatment system at a temperature below a normal working temperature. US3485037 is virtually silent as to how an engine would function with the system shown. US2011/180287 shows a system in which the engine 1 may be disconnected from the remainder of the system by clutch 2, so it would certainly not be inevitable that the kinetic energy storage device would apply a load to the engine. I cannot see that it would be obvious for the skilled man to operate the systems shown in US3485037 and US2011/180287 in the manner required by part (c) of claim 20.

43. In the system shown in US2007/175209 the pump 16 is directed connected to engine 10 and is therefore driven constantly once the engine is running. Since pump 16 is driven constantly is seems that hydraulic fluid is constantly circulating from sump 14 through pump 16 and back to the sump 14. In doing so the fluid would pass through motor 36 which is connected via pump 38 to kinetic energy storage device 40. In paragraph 0021 this connection is described as being "by way of, for example, a common shaft 58, a gear train (not shown), a cam mechanism (not shown), a linkage system (not shown), or in any other appropriate manner such that a rotation of driving element 36 results in an actuating motion of the connected components". Although paragraph 0024 envisages an optional clutch associated with the kinetic energy storage device 40 this seems to me to mean that US2007/175209 discloses an arrangement in which the kinetic energy storage device 40 is constantly driven by engine 10. Provided the engine 10 were provided with an exhaust after treatment system this would inevitably result in the system meeting part (c) of claim 20. Since I have already concluded that providing an exhaust after treatment system would have been obvious, it follows that claim 20 would have been obvious.

44. The request also argues that claim 20 was obvious in view of JP2011-127534. This document discloses the internal combustion engine having an exhaust after treatment system required by part (a) of claim 20, that engine operating in the manner required by part (c) of claim 20. The difference identified between JP2011-127534 and claim 20 therefore lies in the hydraulic system of part (b) of claim 20. JP2011-127534 does show a hydraulic system including hydraulic fluid, a hydraulic machine or pump 51 for pressuring the hydraulic fluid and a hydraulic circuit for delivering the hydraulic fluid to a hydraulic actuator 16. Paragraph 0025 suggests that the hydraulic machine or pump 51 is configured to receive the hydraulic fluid from the hydraulic actuator 16 as it is lowered and that kinetic energy is recovered. However, no kinetic energy storage device for storing energy in a kinetic form is disclosed, there is no mention of an energy storage device being operably connected to the hydraulic machine or pump 51, nor of the system being configured such that

the hydraulic machine is operable to transfer energy from the hydraulic fluid received from the hydraulic actuator to the an energy storage device. There is no mention of any use of energy storage battery 66 to store energy derived from fluid actuators.

45. The request goes on to suggest that these differences can be found in US2011/180287 and that it would therefore be obvious to configure the system of JP2011-127534 as in US2011/180287. Without further argument the request also suggests that it would be obvious to apply the teaching of JP2011-127534 to any of US3485037, US2007/175209 or US2011/180287. This appears to be an attempt to suggest that a mosaic of two patent documents demonstrates that the invention was obvious. Whilst such a mosaic is potentially viable, the request does not explain why the skilled man presented with any one of these documents would think it obvious to supplement the disclosure of that document with other information. For example it is not established that the relevant information in any of these documents was common general knowledge. Nor is it explained why the skilled person would come across the documents and consider them together. In the absence of such justification I do not see that it is justified to conclude that the invention of claim 20 was obvious in light of the combinations of documents proposed in the request.

Dependent claims

46. Having considered the independent claims, in view of the large amount of prior art included in the request I do not consider it appropriate to consider the novelty and inventiveness of each of the other 31 dependent claims.

Opinion

47. It is my opinion claim 1 of the patent is not novel in light of prior art document US3485037.

48. Further, it is my opinion that claim 1 is obvious in light of US2011/180287, US2007/175209 or EP1439310.

49. In my opinion claim 20 is obvious in view of US2007/175209 and common general knowledge.

Application for review

50. Under section 74B and rule 98, the proprietor may, within three months of the date of issue of this opinion, apply to the comptroller for a review of the opinion.

Karl Whitfield
Examiner

NOTE

This opinion is not based on the outcome of fully litigated proceedings. Rather, it is based on whatever material the persons requesting the opinion and filing observations have chosen to put before the Office.