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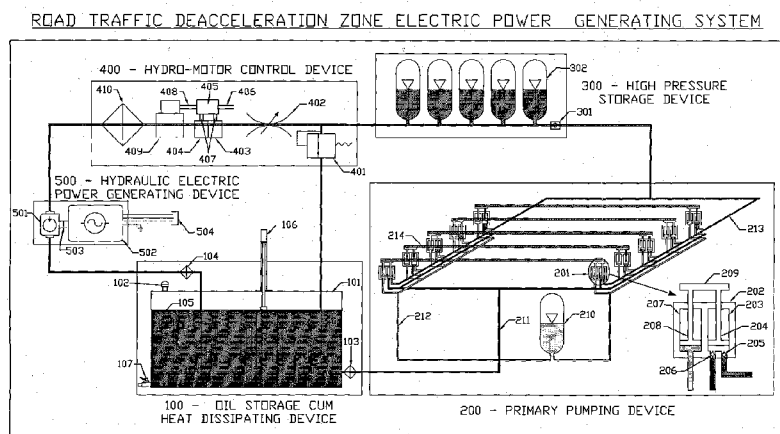
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(54) Title: ROAD TRAFFIC DECELERATION ZONE ELECTRIC POWER GENERATING SYSTEM



(57) Abstract: A road traffic deceleration zone electric power generating system and method for pumping oil from low pressure to high pressure when vehicles pass over the linking slats and converting lost energy of moving vehicles into electrical power. The system comprises an oil storage cum heat dissipating device, a pumping device, a high pressure storage device a hydro-motor control device and a hydraulic electric power generating device. The pumping device comprises a plurality of pairs of guided cylinder assemblies. Each pair of guided cylinder assemblies comprising a compounding of two hydraulic cylinders namely a pumping cylinder and a guide cum retract cylinder. Each pair of guided cylinder assembly is linked by a slat.

**“ROAD TRAFFIC DECELERATION ZONE  
ELECTRIC POWER GENERATING SYSTEM”**

## FIELD OF THE INVENTION

[0001] The present invention relates to an electric power generating method and system actuated by a kinetic energy harvesting mechanism. The present invention specifically relates to a system and method for generation of electrical power from lost energy in deceleration zones.

## BACKGROUND OF THE INVENTION

[0002] Energy harvesting devices are capable of generating power from untapped deceleration energy of vehicles which can be used for a variety of applications. These devices have tremendous potential to meet our global energy challenges.

[0003] Currently there are devices which are capable of generating power by pumping fluid from a reservoir to an accumulator by the actuation of energy collection devices in the path of traffic flow and the fluid from the accumulator is used to drive an electric power generator. US Patent No. 2007/0085342 A1 discloses a pumping device in which spring retracted single acting hydraulic cylinders are used, and during retraction the spring force will be maximum when piston is at bottom dead centre and gradually decreases when approaching top dead centre and will be minimum at top dead centre. That is retracting force varies according to piston stroke length, for example if piston stroke length is 120 mm and spring rate (stiffness) is 25kgf / mm the spring force variation is 25kgf to  $120 \times 25 = 3000$  kgf, whereas 75kgf force may be sufficient for actual retraction of the piston. The actual required retraction force 75kgf is only 2.50% of maximum spring force of 3000kg, balance 97.50% of spring force contributes only to reduce the pumping efficiency, which is an undesired effect.

[0004] Presently there are also hydraulic motor coupled power generating devices which do not have a hydraulic motor function controlling device. Some of the disadvantages in this arrangement are as follows:

(i) the speed of the hydraulic motor cannot be set to the synchronous speed of the alternator which is mandatory to distribute the generated electric power either to an isolated area or to a common grid.

(ii) the automatic start / stop action of hydraulic motor cannot be achieved this is also essential during continuous round the clock operation of the system.

(iii) pressurized hydraulic oil supply to motor has no filtration, this is essential to prevent jamming of hydraulic motor.

(iv) pressurized hydraulic oil supply to motor has no safety or pressure relief valve which is mandatory for protecting all the hydraulic components in the system from damages or failure.

[0005] Another lacuna of current systems is of oil storage devices which do not have oil level indicating unit, breather, suction strainer and return line filter.

### SUMMARY OF THE INVENTION

[0006] The object of the present invention is to generate electrical energy from the wasted kinetic energy in road traffic deceleration zone.

[0007] Advantages of the electrical power generating system are as follows:

[0008] A guided cylinder assembly in the primary pumping device gives a constant retraction force throughout the stroke length.

[0009] A hydro-motor control device with the ability to perform functions of speed adjustment of hydro-motor, automatic start/stop of hydro-motor, proper filtration of oil and pressure relief or safety drain of hydraulic oil.

[00010] An oil storage cum heat dissipating device equipped with an oil level indicating breather cap, suction strainer and return line filter adds functionality for proper functioning of the oil storage cum heat dissipating device.

[00011] In accordance with one aspect, the present invention, which achieves the objectives, relates to a system for generating electricity from moving vehicles, comprising an oil storage cum heat dissipating device; a pumping device operatively connected to the oil storage cum heat dissipating device; the pumping device comprising a plurality of pairs of guided cylinder assemblies; each pair of guided cylinder assemblies comprising a compounding of two hydraulic cylinders namely a pumping cylinder and a guide cum retract cylinder; said each pair of guided cylinder assembly linked by a slat; a high pressure storage device operatively connected to the pumping device; a hydro-motor control device operatively connected to the high pressure storage device; and a hydraulic electric power generating device operatively connected to the hydro-motor control device and the oil storage cum heat dissipating device; whereby oil is pumped from low pressure to high pressure when a vehicle passes over the linking slats and lost energy of moving vehicles is converted into electrical power.

[00012] In accordance with another aspect, the present invention, which achieves the objectives, relates to a method for generation of electrical power from moving vehicles comprising providing a plurality of linking slats to be pressed downwards by vehicles passing over it

which in turn pushes down a plurality of guided cylinder assemblies comprising a pumping cylinder and a guide cum retraction cylinder; providing a delivery check valve port in the pumping cylinder for allowing oil to exit from the pumping cylinder and be pumped to a high pressure storage device when the guided cylinder assembly is pushed down; pushing the oil in the guide cum retraction cylinder to the medium pressure accumulator; allowing the plurality of linking slats to retract when the vehicle crosses it which in turn retracts the guided cylinder assembly; providing a suction valve port in the pumping cylinder for oil to be sucked from low pressure oil storage cum heat dissipating device to the guided cylinder assembly when the guided cylinder assembly is retracted; allowing the oil from medium pressure accumulator to enter guide cum retracting cylinder; controlling the flow of hydraulic fluid from high pressure storage device to the hydraulic electric power generating device; powering a hydraulic electric power generating device using the high pressure fluid outflow to generate power; returning the hydraulic fluid to the oil storage cum heat dissipating device.

[00013] Further objects and advantages of the invention will become apparent from a consideration of the drawings and ensuing description.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[00014] Referring now to the drawings wherein the showings are for the purpose of illustrating a preferred embodiment of the invention only, and not for the purpose of limiting the same.

[00015] An exemplary embodiment of the present invention is illustrated by way of example in the accompanying drawings in which:

[00016] FIGURE 1 illustrates a road traffic deceleration zone electric power generating system, in accordance with an exemplary embodiment of the present invention;

[00017] FIGURE 2 illustrates an oil storage cum heat dissipating device, in accordance with an exemplary embodiment of the present invention;

[00018] FIGURE 3 illustrates a primary pumping device, in accordance with an exemplary embodiment of the present invention;

[00019] FIGURE 4 illustrates a high pressure storage device, in accordance with an exemplary embodiment of the present invention;

[00020] FIGURE 5 illustrates a hydro-motor control device, in accordance with an exemplary embodiment of the present invention; and

[00021] FIGURE 6 illustrates a hydraulic electric power generating device, in accordance with an exemplary embodiment of the present invention.

[00022] REFERENCE NUMERALS IN DRAWINGS

101 – Oil reservoir (or) tank

102 – Breather cap

103 – Suction strainer

104 – Return line filter

105 – Hydraulic oil

106 – Oil level indicator (float type)

107 – Oil drain valve

201 – Guided cylinder assembly

- 202 - Guided cylinder housing
- 203 - Pumping cylinder
- 204 - Pumping cylinder piston-rod assembly
- 205 - Integral delivery check valve
- 206 - Integral suction check valve
- 207 - Guide cum retract cylinder
- 208 - Guide cum retract cylinder piston-rod assembly
- 209 - Guide bridge plate
- 210 - Accumulator medium pressure
- 211 - Low pressure pipe line
- 212 - Medium pressure pipe line
- 213 - High pressure pipe line
- 214 - Linking slat
  
- 301 - Back pressure locking check valve
- 302 - Accumulator high pressure
  
- 401 - Pressure relief valve (or) drain valve (or) safety valve
- 402 - Flow control valve
- 403 - Pressure switch - lower limit
- 404 - Pressure switch - upper limit
- 405 - Solenoid valve controller
- 406 - AC power supply wire of solenoid valve controller
- 407 - Input signal wires of solenoid valve controller
- 408 - Output signal wires of solenoid valve controller
- 409 - Solenoid valve (normally closed)
- 410 - Pressure line filter
  
- 501 - Hydraulic motor
- 502 - Alternator
- 503 - Motor - Alternator coupler
- 504 - Output wires of Alternator

## DETAILED DESCRIPTION OF THE INVENTION

[00023] The present invention will be described herein below with reference to the accompanying drawings.

[00024] "Slat" as mentioned herein 'a light thin narrow strip of metal'.

[00025] Referring to Figure 1, a system of electrical power generation is illustrated, in accordance with an exemplary embodiment of the present invention. The present invention comprises an oil storage cum heat dissipating device [100], a primary pumping device [200], a high pressure storage device [300], a hydro-motor control device [400], and a hydraulic electric power generating device [500].

[00026] Referring to Figure 2, an oil storage cum heat dissipating device [100] is illustrated, in accordance with an exemplary embodiment of the present invention. The oil storage cum heat dissipating device comprises an oil reservoir (or) tank [101], a breather cap [102], a suction strainer [103], a return line filter [104], hydraulic oil [105], an oil level indicator [106], an oil drain valve [107].

[00027] Oil reservoir [101] stores sufficient amount of hydraulic oil [105] required for smooth functioning of the whole system. The walls of the tank are thermally conductive and dissipate heat to the atmosphere ensuring the oil temperature does not exceed 60 ° C.

[00028] Breather cap [102] installed at the top of the tank keeps the pressure inside and outside the tank constant ensuring smooth suction of oil. During oil topping this cap is opened and fresh oil is added without disturbing the functioning of other installed

components. This facilitates oil topping process even when the system is functioning.

[00029] Suction strainer [103] installed at the bottom side wall of the tank is basically a type of filter which allows free flow of oil and filters larger sized oil impurities thread seal tapes, metal burrs etc. and prevents them to enter the pumping device. This ensures jam free operation of primary pumping device parts. Return line filter [104] fitted at the top of the tank, is mainly to filter larger impurities which may enter the pipeline fittings between Hydromotor and tank during installation and maintenance of hydromotor.

[00030] Oil level indicator [106] is installed at the top of the tank and it is meant for observing or periodic monitoring of the oil level inside the tank without opening the tank covers.

[00031] Oil drain valve [107] fastened at the bottom most point of tank is meant for tapping small quantity of oil for testing without disturbing the functioning of other installed components. This valve is also used for completely changing the oil inside the tank without dismantling the tank cover.

[00032] Referring to Figure 3, a primary pumping device [200] is illustrated, in accordance with an exemplary embodiment of the present invention. The primary pumping device comprises a plurality of guided cylinder assemblies [201], an accumulator medium pressure [210], a low pressure pipe line [211], a medium pressure pipe line [212], a high pressure pipe line [213] and a plurality of linking slats [214]. Each of the guided cylinder assembly comprises a guided cylinder housing [202], a pumping cylinder [203], a pumping cylinder piston-rod assembly [204], an integral delivery check valve [205], an integral suction check valve [206], a guide cum retract cylinder [207],

a guide cum retract cylinder piston-rod assembly [208] and a guide bridge plate [209].

[00033] Guided cylinder assembly [201] is a special compounding of two hydraulic cylinders of same size and stroke namely pumping cylinder [203] and guide cum retract cylinder [207]. Guided cylinder housing [202] compactly houses these two cylinders.

[00034] Pumping cylinder [203] has two oil ports, one port fitted with integral delivery check valve [205] and the second port fitted with integral suction check valve [206].

[00035] Guide cum retract cylinder [207] has one oil port connected to accumulator medium pressure [210] which is pre-filled with nitrogen. This accumulator provides a constant upward force to guide cum retract cylinder piston-rod assembly [208]. This force is utilized for retraction of pumping cylinder piston-rod assembly [204] as the piston-rod assembly of both the cylinders [204] and [208] are rigidly connected to guide bridge Plate [209].

[00036] The guide cum retract cylinder also acts as guide for pumping cylinder piston-rod assembly. This guiding can take any eccentric load exerted by the passing vehicle.

[00037] As the name implies, linking slat [204] links two guided cylinder assemblies [201] by means of guide pillar and bushes. These linking slat guided cylinder assemblies are stacked horizontally as shown in Figure 1 on a vehicle traffic lane. The length of the linking slats is maintained according to the width of the vehicle traffic lane.

[00038] All the integral delivery check valve oil ports [205] are connected to high pressure pipe line [213] and all the integral suction check valve oil ports [206] are connected to low pressure pipe line

[211]. Similarly all the oil ports of guide cum retract cylinders [207] are connected to medium pressure pipe line [212].

[00039] Low pressure pipe line [211] is connected to suction strainer [103] fitted in oil reservoir [101].

[00040] Medium pressure pipe line [212] is connected to accumulator medium pressure [210].

[00041] High pressure pipe line [213] is connected to back pressure locking check valve [301] fitted to high pressure accumulators [302].

[00042] According to an exemplary embodiment of the present invention, the oil pumping process of primary pumping device is provided below:

[00043] Integral suction check valve [206] only allows oil to enter into pumping cylinder [203] from reservoir [101] through low pressure pipe line [211]. This happens when the pumping cylinder piston-rod assembly [204] is retracted.

[00044] Similarly the integral delivery check valve [205] only allows oil to exit from Pumping cylinder [203] which in turn enters into high pressure accumulator [302] through high pressure pipe line [213]. This happens when pumping cylinder piston-rod assembly [204] is depressed (pushed down).

[00045] When the vehicle pass over linking slats [214], the rolling tyres of the vehicle sequentially press the linking slats [214] downwards. Due to this action the piston-rod assemblies of pumping cylinder and guide cum retracting cylinders are pushed down. During this process:

- (i) delivery check valve port [205] of pumping cylinder opens and oil is pushed or pumped out and get stored in high pressure accumulator [302] under high pressure; and
- (ii) oil in the guide cum retraction cylinder is pushed out, the displaced Oil enters the medium pressure accumulator [210]. Nitrogen prefilled Medium pressure accumulator keeps upward force on the Piston-rod assembly of guide cum retraction cylinder constant.

[00046] When the vehicle crosses linking slats [214], the rolling tyres of the Vehicle sequentially release the depressing load on linking slats [214]. Due to this action the upward force of piston-rod assembly of the guide cum retracting cylinder lifts or retracts both the piston-rod assemblies up.

[00047] During this process:

- (i) oil from medium pressure accumulator enters guide cum retracting cylinder through medium pressure pipeline [210]; and
- (ii) suction check valve [206] of pumping cylinder opens and oil from reservoir [101] enters pumping cylinder [203] through low pressure pipe line [211].

[00048] This pumping process happens twice during two axle vehicles passing and thrice during three axle vehicles passing. In proportion to the number of axles in the passing vehicle, the pumping process and amount of oil pumped increases.

[00049] Referring to Figure 4, a high pressure storage device [300] is illustrated, in accordance with an exemplary embodiment of the present invention. The high pressure storage device comprises a back

pressure locking check valve [301] and an accumulator high pressure [302] which is nitrogen pre-filled. This device plays the role of storing high pressure oil required for running hydraulic motor.

[00050] Back pressure lock check valve [301] allows high pressure oil pumped by primary pumping device to enter series mounted high pressure accumulators [302] and does not allow the oil to flow back to the primary pumping device. High pressure accumulators are pre-filled with nitrogen to a pressure required to drive the hydromotor smoothly at synchronous speed. The number of accumulators depends on the back-up running time of hydraulic electric power generating device [500]. It increases with increase of back-up time. This means high pressure storage capacity increases with increase of accumulators mounted in series.

[00051] Referring to Figure 5, a hydro-motor control device [400] is illustrated, in accordance with an exemplary embodiment of the present invention. The hydro-motor control device comprises a pressure relief valve (or) drain valve (or) safety valve [401], a flow control valve [402], a pressure switch – lower limit [403], a pressure switch – upper limit [404], a solenoid valve controller [405], AC power supply wire of solenoid valve controller [406], input signal wires of solenoid valve controller [407], output signal wires of solenoid valve controller [408], a solenoid valve (normally closed) [409] and a pressure line filter [410].

[00052] Pressure relief valve [401] also called as drain or safety valve is set or calibrated to a draining pressure slightly above upper control limit of hydro motor synchronous speed pressure. When the system oil pressure exceeds the set draining pressure the oil from accumulator is drained to reservoir and ensures the system pressure build up does not cross safe limit. This also protects all the other system

components from failure due to high pressure. As usual this valve is installed along with a pressure gauge.

[00053] Flow control valve [402] is used for controlling the volume of oil flowing to hydromotor. The amount of oil flow increases when the valve orifice is opened more. This flow control valve is set for a flow corresponding to the synchronous speed of the hydromotor. When flow control valve orifice opening increases, oil flow increases. Similarly when oil flow increases hydromotor speed (RPM) increases, thus flow control valve helps to control hydromotor speed (RPM).

[00054] Pressure switch lower limit [403] and pressure switch upper limit [404] are installed in hydromotor control device to monitor the hydraulic oil Pressure. When oil pressure build-up reaches upper control limit, switch [404] will be activated and pass electric signal (24 V DC) to solenoid valve controller [405]. Similarly when oil pressure drops below lower control limit, switch [403] will be activated and pass electric signal (24V DC) to solenoid valve controller [405].

[00055] Solenoid valve controller [405] is an electrical device which works with input 230 V AC power source [406] and takes signal [407] from pressure switches [403] & [404], manipulates it and either activates or deactivates the solenoid valve [409] through output signal wires [408]. When solenoid valve is activated, it allows the high pressure oil flow to hydro-motor and when the solenoid valve is deactivated it blocks the high pressure oil flow to hydro-motor.

[00056] The solenoid valve controller function is explained below, in accordance with an exemplary embodiment of the present invention.

- (i) When system pressure fall below lower control limit, it means the accumulators are empty and solenoid valve

[409] will be deactivated by the controller to stop hydromotor by blocking the high pressure Oil flow.

- (ii) (ii) When system pressure build-up reaches upper control limit, it means the accumulators are full and solenoid valve [409] will be activated by the controller to re-start the hydromotor by allowing high Pressure oil flow.
- (iii) When the system pressure is in between lower control limit and upper control limit, it means the accumulators are partially filled and at that particular time.
  - (a) If motor is running it continues to run till system pressure drops below lower control limit.
  - (b) If motor is idle it remains in idle state till the system pressure reaches upper control limit.

[00057] Pressure line filter [410] filters fine oil impurities and delivers high pressure oil to hydromotor [501]. This filtration safeguards motor running at high speed from jamming.

[00058] Referring to Figure 6, a hydraulic electric power generating device [500] is illustrated, in accordance with an exemplary embodiment of the present invention. The hydraulic electric power generating device comprises a hydraulic motor [501], an alternator [502], a motor – alternator coupler [503] and output wires of Alternator [504].

[00059] Hydraulic electric power generating device [500] receives a particular amount of high pressure hydraulic oil from Hydromotor control device [400] and generates alternating current AC. Hydraulic motor coupled alternator present in this device does the job of electric power generation. The outlet oil at low pressure from Hydraulic motor is fed back to the oil storage cum heat dissipating device [100].

[00060] The foregoing description is a specific embodiment of the present invention. It should be appreciated that this embodiment is described for purpose of illustration only, and that numerous alterations and modifications may be practiced by those skilled in the art without departing from the spirit and scope of the invention. It is intended that all such modifications and alterations be included insofar as they come within the scope of the invention as claimed or the equivalents thereof.

[00061] Other modifications will be apparent to those skilled in the art and, therefore, the invention is defined in the claims.

**CLAIMS:**

- 1) A system for generating electricity from moving vehicles, comprising:
  - i) an oil storage cum heat dissipating device;
  - ii) a pumping device operatively connected to the oil storage cum heat dissipating device; the pumping device comprising a plurality of pairs of guided cylinder assemblies; each pair of guided cylinder assemblies comprising a compounding of two hydraulic cylinders namely a pumping cylinder and a guide cum retract cylinder; said each pair of guided cylinder assembly linked by a slat;
  - iii) a high pressure storage device operatively connected to the pumping device;
  - iv) a hydro-motor control device operatively connected to the high pressure storage device; and
  - v) a hydraulic electric power generating device operatively connected to the hydro-motor control device and the oil storage cum heat dissipating device;whereby oil is pumped from low pressure to high pressure when a vehicle passes over the linking slats and lost energy of moving vehicles is converted into electrical power.
- 2) The system of claim 1 wherein the pumping cylinder comprises two oil ports, one fitted with an integral delivery check valve connected to the high pressure storage device and the second port fitted with an integral suction valve connected to the oil storage cum heat dissipating device.
- 3) The system of claim 1 wherein the guide cum retract cylinder comprises at least one oil port connected to an accumulator of medium pressure which is pre-filled with nitrogen.

- 4) The system of claim 1 wherein the oil storage cum heat dissipating device further includes an oil level indicator.
- 5) The system of claim 1 wherein the oil storage cum heat dissipating device comprises a breather cap.
- 6) The system of claim 1 wherein the oil storage cum heat dissipating device comprises a suction strainer.
- 7) The system of claim 1 wherein the oil storage cum heat dissipating device comprises a return line filter.
- 8) The system of claim 1 wherein the high pressure storage device comprises a series connected nitrogen pre-filled oil accumulators.
- 9) The system of claim 1 wherein the high pressure storage device comprises a back pressure locking check valve.
- 10) The system of claim 1 wherein the hydro-motor control device comprises a flow control valve.
- 11) The system of claim 1 wherein the hydro-motor control device comprises a solenoid valve controller.
- 12) The system of claim 1 wherein the hydro-motor control device comprises a pressure line filter.
- 13) The system of claim 1 wherein the hydro-motor control device comprises a pressure relief valve.
- 14) A method for generation of electrical power from moving vehicles comprising:

- i) providing a plurality of linking slats to be pressed downwards by vehicles passing over it which in turn pushes down a plurality of guided cylinder assemblies comprising a pumping cylinder and a guide cum retraction cylinder;
  - ii) providing a delivery check valve port in the pumping cylinder for allowing oil to exit from the pumping cylinder and be pumped to a high pressure storage device when the guided cylinder assembly is pushed down;
  - iii) pushing the oil in the guide cum retraction cylinder to the medium pressure accumulator;
  - iv) allowing the plurality of linking slats to retract when the vehicle crosses it which in turn retracts the guided cylinder assembly;
  - v) providing a suction valve port in the pumping cylinder for oil to be sucked from low pressure oil storage cum heat dissipating device to the guided cylinder assembly when the guided cylinder assembly is retracted;
  - vi) allowing the oil from medium pressure accumulator to enter guide cum retracting cylinder;
  - vii) controlling the flow of hydraulic fluid from high pressure storage device to the hydraulic electric power generating device;
  - viii) powering a hydraulic electric power generating device using the high pressure fluid outflow to generate power;
  - ix) returning the hydraulic fluid to the oil storage cum heat dissipating device.
- 15) The method of claim 14, further including the step of filtering the hydraulic oil before returning to the oil storage cum heat dissipating device.

- 16) The method of claim 14, further including the step of switching off the motor when the hydraulic fluid in the accumulator is zero, and switching on the motor when the hydraulic fluid in the accumulator is full.

FIGURE NO. 1 OF 6

## ROAD TRAFFIC DEACCELERATION ZONE ELECTRIC POWER GENERATING SYSTEM

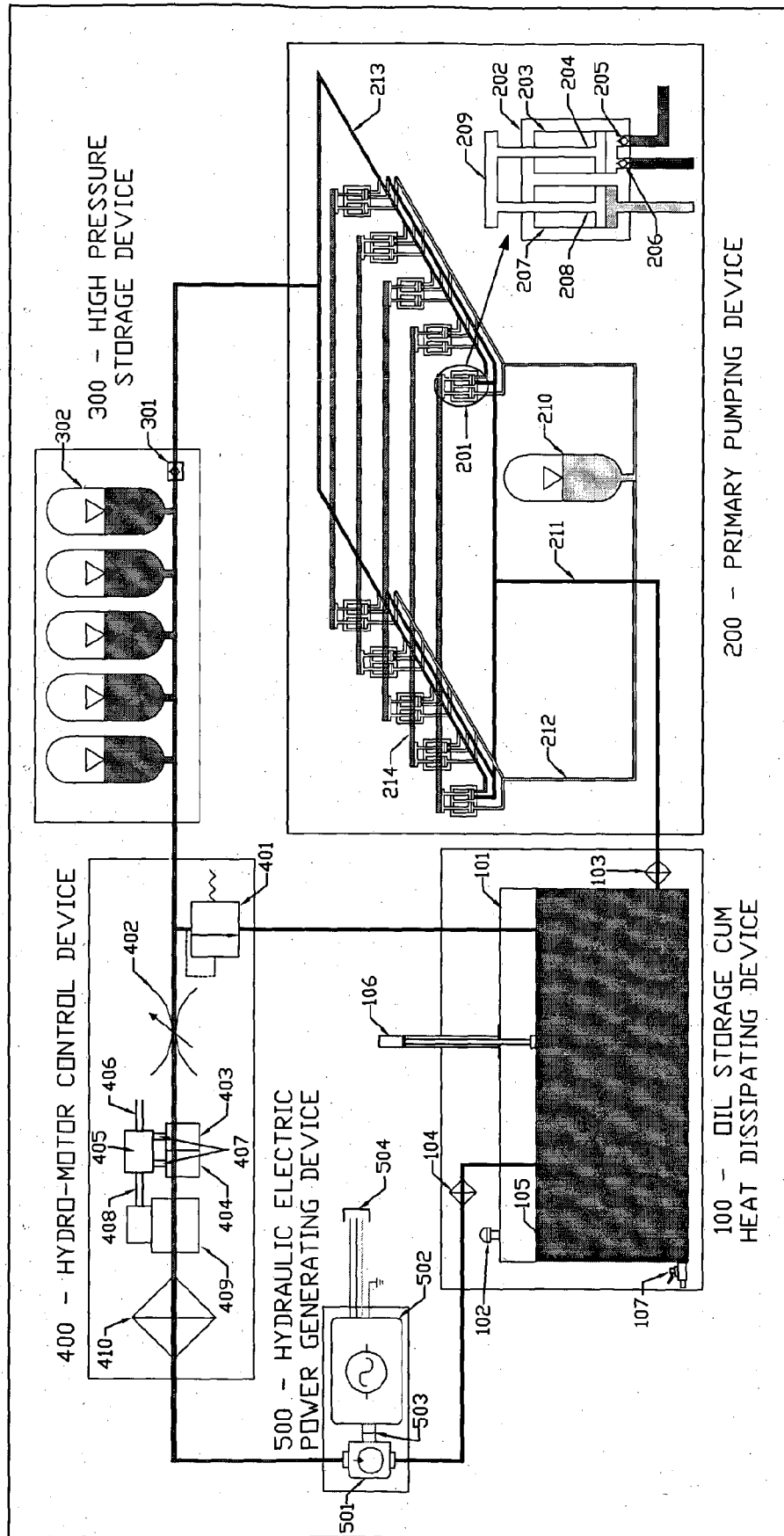
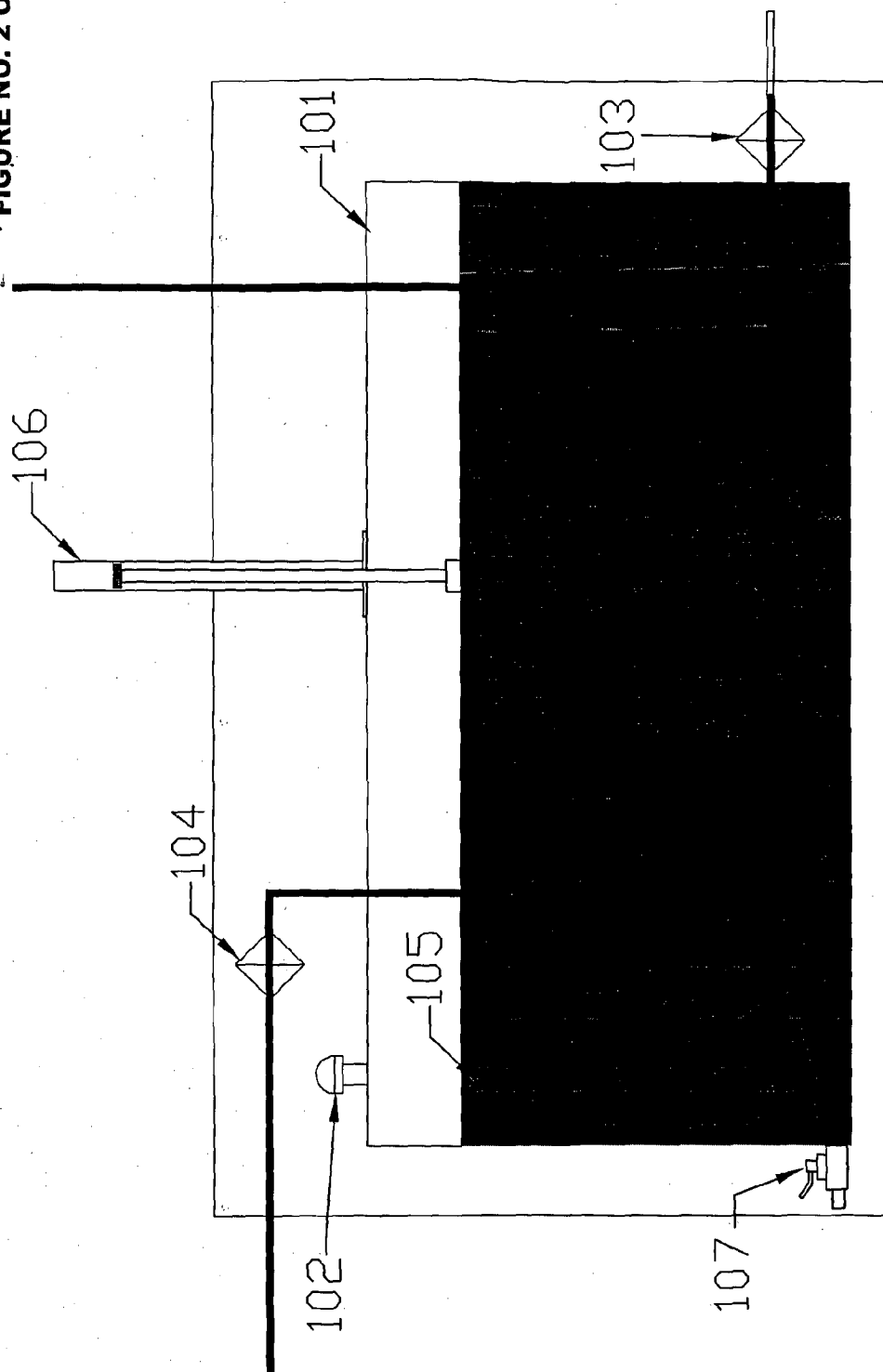
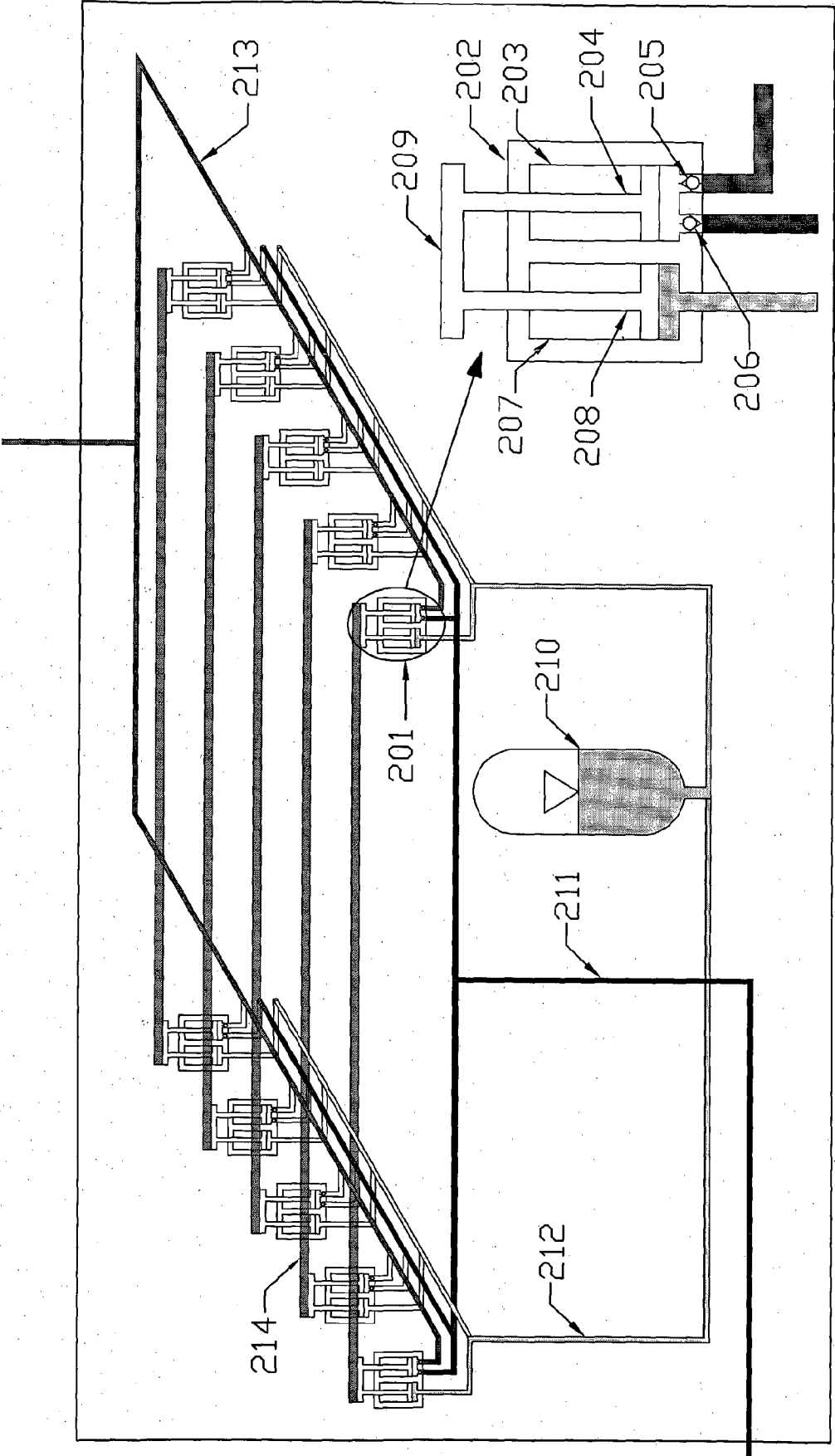


FIGURE NO. 2 OF 6



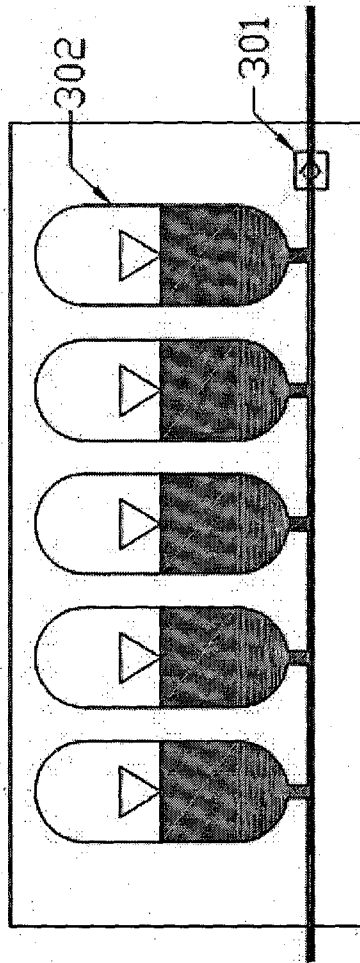
100 - OIL STORAGE CUM  
HEAT DISSIPATING DEVICE

FIGURE NO. 3 OF 6



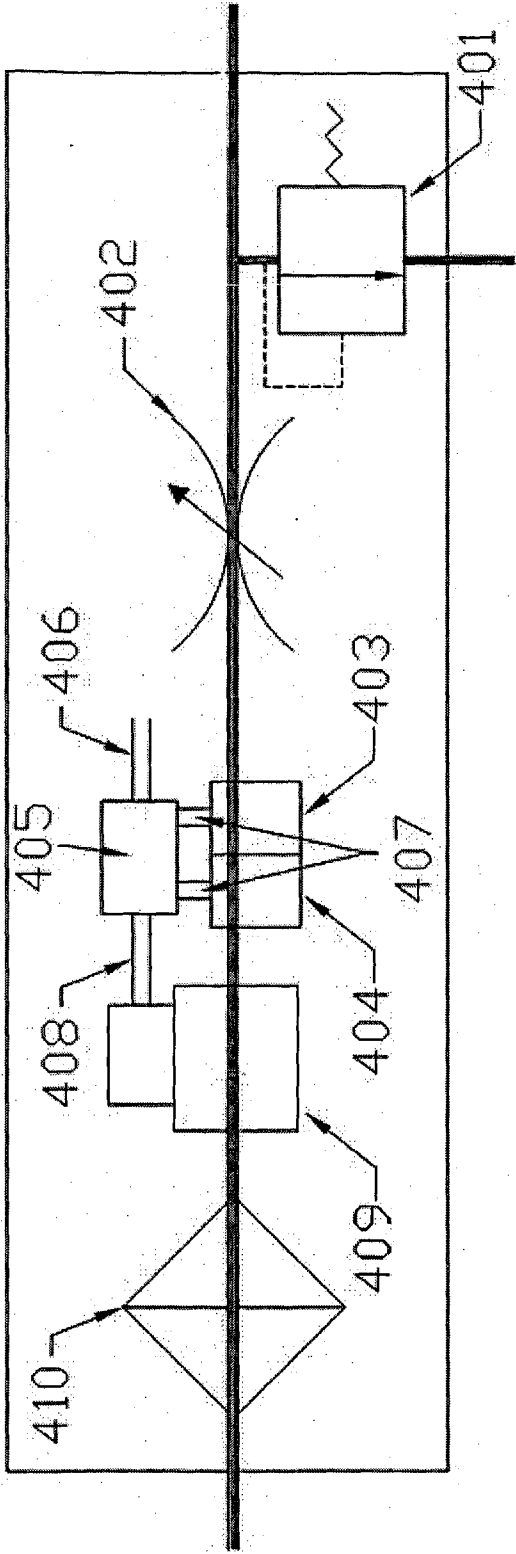
200 - PRIMARY PUMPING DEVICE

FIGURE NO. 4 OF 6



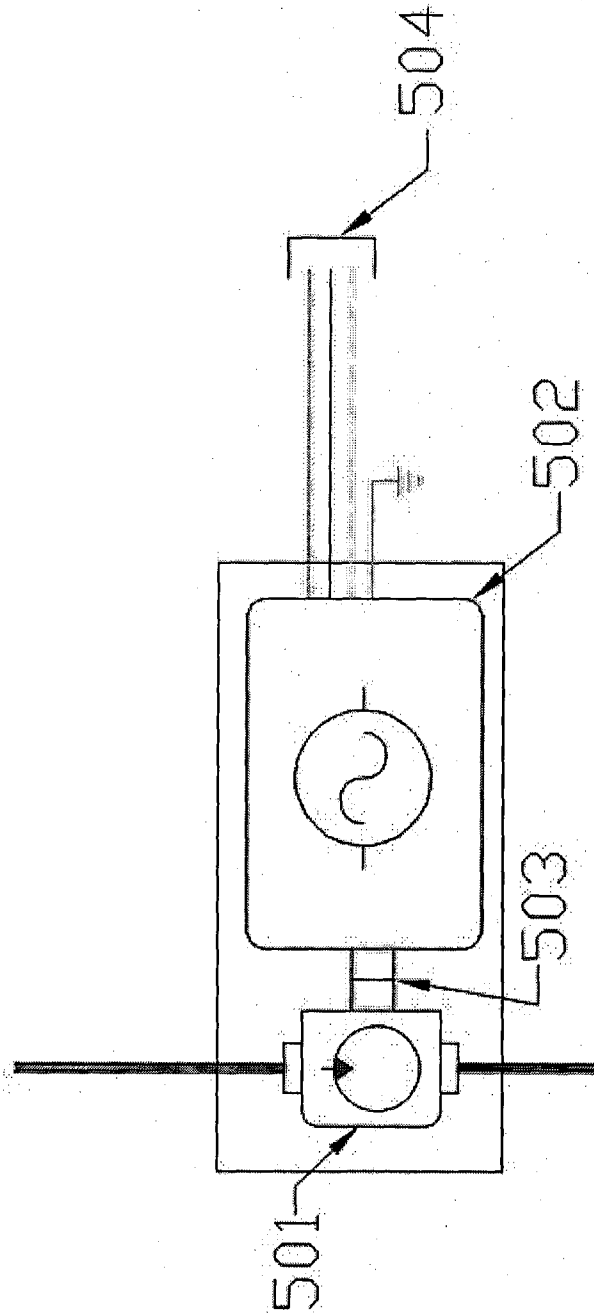
300 - HIGH PRESSURE  
STORAGE DEVICE

FIGURE NO. 5 OF 6



400 - HYDRO-MOTOR CONTROL DEVICE

FIGURE NO. 6 OF 6



500 - HYDRAULIC ELECTRIC  
POWER GENERATING DEVICE

## INTERNATIONAL SEARCH REPORT

International application No

PCT/IN2014/000524

A. CLASSIFICATION OF SUBJECT MATTER  
INV. F03G7/08  
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
F03G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2008/224477 A1 (KENNEY TERRY DOUGLAS [US]) 18 September 2008 (2008-09-18) paragraphs [0012] - [0053]; figures 1,2,5,9,10 -----	1-16
Y	CN 2 188 134 Y (WANG YONG [CN]) 25 January 1995 (1995-01-25) page 1 - page 3; figures 1,2 -----	1-16
Y	US 2005/001430 A1 (RICKETTS TOD A [US]) 6 January 2005 (2005-01-06) paragraphs [0062] - [0088], [0124]; figures 1-5,26, -----	1-16



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

23 January 2015

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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