



(51) International Patent Classification:
F16H 3/08 (2006.01)

(21) International Application Number:
PCT/IN2020/050298

(22) International Filing Date:
28 March 2020 (28.03.2020)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
201941012934 30 March 2019 (30.03.2019) IN

(71) Applicant: **TVS MOTOR COMPANY LIMITED**
[IN/IN]; "Jayalakshmi Estates", No.29 (Old No.8), Haddows Road, Chennai, 600 006 (IN).

(72) Inventors: **GNANAKOTAIAH, Gutti**; TVS Motor Company Limited, "Jayalakshmi Estates", No.29 (Old No.8), Haddows Road, Chennai, 600 006 (IN). **VENUGOPALAN, Pattabiraman**; TVS Motor Company Limited, "Jayalakshmi Estates", No.29 (Old No.8), Haddows

Road, Chennai, 600 006 (IN). **MAHESH KUMAR, Muniyachary**; TVS Motor Company Limited, "Jayalakshmi Estates", No.29 (Old No.8), Haddows Road, Chennai, 600 006 (IN).

(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,

(54) Title: A TRANSMISSION ASSEMBLY

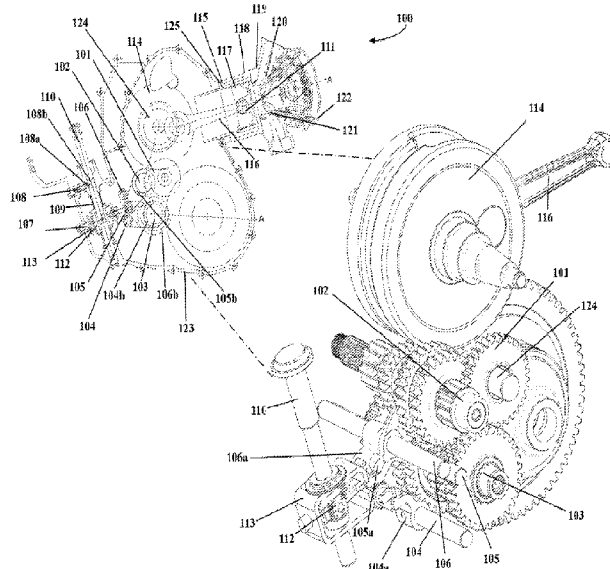


Fig. 1

(57) Abstract: The present invention related to the hybrid transmission system, wherein said hybrid transmission system comprises high torque system and low torque system. The reduction gear ratio for high torque system ranges from 3.0 to 1.0 and for the low torque system it ranges from 1.5 to 0.5. The hybrid transmission system ensures efficient transmission accompanied by less noise and smooth gear shift operation. The hybrid transmission system configured to have compact layout and less weight.

MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- *as to the identity of the inventor (Rule 4.17(i))*
- *of inventorship (Rule 4.17(iv))*

Published:

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*
- *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

A TRANSMISSION ASSEMBLY

TECHNICAL FIELD

[0001] The present subject matter relates to an internal combustion (IC) having transmission system. More particularly, the present subject matter relates to a transmission system for an IC engine.

5

BACKGROUND

[0002] Automotive engines are configured to have high power to weight ratio, this is achieved by high rotational speed, and the internal combustion (IC) engine are the source for that power. The internal combustion (IC) engine comprises a cylinder head, abutting a cylinder block to form a combustion chamber where the burning of air fuel mixture occurs. The forces generated due to combustion of air fuel mixture is transferred to a piston which is capable of reciprocating inside the cylinder block, and this reciprocating motion is transferred to rotary motion of the crankshaft through a connecting rod by the slider crank mechanism. Many vehicles operate on multi-stage transmission system, wherein a crankshaft of the IC engine is connected to a wheel of the vehicle through multi stage reduction gear train.

[0003] As in automobiles torque and speed are important parameters, these can vary as per different segment of the vehicle; likewise the vehicles are designed by keeping these two parameters in mind. It is always a challenge for the automobile manufactures to have appropriate balance between both torque and speed, so in order to achieve different speed at varying loads similarly different torque at different loads requires gearbox. Power generated from the power unit when transmitted directly to rear wheel will lead to inappropriate torque because direct drive results in uncontrolled speed or sub optimal speed and operating conditions to achieve best engine performance i.e. torque and rpm (revolutions per minute), therefore, best vehicle performance and optimal operating conditions, to transmit power from the power unit to rear wheel of the vehicle, a transmission or gear box is typically provided. However, a trade-off between torque requirement and fuel economy is difficult as at higher torque requirements, the fuel economy drops.

30 The critical issues involved in the design of the transmission system are to

consider improving efficiency, better operability and reduce transmission losses and at the same time retain its attractive features of low cost and easy drivability. The gear box provides the various kind of gear ratio as per user requirement. The gearbox is like a machine having controlled application enclosing various gears of different sizes, shafts. The gear box has a multiple gear ratio with ability to switch between various speeds. There are many modes of switching like manually or automatically. Automatic transmission system and manual transmission system implemented in such vehicles are known in art. Introducing automatic transmission systems in low cost and compact layout of vehicles is difficult in view of the adverse impacts viz. size, layout, cost, weight, number of parts to accommodate the additional transmission components such as clutch, gear trains and one way clutches on other hand the manual transmission allow driver to select different speed ratio or gear ratio manually and above all high cost. Some special skill of driving is required to operate this type of gear box. The manual transmissions are of different types based on the vehicle segment and customer requirements. The different types of manual transmission gearbox known in art including sliding mesh gearbox, constant mesh gearbox and synchromesh type of gear box known in the art.

[0004] The sliding mesh gear box and constant meshing gear box have its own disadvantages as the gear shifting is accompanied by noise, probability of poor engagement and high rattling. The synchromesh gear box is improvement over constant mesh gear box which assures smooth and good engagement probability while gear shifting but besides the known advantages of synchromesh gear box it involves high cost due to inbuilt complex design and mechanism. So, it is always a challenge for the automobile players to design a gear box which is more efficient and less costly. The trade-off between efficiency and cost is critical aspect for the automobile players. At the same time the design should be so compact which will not adversely affect or compromise the vehicle layout.

[0005] Hence, there is a need for an improved transmission system which alleviates one or more drawbacks highlighted above and other problems in known art.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The detailed description is described with reference to the accompanying figures. The same numbers are used throughout the drawings to
5 reference like features and components.

[0007] **Fig. 1** is a left side view of an engine with transmission system and enlarged perspective view of transmission system as per preferred embodiment of the present invention.

[0008] **Fig. 2** illustrates the top cut section view of the engine (100) having
10 transmission system across Plane A-A and enlarged perspective view of the transmission system as per preferred embodiment of the present invention.

[0009] **Fig. 3** illustrates the enlarged view of the fig.2 showing gear shifting operation for the high torque system i.e. first and second gearing where few parts are omitted from the fig. 2 as per preferred embodiment of the present invention.

15 [00010] **Fig 4** illustrates the enlarged view of the fig.2 showing gear shifting operation for the low torque system i.e. third and fourth gearing where few parts are omitted from the fig. 2 as per preferred embodiment of the present invention as per preferred embodiment of the present invention.

[00011] **Fig. 5** illustrates the enlarged view of the fig.2 showing gear shifting
20 operation for the fifth and reverse gearing where few parts are omitted from the figure 2 as per preferred embodiment of the present invention.

[00012] **Fig. 6** illustrates the side cut section view of the engine having transmission system and shows the top cut section view of the engine (100) having transmission system across Plane C-C showing gear shifting operation for
25 the fifth to reverse gearing as per preferred embodiment of the present invention.

DETAILED DESCRIPTION

[00013] Various features and embodiments of the present invention here will be discernible from the following further description thereof, set out hereunder.
30 According to an embodiment, an internal combustion (IC) engine described here operates in four cycles and is configured with a single combustion chamber /

single cylinder. Such an internal combustion (IC) engine is installed in three or four wheeled vehicles. It is contemplated that the concepts of the present invention may be applied to other types of engines e.g. multi cylinder engines, different types of vehicles employing the similar transmission within the spirit and scope of this invention. Further "front" and "rear", and "left" and "right" referred to in the ensuing description of the illustrated embodiment refer to front and rear, and left and right directions as seen from a rear portion of the engine and looking forward. Furthermore, a longitudinal axis unless otherwise mentioned, refers to a front to rear axis relative to the engine, while a lateral axis unless otherwise mentioned, refers generally to a side to side, or left to right axis relative to the engine. The detailed explanation of the constitution of parts other than the present subject matter which constitutes an essential part has been omitted at suitable places.

[00014] However, it is contemplated that the disclosure in the present invention may be applied to any vehicle without defeating the spirit of the present subject matter. The detailed explanation of the constitution of parts other than the present invention which constitutes an essential part has been omitted at suitable places.

[00015] An internal combustion (IC) engine typically comprises at least a cylinder block which includes a cylinder bore, a piston reciprocating in the cylinder bore, a cylinder head located above the cylinder block and a combustion chamber interposed between the cylinder head and the cylinder block. During operation of the internal combustion (IC) engine, the burning of air fuel mixture occurs in the cylinder block. The forces generated due to combustion of air fuel mixture is transferred to a piston which is capable of reciprocating inside the cylinder block, and this reciprocating motion is transferred to rotary motion of the crankshaft through a connecting rod by the slider crank mechanism. The cylinder head comprises intake valve and exhaust valve which control the intake of air fuel mixture inside the combustion chamber, and controls the exit of exhaust gases after combustion respectively.

[00016] The IC engine is typically functionally connected to a rear axle of the vehicle, which provides the forward motion to the vehicle. Alternatively, the

torque output from the power unit may be connected to the front axle or both front & rear axles. Typically, the frame assembly acts as a skeleton for the vehicle that supports the vehicle loads.

[00017] Conventionally, in the vehicles, there is a problem of low torque at low speeds. For example, when the vehicle is climbing a gradient on the road or heavy load is to be pulled there is requirement of a lot of torque at the rear wheel to pull the vehicle, and the transmission system may not be able to provide the same. Further, moving at low speeds with less torque results in loss of fuel economy. Furthermore, at higher speeds, a fixed transmission ratio gives limitation to speeds at which the vehicle can travel and results in loss of fuel economy. Hence, the transmission system may not be able to provide sufficient torque and the internal combustion engine may get stalled / switched off. Hence, the design of existing IC engine and its related components disposed within it is critical as it is designed in optimizing the engine layout to make it less bulky and easy to assemble, maintain and service. Designing an efficient & small size transmission system in a compact layout involves extensive design and layout challenges, which is not only difficult but also cumbersome and difficult to access during service / repair.

[00018] Further, a transmission system should be implementable with minimal compromises on the vehicle layout as well as frame structure supporting the IC engine. Furthermore, from manufacturer point of view, there is always a need to minimise product variety and standardize parts so as to be able to manufacture different types / models of vehicles catering to various markets, customers & usage segments. Variety and changes in vehicle aggregates leads to high cost, complexity in manufacturing as well as difficulties in the entire logistics of the life cycle of the vehicle including field spares supply and maintenance. There is often a need to have a flexible vehicle design which can be able to quickly adapted to different powertrain and transmission configuration e.g. single speed to multispeed based on customer needs and requirements.

[00019] An automatic transmission is one of the obvious choices but not very desirable as it can adversely affect the vehicle's mechanical efficiency, fuel consumption, and cost. It can accommodate the range of vehicle needs and can

operate smoothly. In this regard, there are many transmission mechanisms known in art. But the automatic transmission systems have drawbacks wherein additional components are introduced causing layout constraints in the design. Such additional components include the introduction of a new transmission stage

5 in the existing transmission like gear train mechanism and multiple centrifugal clutches. This requires complete overhaul of the IC engine layout and involves extensive research and development and considerable investment to design a new IC engine with an automatic transmission system. The crankshaft can accommodate only selected components, and hence any addition of new

10 components such as gear pump, electric start systems are difficult. This also increases the cost of the vehicle extensively. Further, changes in IC engine layout affects its space occupied in the vehicle and hence involves complete redesign of frame assembly to support the IC engine and change its location. Moreover, the change in design leads to increase in the size of the crankcase and modifying the

15 existing design leads to more cost to due complex machinability of intrinsic parts. Hence, there is a need to introduce transmission systems with least and/or minimum changes in IC engine layout which is configurable to cater to different requirements outlined above. Also, in transmission systems known in existing art, serviceability is difficult due to difficulty in removal and access.

20 **[00020]** On the other hand, a manual transmission system allows driver to select different speed ratio or gear ratio manually. Hence some special skill of driving is required to operate this type of gear box. The manual transmission system has different types which includes sliding mesh type gear box, constant mesh type gear box and synchromesh type of gear box. All these types are known in the arts.

25 **[00021]** The sliding mesh gear box comprises gearing on the main shaft which are configured to move right or left for meshing them with suitable gears on the counter shaft for obtaining different gear ratio. In this sliding mesh type gear box, the gears are meshed by sliding because of that superior skill is required to operate this kind of gear box and there are high chances of wear and tear of gears in

30 gearbox. This kind of gear box typically encompasses spur type gears owing to which during gear shifting the engagement probability is very poor accompanied

by noise which irritates the driver and passengers. Additionally, it requires more effort to change the gear. Due to these inherent disadvantages there are more chances of failure since gear tooth while sliding has to bear more impact loading and recurrent changing of gears increases the probabilities of gear failure which results in poor durability and life compared to other type of gear box known in the art. Despite, inherent disadvantages of the sliding mesh gear box these are preferred due to high efficiency and low cost, so it is challenge for the automobile players to design gear teeth of high stability, durability under fluctuating load albeit same may be achieved by implementing high strength gears which are undesirably costly.

[00022] Further the manual transmission constant mesh is an improvement over the sliding-mesh gearbox as in constant mesh gear box configured to have gearing installed on main shaft, lay shaft and clutch shaft which are in continuous mesh with each other, where the shifting of gear is obtained by the sliding of clutch member i.e. dog clutches over the splined main shaft in order to obtain torque output. Yet the shifting operation of gear is accompanied by noise and is not smooth because of the difference in speed or rpm of the lay shaft, main shaft and clutch shaft at the time of shifting. Moreover, it is less efficient and costlier as compare to other type of gear boxes known in the art. The cost is higher due to additional components like dog clutches. The driver requires tremendous skill to operate this type of transmission system. That gave way to the synchromesh type gearbox. The synchronous type gear box ensures the smooth and quiet shifting of gears due to the use of synchromesh devices; these synchromesh devices helps in bringing the same speed of all the shafts using frictional contact before the meshing of the suitable gears and also causes less wear and tear to the gears. That means operator no longer have to trouble themselves with the inevitability of double declutching during false engagement as they would using a sliding mesh gear box or constant mesh gearbox.

[00023] Besides the known advantages of synchromesh gear box, it involves high cost due to inbuilt complex design and mechanism. So, there exists a challenge for the automobile players to design a gear box which is more efficient, ease to

operate and less costly. The trade-off between efficiency and cost is critical aspect for the automobile players. At the same time the design should be so compact which will enable flexibility across different layouts and platforms of product architectures.

5 [00024] It is therefore an aspect of the invention to provide an efficient transmission system which assures good probability of engagement during gear shifting.

[00025] It is another aspect of the invention to provide an efficient transmission system which assures smooth gear shifting operation with less noise and vibration.

10 [00026] It is yet another aspect of the invention to provide an efficient transmission system which is compact in design and of less weight.

[00027] It is another aspect of the invention as per present embodiment to provide an efficient transmission system enclosing which reduces part count and cost.

[00028] The present subject matter relates to a hybrid transmission system
15 comprises a high torque system and a low torque system operable by H – shift mechanism, wherein said high torque system comprises a synchromesh sleeve assembly and gearing provided on the clutch shaft assembly, drive shaft assembly, said gearing provides first, second forward driving paths from the clutch shaft assembly to the drive shaft assembly with a predetermined gear ratio from first to
20 second forward driving path. The low torque system comprises gearing provided on the input, drive shaft assembly, the gearing providing third, fourth, fifth forward driving path from clutch shaft assembly to the drive shaft assembly with a predetermined reduction gear ratio from the third to fifth forward driving path. The low torque system configured to operate on the lug and slot mechanism.
25 Thus, the hybrid H shift transmission system, configured with a high torque and low torque and / or reverse conditions, the system operates with the principle of engaging a drive gear with a predetermined driven gear to enable torque transmission with a predetermined transmission ratio.

[00029] The aforesaid and other advantages of the present subject matter would be
30 described in greater detail in conjunction with an embodiment of a single cylinder

IC engine with a 5 speed (4 forward + 1 reverse) transmission system with the figures in the following description.

[00030] Fig. 1. Illustrates the engine configured to have five speed transmission

system for a vehicle and enlarged perspective view of the transmission system, the

5 internal combustion (IC) engine (100) comprises a cylinder block (118) includes a cylinder bore (125), a piston (117) reciprocating in the cylinder bore (125) a cylinder head (119) located above the cylinder block (118) and a combustion chamber interposed between the cylinder head (119) and the cylinder block (118).

The cylinder head (119) comprises intake valve (120) and exhaust valve (121)
10 which controls the intake of air fuel mixture inside the combustion chamber, and controls the exit of exhaust gases after combustion respectively. The cylinder head (119) is covered by the cylinder head cover (122) during operation of the internal combustion (IC) engine (100), the burning of air fuel mixture occurs in the cylinder chamber. The forces generated due to combustion of air fuel mixture is
15 transferred to a piston (117) which is capable of reciprocating inside the cylinder block (118), and this reciprocating motion is transferred to rotary motion of the crankshaft (114) through a connecting rod (116) by the slider crank mechanism.

[00031] Typically, in a three or four wheeled vehicle an internal combustion (IC) engine (100) is located at least partially below the seat assembly (not shown) at a

20 lower rear portion of the vehicle. As per alternative embodiment, the internal combustion (IC) engine (100) is located at a front portion of the vehicle. The internal combustion (IC) engine (100) is supported by and attached to the frame assembly (not shown) of the vehicle. A multispeed hybrid transmission system forms a part of the internal combustion (IC) engine (100) and is disposed on the
25 rear portion of the internal combustion (IC) engine (100) and mounted so as to be disposed on right or left of the vehicle.

[00032] In preferred embodiment, the transmission system is disposed towards the center of the engine (100) as viewed from the rear direction of the vehicle. The transmission system is enclosed within a crankcase (123) on the rear side of the
30 internal combustion (IC) engine (100) and the transmission system is enclosed by a housing (not shown) thus forming an enclosed space.

[00033] The transmission system is operable through a manual shift actuator or gear shift lever (not shown) at driver end. The transmission system is configured with a shift mechanism which includes H- shift mechanism. A gear shift actuator system (not shown) configured to have a mounting bracket of the gear shift lever
5 (not shown) mounted in a console which can be placed on the dashboard (not shown) or any position which is within the ergonomic reach of the driver. The movement of gear shifting control system (not shown) is transmitted to a transmission assembly through transmitting means like flexible cable means (not shown) or bracket (not shown) to shift forks in the housing of the transmission. A
10 gear shift and select shaft assembly is partially enclosed within the crankcase (123) that is configured to condition the transmission system for operation in the first to fifth gear ratio and also for reverse drive mechanism.

[00034] The gear shift assembly comprises a gear shift selector shaft (110) which carries the gear shift lever case (113) and gear selector (112). The gear shift lever
15 case (113) houses the gear selector (112) which is fixedly mounted on the gear shift selector shaft (110). The top land (not shown) of gear selector (112) is configured to have a predetermined map (not shown). A gear shift interlock means e.g. a bolt (107) is mounted on the crankcase (123) which is arranged at the top of the gear shift selector shaft (110). The gear shift interlock bolt (107) passes
20 from the guide slot (not shown) provided in the gear shift lever case (113) where it is configured to move over the predetermined map (not shown) by the action of the shift lever (not shown). This develops encoded resistive forces against which the gear shift selector shaft (110) must be moved during the engaging and selecting movements. The gear shift interlock bolt (107) avoids movement of two
25 shift forks to prevent the double meshing of gear.

[00035] A guide bolt (108) is mounted on the crankcase (123) is arranged at the top of the gear shift selector shaft (110). The guide bolt (108) is configured to have a guide ball (108a) which is pushed into the groove (108b) on the gear shift selector shaft (110) by the guide bolt (108) thereby avoiding gear jump and
30 uncertain shifting.

[00036] The gear shift selector shaft (110) is biased in a well-known manner by elastic means e.g. spring (109), spring means (109) provides reaction forces when the gear shift lever (not shown) is released by the driver in the neutral position and also to prevent gear from being directly shifted from 5th to reverse gear.

- 5 [00037] The clutch shaft assembly (102) is represented by a number of clutch shaft assembly gears. The clutch shaft assembly (102) is driven from the transmission input by means well understood within the art.

[00038] The gear select assembly comprises of at least three gear shift shafts (104, 105, 106), at least three yokes (104a, 105a, 106a) (as shown in fig. 2) and at least
10 three shift fork (104b, 105b, 106b) that moves along gear shift shaft (104, 105, 106). As per an aspect of the present subject matter, the three-gear shift shaft (104, 105, 106) includes high torque gear shift shaft (104), low torque gear shift shaft (106) and fifth gear shift shaft (105).

[00039] The high torque gear shift shaft (104) is configured to have a high torque
15 shift fork (104b) and high torque yoke (104a). The low torque gear shift shaft (106) is configured to have a low torque shift fork (106b) and low torque yoke (106a). The fifth gear shift shaft (105) configured to have a fifth gear shift fork (105b) and fifth gear yoke (105a).

[00040] Each shift fork structure (104b, 105b, 106b) is defined by a couple of
20 limbs that define there between a U-shaped opening which extend on opposite sides of the appropriate axially movable member and which turn interiorly for a short distance at the extremities to enter a groove around the central portion of the associated axially movable member . Each shift fork extends upwardly from the axially movable member and thus each axially movable member may be shifted
25 axially on clutch shaft assembly (102) or drive shaft assembly (103) as desired by applying an appropriate force to the upper end of the associated shift fork (104b, 105b, 106b). To support the several shift forks of the transmission the gear shift shaft extends above the clutch shaft assembly (102) in parallel relationship therewith and each such shift fork has an opening near the upper end through
30 which the gear shift shaft extends. Openings of the shift forks (104b, 105b, 106b) are of larger diameter than gear shift shaft (104, 105, 106).

[00041] Fig. 2 illustrates the top cut section view across Plane A-A of the engine (100) having transmission system as per present embodiment and enlarged perspective view of the transmission system. After the burning of air fuel mixture occurs in the cylinder chamber, The forces generated due to combustion of air fuel mixture is transferred to a piston (117) which is capable of reciprocating inside the cylinder block (118), and this reciprocating motion is transferred to rotary motion of the crankshaft (114) through a connecting rod (116) via the slider crank mechanism. The crankcase (123) in which transmission system is present extends rightward (RH) and leftward (LH) in the internal combustion engine (IC) engine (100) in a width direction, said crankcase (123) comprising of a top surface, and a bottom surface, and a plurality of side surfaces of the crankcase, wherein the side surfaces are substantially vertical and configured to extend between the top surface and the bottom surface. The part extended in rightward (RH) direction is known as a crankcase RH (123R) and the part extended in leftward (LH) direction is known as a crankcase LH (123L). Similar to the crankcase (123), a crankshaft (114) also extends rightward (RH) and leftward (LH) in the internal combustion engine (IC) engine (100) in a width direction. This extension results in two parts of the crankshaft (114), first one is known as a crankshaft RH as the crankshaft extends in rightward (RH) direction and second one is known as a crankshaft LH as the crankshaft (114) extends in leftward (LH) direction. The crankcase LH (123L) and crankcase RH (123R) is covered by housing (not shown). This housing (not shown) makes the system leak proof and enables effective lubrication. An oil sump (not shown) is provided in the bottom-side of the crankcase (123) for continuous lubrication and cooling of a piston (117) and a plurality of piston cylinder wall (115) and other parts of the internal combustion (IC) engine (100). The lubrication and cooling of the piston (117), the plurality of piston cylinder wall (115) and other parts of the internal combustion (IC) engine (100) commences once an operation cycle of thermal energy conversion into mechanical energy begins. Once the operation cycle starts, rotation of the crankshaft (114) also starts. A clutch member (213) is installed at one end of

clutch shaft assembly (102) and which is operable to establish a driving connection between clutch shaft assembly (102) and crankshaft (114).

[00042] The crankshaft (114) is configured to have an oil path. An electrical machine (221) e.g. a magneto or an integrated starter generator is installed on the
5 extended portion of the crankshaft RH (114R). The crankshaft LH (114L) is installed with the primary drive gear (201) at its end. The primary drive gear (201) is in direct mesh with the primary driven gear (205). Hence when crankshaft (114) rotates the force is transmitted from to the primary drive gear (201) which is in turn rotates the primary driven gear (205) mounted on the clutch shaft assembly
10 (102). The clutch shaft assembly (102) is supported by journal bearings on the crankcase LH & RH at both its ends & by a ball bearing (212) substantially at its middle portion. The drive shaft assembly (103) is disposed parallel and alongside the clutch shaft assembly (102). The drive shaft assembly (103) supported by bearings (206) on both the ends.

[00043] The crankcase (123) encloses a hybrid transmission system operable by a shifting mechanism. The hybrid transmission system comprises a high torque system and low torque system. The high torque system comprises a high input gearing and high torque output gearing which are in meshing relationship to each other. The high torque input gearing includes at least two drive gears (214, 216)
20 installed on clutch shaft assembly (102). The high torque output gearing includes at least two driven gears (207, 208) installed on drive shaft assembly (103) and operatively connected to drive gears. It is also configured with at least one synchromesh sleeve assembly (219) wherein said high torque input gearing and high torque output gearing provides forward driving path from the clutch shaft
25 assembly (102) to the drive shaft assembly (103) with a predetermined reduction gear ratio. As per an embodiment, the reduction ratio varies in the range of 3.0 to 1.0.

[00044] As per preferred embodiment, the high torque transmission system comprises a first drive gear (214) installed on clutch shaft assembly(102) and
30 engaged with first driven gear (207) ,a second drive gear (216) movable installed on clutch shaft assembly(102) and engaged with the second driven gear

(208), said second drive gear (216) configured to have plurality of lugs(216a) to engage with the corresponding adjacent third drive gear (215), a synchromesh sleeve assembly (219) wherein said synchromesh sleeve assembly (219) is movably installed on the drive shaft assembly (103) to be selectively connected to the first driven gear (207) and second driven gear (208) selectively. Further, the driven gear (207) and the second driven gear (208) is provided with a first driven cone (207a) and a second driven cone (208a) respectively.

[00045] The low torque system comprises low torque input gearing and low torque output gearing. The low torque input gearing includes at least two fixed drive gears (215, 218) installed on clutch shaft assembly (102), said fixed drive gears configured to have lugs or slot selectively, at least two movable drive gear (216, 217) installed on clutch shaft assembly (102), said drive gears (216, 217) configured to have lugs or slots, wherein said movable gears (216, 217) are integrated as single unit.

[00046] The low torque output gearing includes at least one fixedly installed driven gears (209) installed on drive shaft assembly (103), said driven gear (209) configured to have lugs or slots selectively, at least one movable driven gear (210) installed on drive shaft assembly (103), said driven gear (210) configured to have both lugs and slots, wherein said low torque input gearing and low torque output gearing provides forward driving path from the clutch shaft assembly (102) to the drive shaft assembly (103) with a predetermined reduction gear. As per an embodiment, the reduction ratio varies in the range of 1.5 to 0.5.

[00047] As per preferred embodiment, the low torque transmission system comprises a third drive gear (215) installed on clutch shaft assembly(102) and engaged with the synchromesh sleeve assembly (219) , said third drive gear (215) is fixedly mounted and configured to have slots (215a) in order to engage with corresponding lug (216a) of the adjacent second drive gear (216), a fourth drive gear (218) installed on clutch shaft assembly(102) and engaged with a fourth driven gear (210), said fourth drive gear (218) is fixedly mounted on clutch shaft assembly(102) and is configured to have projected lugs (218a) to engage with the corresponding slot (217a) of the adjacent fifth drive gear (217), a fifth drive

gear (217) is movably installed on clutch shaft assembly(102) and engaged with a fifth driven gear (209) to selectively engage with the fourth drive gear (218), said fifth drive gear (217) is integrated with the second drive gear (216). The fourth driven gear (210) is movably installed on drive shaft assembly (103), said fourth
 5 driven gear (210) configured to have projected lugs (210b) (as show in fig. 6) to engage with a corresponding adjacent reverse driven gear (211). The reverse driven gear (211) is fixedly installed on the drive shaft assembly (103). The reverse driven gear (211) is engaged with an idler gear (101) (as shown in fig. 1), said idler gear (101) (as shown in fig. 1) is installed on the idler shaft (124) (as
 10 shown in fig. 1). The idler gear (101) (as shown in fig. 1) is engaged with a reverse drive gear (220), said reverse drive gear (220) is fixedly installed on the clutch shaft assembly (102).

[00048] The gearing system providing first, second, third, fourth, fifth forward driving paths from the clutch shaft assembly(102) to the drive shaft assembly (103), is configured with a predetermined reduction gear ratio between the clutch
 15 shaft assembly(102) and drive shaft assembly (103) from first to the fifth forward driving path. The hybrid transmission system operable by H – shift mechanism.

[00049] The final drive gear (204) is installed on the drive shaft assembly (103) which is in direct mesh with the final driven gear (202). The power or torque is
 20 transmitted from the final driven gear (202) to the differential (203), and subsequently to the drive shaft assembly (103) which is operatively connected to the drive wheels (not shown) of the vehicle, through the differential (203).

[00050] **Fig. 3** illustrates the enlarged view of the fig.2 showing gear shifting operation for the high torque system i.e. first and second gearing where few parts
 25 are omitted from the fig. 2 for clarity. The input for gear shift for the engine end is through the gear selector (112) which actuates the gear shift shaft (104) through the high torque yoke (104a). The gear shift interlock bolt (107) avoids movement of two shift forks to prevent the double meshing of gears. According to preferred embodiment of the present invention the synchronizer sleeve assembly (219)
 30 comprises synchronizer sleeve (303), at least two synchronizer rings (304), synchronizer hub (301) and key (302). When shifting into the first speed from the

neutral stage due to actuation of the shift lever, the gear selector (112) displaces to the left side, this in turn moves the high torque gear shift shaft (104) from neutral position 104N to left position 104L through the high torque yoke (104a). The high torque gear shift shaft (104) displaces the high torque shift fork (104b) through the high torque yoke (104a) to the left side during which the high torque shift fork (104b) moves synchromesh sleeve (303).

[00051] The synchromesh sleeve (303), synchromesh hub (301) configured to have internal splines (not shown) and a meshed key (302) move together to the left side. The end of the key (302) pushes the cone of the synchromesh ring (304) against the cone (207a) of first driven gear (207). This frictional force transmits the rotation force of the synchromesh sleeve (303) to the first driven gear (207). Finally, synchromesh sleeve (303) matches the speed and engages fully to transmit the torque and speed based on the first driven gear (207) according to its gear ratio. It establishes first forward driving path.

[00052] When operator shifts into the second speed from the first speed, the gear selector (112) turns or displaces to the right side, this in turn moves the gear shift shaft (104) from position 104L to 104R through high torque yoke (104a) to the right side. The high torque gear shift shaft (104) displaces the high torque shift fork (104b) through the high torque yoke (104a) to the right side. The high torque shift fork (104b) moves the synchromesh sleeve (303), synchromesh hub (301) and meshed key (302) together to the right. The end of the key (302) pushes the cone of the synchromesh ring (304) against the cone (208a) of second driven gear (208). This frictional force transmits the rotation force of the synchromesh sleeve (303) to the second driven gear (208). Finally, it matches the speed and engages fully to transmit the torque and speed based on the second driven gear (208) according to its ratio. It establishes second forward driving path. These two speeds as discussed are provided with the synchromesh sleeve assembly.

[00053] **Fig. 4** illustrates the enlarged view of the fig.2 showing gear shifting operation for the low torque system i.e. third and fourth gearing where few parts are omitted from the fig. 2 for clarity. When the gear are manually shifted from second gearing to third gearing using the H shift mechanism at the driver end, the

gear selector (112) turns or displaces to left side, it then moves the gear shift shaft (106) towards left i.e. (106N) to (106L), which in turn moves the fifth gear low torque yoke (106a) and shift fork (106b) to the left side, during which the integrated movable drive gear i.e. second drive gear (216) and fifth drive gear (217) moves towards left. The lugs (216a) provided at the second drive gear (216) engage with the slot (215a) provided on third drive gear (215). This engagement transmits the corresponding torque and speed according to the designed ratio. It establishes third forward driving path.

[00054] When the gear is shifted from third gearing to fourth gearing using the selector (112) displaced to right side, it moves the gear shift shaft (106) towards right side, i.e. from 106L to 106R through the low torque yoke (106a). The gear shift shaft (106) moves the torque shift fork (106b) to the right side, during which the slot (217a) provided on the integrated drive gear i.e. i.e. Second drive gear (216) and fifth drive gear (217) is engaged with the lug (218a) provided on the fourth drive gear (218) and transmit the corresponding torque and speed according to the designed ratio. It establishes the fourth forward driving path.

[00055] **Fig. 5** illustrates the enlarged view of the fig.2 showing gear shifting operation for the low torque system having fifth gearing where few parts are omitted from the fig 2 for clarity. When the gear is shifted from fourth gearing to fifth gearing using the H shift mechanism at the driver end, the selector (112) is displaced to left side, it moves the gear shift shaft (105) towards left side i.e. 105N to 105L, which in turn moves the fifth gear yoke (105a), and shift fork (105b) to the left side, during which the slot (210b) provided on the fourth driven gear (210) engages with the lug (209a) provided on the fifth driven gear (209). This engagement transmits the corresponding torque and speed according to the designed ratio. It establishes fifth forward path.

[00056] **Fig. 6** illustrates the side cut section view across Plane C-C of the engine having transmission system and shows the top cut section view of the engine (100) (as shown in fig. 6(a) having transmission system showing gear shifting operation for the fifth to reverse gearing as per present embodiment. The fourth driven gear (210) is movably installed on drive shaft assembly (103), said fourth

driven gear (210) configured to have projected lugs (210a) to engage with a corresponding slot (211a) of the adjacent reverse driven gear (211) wherein said reverse driven gear (211) is fixedly installed on the drive shaft assembly (103). The reverse driven gear (211) is engaged with an idler gear (101) which is
5 installed on the idler shaft (124). The idler gear (101) is engaged with a reverse drive gear (220), said reverse drive gear (220) is fixedly installed on the clutch shaft assembly (102). So when the gear is shifted to reverse speed using the H shift mechanism at the driver end, the gear selector (112) is displaced to right side, it moves the fifth gear shift shaft (105) (as shown in fig. 5) towards right i.e. 105L
10 to 105R, which in turn moves the fifth gear yoke (105a) (as shown in fig. 5) and fifth gear shift fork (105b) (as shown in fig. 5) to the right side, during which the lug (210a) provided on the fourth driven gear (210) engages with the slot (211a) provided on reverse driven gear (211). This engagement transmits the corresponding torque to idler gear (101) which in turn rotates the reverse drive
15 gear (220) to the designed reverse gear ratio. It establishes the reverse gearing path.

[00057] The hybrid transmission system ensures smooth engagement of gears accompanied by less noise during gear shifting due to synchromesh sleeve assembly in higher torque gears thereby eliminating undesirable struggle for the
20 drivers typically experienced during traffic conditions from Neutral gear to first gear and first gear to second gear and also during the down shifting from second to first gear and first gear to neutral. The present subject matter enables eliminating fatigue of the driver. This ease of operation and comfort achieved while changing the low torque gears speed gears and vice versa is due to inertial
25 effects at corresponding speeds of the overall gear train system. Also, the disclosed subject matter involves less number of operations by configuring a Lug and slot shifting mechanism which is more efficient. The provision of lug and slot leads to use of standardized parts across different types of transmission system viz. synchromesh or the like and also achieves the flexibility in the design with
30 less cost.

[00058] The hybrid H-shift transmission system ensures more driver comfort as the double declutching is avoided and tremendous skill required to change gears is avoided at the driver end. As per an embodiment, the hybrid transmission can be implemented for a powertrain involving at least one high torque ratio and at least one low torque ratio and at least one reverse ratio i.e. at least a 3 speed (2 forward + 1 reverse) system.

[00059] While the present invention has been shown and described with reference to the foregoing preferred embodiments, likewise the shifting mechanism is not limited to the H shift mechanism, so it will be apparent to those skilled in the art that changes in form, connection, and detail may be made therein without departing from the spirit and scope of the invention.

List of references

100 – Engine	30 106a – (3 – 4) Low torque yoke
101 – Idler gear	106b – (3 – 4) Low torque shift fork
15 102 – Clutch shaft assembly	106 R - Right, 160N – Neutral, 160L - Left
103 – Drive shaft assembly	107 – Gear shift interlock bolt
104 – (1-2) High torque Gear shift shaft	35 108 – Guide bolt
104a – (1-2) High torque yoke	109 – Springs
20 104b – (1-2) High torque Shift fork	110 – Gear shift selector shaft
104R – Right, 104N - Neutral, 104L - Left	111 – Pin to connect Piston and connecting rod
105 – (5 – R) fifth Gear shift shaft	40 112 – Gear selector
105a – (5 – R) fifth gear yoke	113 – Gear shift lever case
25 105b – (5 – R) fifth gear Shift fork	114 – Crankshaft
105 R - Right, 105N - Neutral, 105L - Left	114L – Crankshaft LH
106 – (3 – 4) Low torque gear shift shaft	114R - Crankshaft RH
	45 115 – Piston wall

116 – Connecting rod	210a – Lug on fourth driven gear
117 – Piston	210b – Slot on fourth driven gear
118 – Cylinder block	25 211 – Reverse driven gear
119 – Cylinder head	211a – Slot on reverse driven gear
5 120 – Inlet Valve	212 – Clutch shaft assembly bearing
121 – Exhaust valve	213 – Clutch
122 – Cylinder head cover	214 – First drive gear
123 – Crankcase	30 215 – Third drive gear
124 – Idler shaft	215a – Slot on third drive gear
10 125 – Cylinder bore	216 – Second drive gear
201 – Primary drive gear	216a – Lug on second drive gear
202 – Final driven gear	217 – Fifth drive gear
203 – Differential	35 217a – Slot on fifth drive gear
204 – Final drive gear	218 – Fourth drive gear
15 205 – Primary Driven gear	218a – Lug on fourth drive gear
206 – Drive shaft assembly bearing	219 – Synchromesh sleeve assembly
207- First driven gear	220 – Reverse drive gear
207a – Cone of first driven gear	40 221 – Electrical machine
208 – Second driven gear	301 – Synchromesh Hub
20 208a – Cone of second driven gear	302 – Key
209 – Fifth driven gear	303 – Synchromesh Sleeve
210 – Fourth driven gear	304 – Synchromesh ring

We Claim:

1. An engine (100) comprising:
 - a crankcase (123) enclosing a hybrid transmission system;
 - said hybrid transmission system operable by a shifting mechanism configured
 - 5 with:
 - at least one clutch shaft assembly (102);
 - at least one drive shaft assembly (103), said drive shaft assembly (103) is parallel and alongside the clutch shaft assembly (102);
 - a clutch member (213), said clutch member (213) is operable to establish
 - 10 a driving connection between the clutch shaft assembly (102) and a crankshaft (114);
 - a low torque system, said low torque system provides forward driving path from the clutch shaft assembly (102) to the drive shaft assembly (103) with a predetermined reduction gear ratio range;
 - 15 a high torque system, said high torque system provides forward driving path from the clutch shaft assembly (102) to the drive shaft assembly (103) with a predetermined reduction gear ratio range.
2. The engine (100) as claimed in claim 1, wherein said high torque system
- 20 provides reduction gear ratio ranges from 3.0 to 1.0.
3. The engine (100) as claimed in claim 1, wherein said low torque system provides reduction gear ratio ranges from 1.5 to 0.5.
- 25 4. The engine (100) as claimed in claim 1, wherein said high torque system comprises:
 - a high torque input gearing, said high torque input gearing includes:
 - at least two drive gears (214, 216) installed on the clutch shaft assembly
 - (102);
 - 30 a high torque output gearing, said high torque output gearing includes:

at least two driven gears (207, 208) installed on the drive shaft assembly (103), said driven gears (207, 208) are operatively connected to at least one of said drive gear;

5 at least one synchromesh sleeve assembly (219), wherein synchromesh sleeve assembly (219) is movably installed on the drive shaft assembly (103) to engage a predetermined gear selectively.

5. The engine (100) as claimed in claim 1, wherein said low torque system comprises:

10 a low torque input gearing, said low torque input gearing includes:

at least two fixed drive gears (215, 218) installed on the clutch shaft assembly (102), said fixed drive gear (215, 218) configured to have lugs or slot selectively,

15 at least two movable drive gear (216, 217) installed on the clutch shaft assembly (102), said movable drive gear (216, 217) configured to have lugs or slots,

and,

a low torque output gearing, said low torque output gearing includes:

20 at least one fixedly installed driven gears (209) installed on the drive shaft assembly (103), said driven gear (209) configured to have lugs or slots selectively,

at least one movable driven gear (210) installed on the drive shaft assembly (103), said driven gear (210) configured to have both lugs and slots;

25 wherein movably installed drive gear (217) and movable installed driven gear (210) are configured to have slots or lugs to engage with the lugs or slots of predetermined driven gear selectively.

6. The engine (100) as claimed in claim 1, wherein said two movable gears (216, 217) are integrated as single unit (216, 217).

30

7. The engine (100) as claimed in claim 1, wherein said high torque transmission system comprises:

a first drive gear (214) installed on the clutch shaft assembly (102) and engaged with a first driven gear (207),

5 a second drive gear (216) movably installed on the clutch shaft assembly (102) and engaged with a second driven gear (208),

said second drive gear (216) configured to have plurality of lugs (216a) to engage with the corresponding slots (215a) of an adjacent third drive gear (215),

10 said third drive gear (215) engaged with the synchromesh sleeve assembly (219),

said synchromesh sleeve assembly (219) is movably installed on the drive shaft assembly (103) to be selectively connected to the first driven gear (207) and the second driven gear (208) selectively.

15

8. The engine (100) as claimed in claim 1, wherein said low torque transmission system comprises:

a third drive gear (215) installed on clutch shaft assembly (102) and engaged with the synchromesh sleeve assembly (219),

20 said third drive gear (215) is fixedly mounted configured to have slots (215a) in order to engage with corresponding lug (216a) of an adjacent second drive gear (216),

a fourth drive gear (218) installed on the clutch shaft assembly (102) and engaged with a fourth driven gear (210),

25 said fourth drive gear (218) is fixedly mounted on the clutch shaft assembly (102) is configured to have projected lugs (218a) to engage with the corresponding slot (217a) of an adjacent fifth drive gear (217),

said fifth drive gear (217) is movably installed on the clutch shaft assembly (102) and engaged with a fifth driven gear (209) to selectively
30 engage with the fourth drive gear (218),

wherein said fifth drive gear (217) is integrated with the second drive gear (216).

9. The engine (100) as claimed in claim 8, wherein said fourth driven gear (210) is
5 movably installed on the drive shaft assembly (103), said fourth driven gear (210) configured to have projected lugs (210a) to engage with a corresponding slot (211a) of an adjacent reverse driven gear (211).

10. The engine (100) as claimed in claim 9, wherein said reverse driven gear (211)
10 is fixedly installed on the drive shaft assembly (103).

11. The engine (100) as claimed in the claim 9 or claim 10, wherein said reverse driven gear (211) is engaged with an idler gear (101), said idler gear (101) is installed on the idler shaft (124).
15

12. The engine (100) as claimed in claim 10, wherein said idler gear (101) is engaged with a reverse drive gear (220), said reverse drive gear (220) is fixedly installed on the clutch shaft assembly (102).

20 13. The engine (100) as claimed in claim 1, wherein said clutch member (213) is installed on the clutch shaft assembly (102).

14. A vehicle configured with a hybrid H – Shifting mechanism as per any of the preceding claims.

25

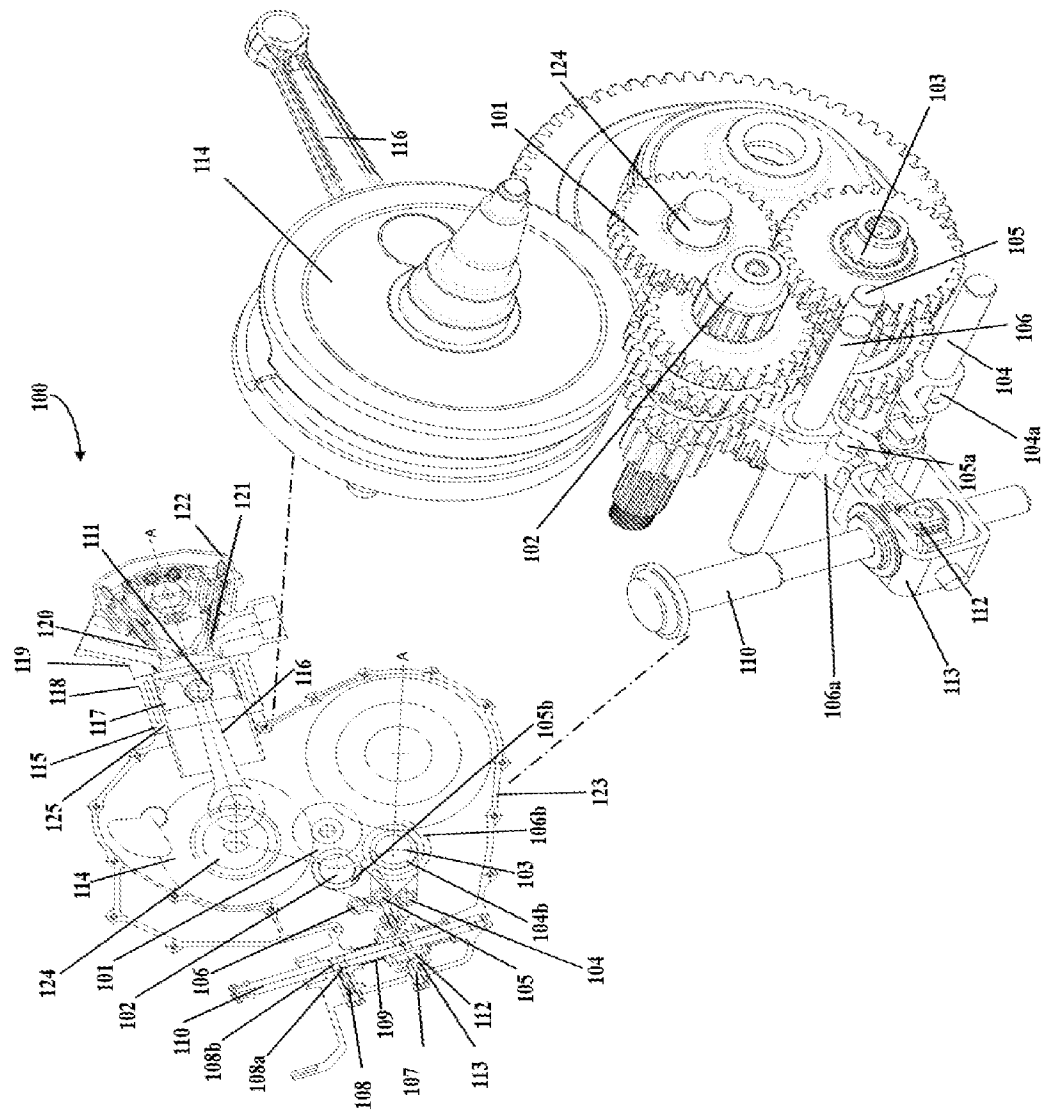


Fig. 1

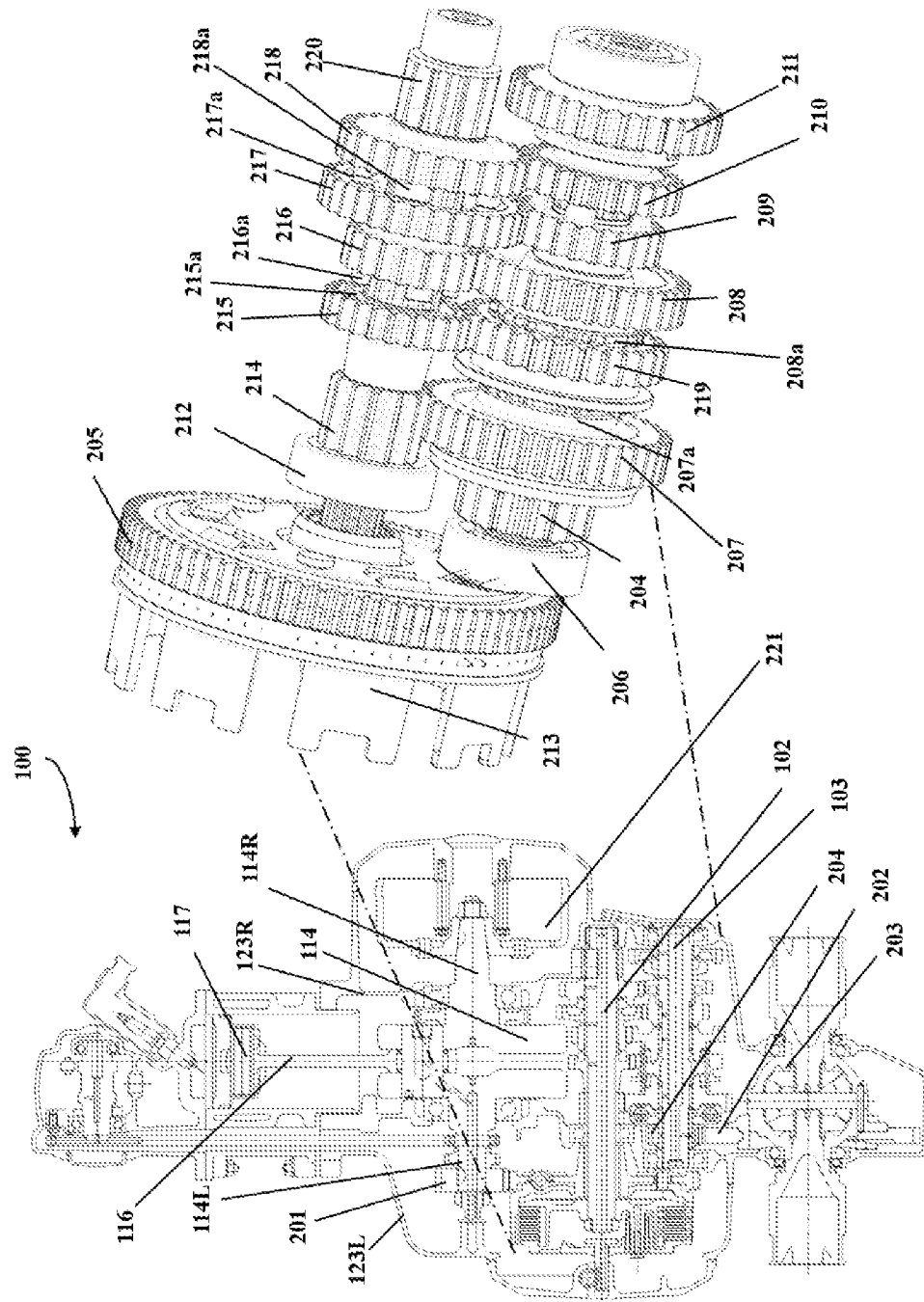


Fig. 2

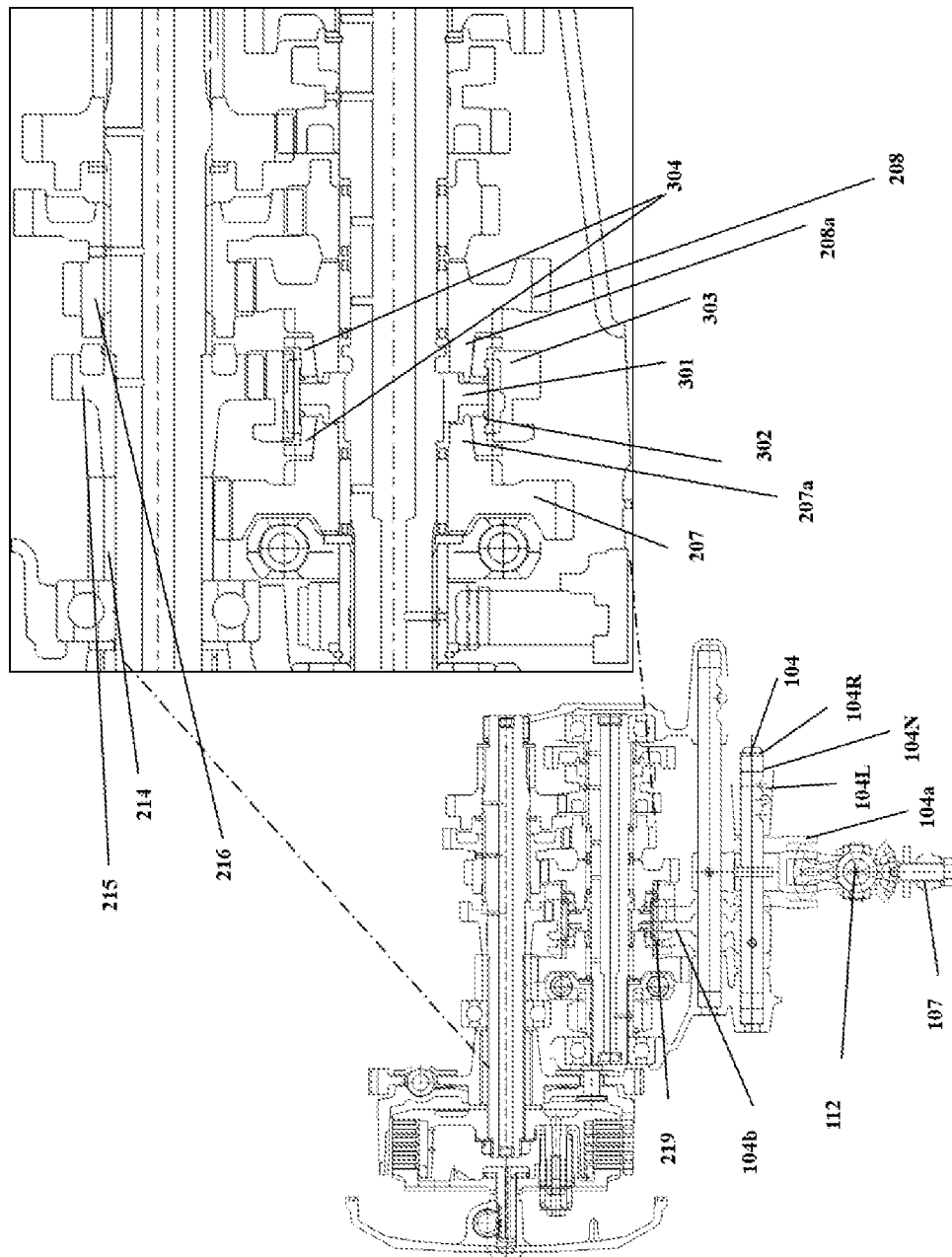


Fig. 3

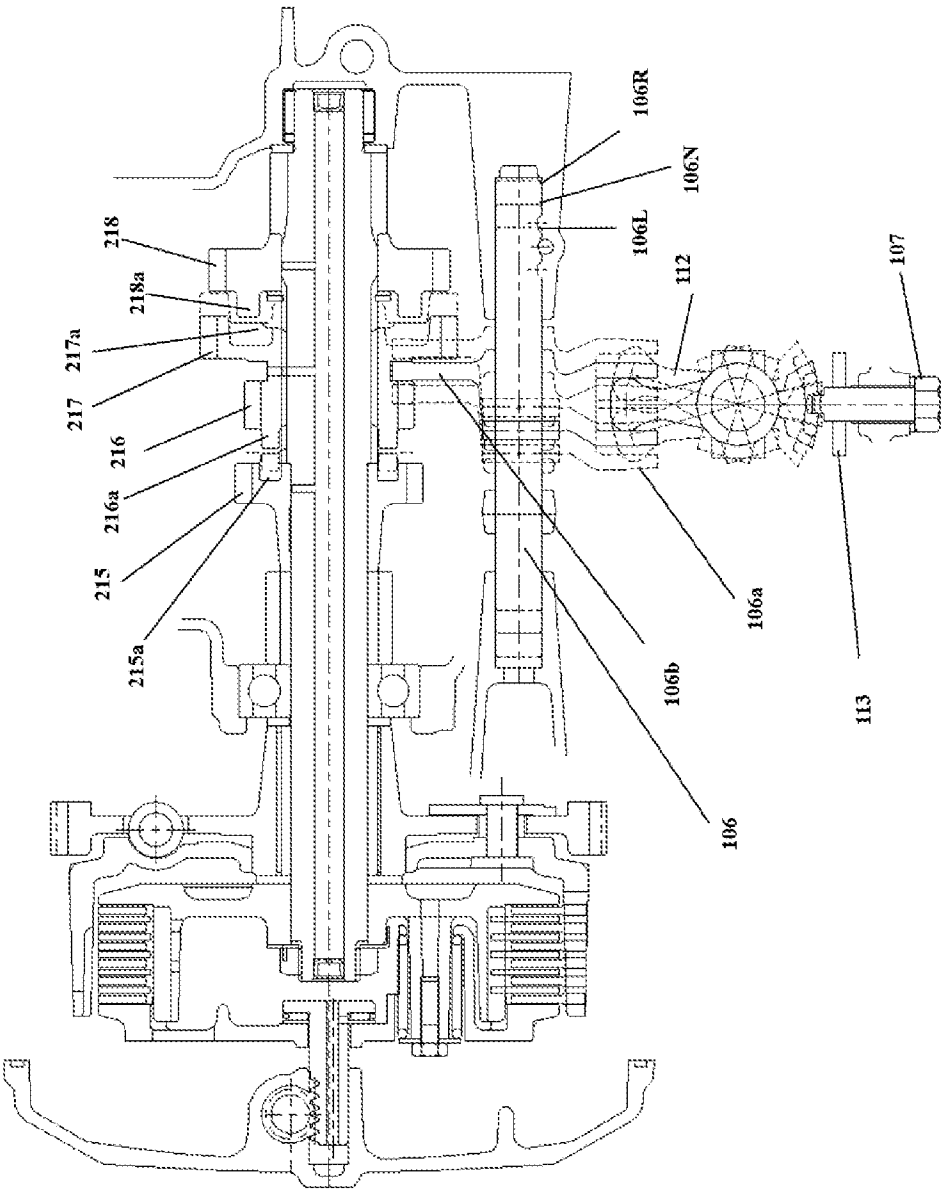


Fig. 4

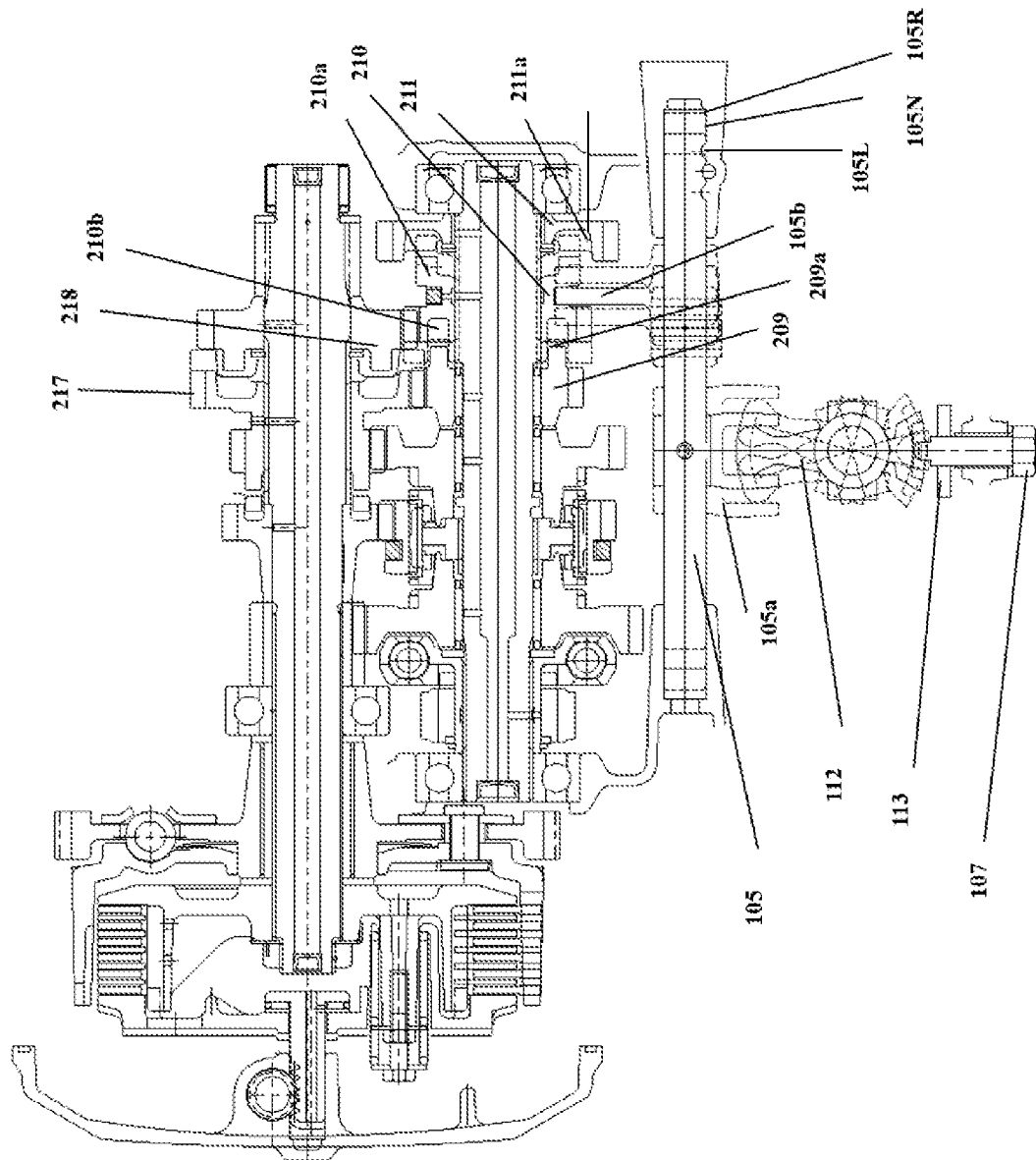


Fig. 5

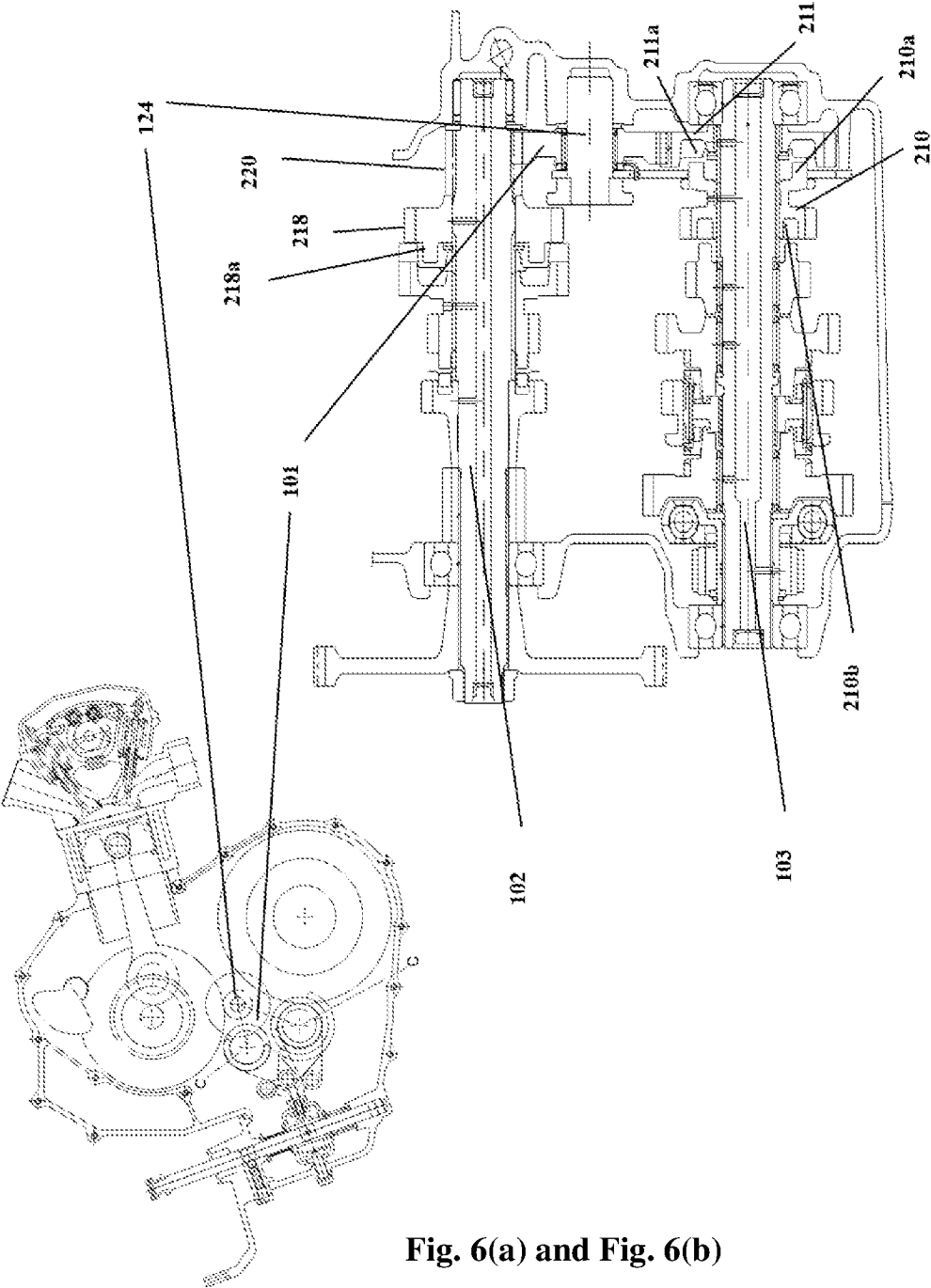


Fig. 6(a) and Fig. 6(b)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN2020/050298

A. CLASSIFICATION OF SUBJECT MATTER
F16H3/08 Version=2020.01

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)

F16H

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)

TotalPatent One, IPO Internal Database

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US20170282702A1 (KIM, Eui Han) 05 Oct, 2017 (05.10.2017) Claim 1 ; Abstract, Paragraph [0006], [0016], [0062], [0068]-[0070] Fig 1, 4, 5	1-3, 6, 10-14
Y	Claim 1	4
A	Claim 1	5, 7-9
Y	----- CN102348568B (HONDA MOTOR CO LTD) 25 June 2014 (25.06.2014) Paragraph [0298] as per translation referred on Google Patent	4

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"D" document cited by the applicant in the international application

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

14-08-2020

Date of mailing of the international search report

14-08-2020

Name and mailing address of the ISA/

Indian Patent Office
Plot No.32, Sector 14, Dwarka, New Delhi-110075
Facsimile No.

Authorized officer

Abhishek Sen

Telephone No. +91-1125300200

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IN2020/050298

Citation	Pub.Date	Family	Pub.Date
US 20170282702 A1	05-10-2017	CN 107002832 A	01-08-2017
		WO 2016108457 A1	07-07-2016
		KR 101513409 B1	13-04-2015
CN 102348568 B	25-06-2014	IN 7869CHENP2011 A	28-12-2012
		US 8747265 B2	10-06-2014
		WO 2010116818 A1	14-10-2010
		JP WO2010116818 A1	18-10-2012