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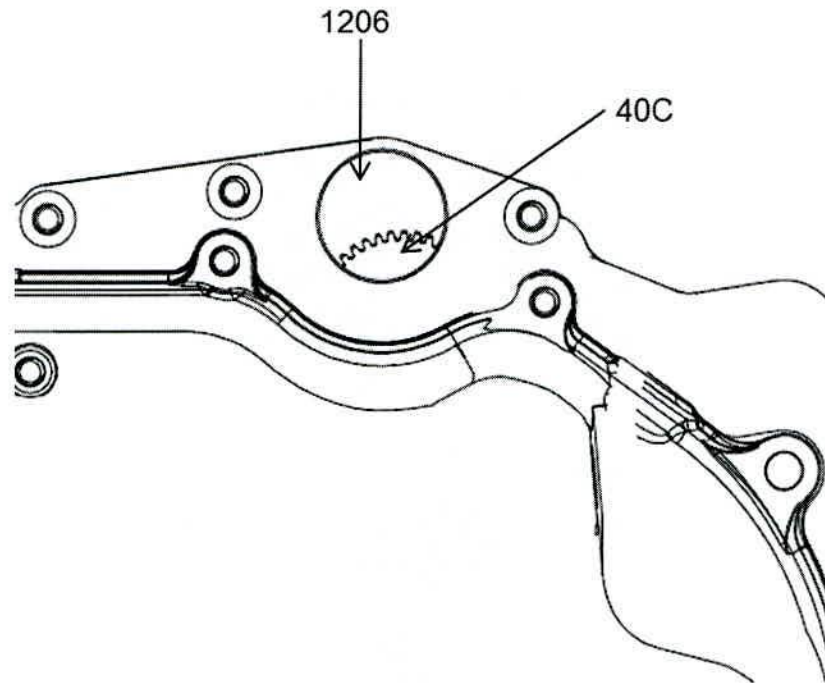


FIGURA 12B

Dado hoy, el día 22 de diciembre del año 2016.

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Por su apoderado

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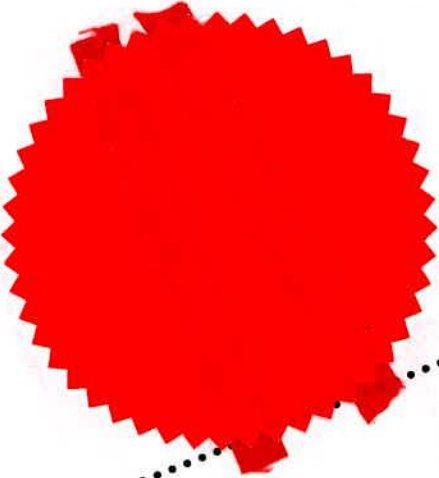
 INTELLECTUAL PROPERTY INDIA PATENTS DESIGNS TRADE MARKS GEOGRAPHICAL INDICATIONS	 सत्यमेव जयते भारत सरकार पेटेंट कार्यालय - बौद्धिक सम्पदा भवन एस.एम. रोड, नजदीक अन्टोप हिल डाकघर, अन्टोप हिल, मुम्बई - 400 037 Government of India Patent Office, Boudhik Sampada Bhawan S.M. Road, Near Post office, Antop Hill, Mumbai – 400 037, India	52 दूरभाष Tel ☎ 022-24137701 022-24141026 022-24150381 022-24148165 फॅक्स Fax ☎ 022-24130387 Email: mumbai-patent@nic.in Website: www.ipindia.nic.in

CERTIFICATE

SECTION 147(1) OF THE PATENTS ACT, 1970

It is hereby certified that, the annexed is a true copy of Complete Specification filed on 22/12/2016 in respect of Patent Application No. 4864/MUM/2015 and of BAJAJ AUTO LIMITED at Akurdi, Pune – 411035, State of Maharashtra, India.

This Certificate is issued under the powers vested in me under Section 147 (1) of the Patents Act, 1970.



..... Dated this 09th day of January, 2017



(MANOJ SOMKUWAR)
EXAMINER OF PATENTS & DESIGNS

FORM – 2**THE PATENTS ACT, 1970****(39 of 1970)****&****The Patents Rules, 2003****COMPLETE SPECIFICATION
(SECTION 10 AND RULE 13)****TITLE****“AN AUTOMATED MANUAL TRANSMISSION SYSTEM”****A P P L I C A N T**

We, **BAJAJ AUTO LIMITED**, an Indian Company, having its registered office at Akurdi, Pune – 411035, State of Maharashtra, India.

The following specification describes the nature of this invention:-

FIELD OF INVENTION

This invention relates to an automated manual transmission system, for example for two wheeled automotive vehicles such as motor scooters or other vehicles. The automated manual transmission system may be used in combination with a prime mover which may, for example, be in form of an internal combustion engine or an electric motor or hybrid or combination thereof.

BACKGROUND OF INVENTION AND PRIOR ART

Two wheeled, three wheeled and four wheeled vehicles, of small engine capacity, are commonly used for commuting in cities and urban areas. Such vehicles are an affordable mode of transportation due to the advantage of fuel efficiency.

An essential but typically bulky component of a power train (i.e. combination of prime mover and drive train) for a vehicle is the transmission system which is subject to rigorous operation during commuting.

There exist cost and packaging constraints for transmission systems, particularly in 2 or 3 wheeler applications. Also, due to the reduced vehicle mass of such vehicles, there is more sensitivity to shock loads from aggressive clutch actuation and/or gear changing, whilst at the same time a high level of responsiveness and maneuverability is required.

In applications using an internal combustion engine as the prime mover, the transmission system transmits motive force, in a controlled manner, through a pathway from rotating crankshaft to driving wheel(s) of the vehicle at a gearing ratio selected, through a gear shifting mechanism, for the vehicle operating

conditions. Transmissions may be automatic, semi-automatic, automated manual or manual.

Automatic transmissions of conventional design suffer from efficiency losses due to the use of pulley and belt mechanisms for power transmission. The belts/pulleys used in CVT are prone to wear and tear over a period of time which further reduces efficiency of system, thus lead to less mileage.

Considering the drawbacks of above transmission systems, there is a need to improve transmission efficiency and also provide automatic clutch operation and shifting of gears to promote rider comfort. These systems are generally known as Automated Manual Transmission Systems (AMT).

Automatic or automated manual transmissions (AMT) have advantages for vehicle control because the rider does not need to frequently operate the gear shifting mechanism, a potentially fatigue inducing task. In addition, such operation of the gear shifting mechanism may result in inefficiency of engine operation. Such automatic or automated transmissions allow the vehicle to be controlled by an electronic control unit with a particular operating strategy, ideally optimized over the operating strategy a competent operator would use.

AMT systems of the prior art are generally very complex and space consuming leading to increase in both vehicle size and cost. For example, complexity may arise from double clutches generally used in AMT systems. Other prior art AMT systems are aimed at incorporating the AMT functions into existing conventional engine and manual gearbox designs with minimal changes to those existing designs. As a consequence, these prior art systems adopt a number of design and operational compromises to achieve such design outcomes.

Furthermore, automated manual transmissions (and other transmission systems for that matter) typically include synchromesh gear shifting which smoothens gear shifting and increases probability of gear shifting up to 100% but at the added cost of complex and costly synchromesh components requiring more space than a sliding or clash mesh type transmission system.

Currently known AMT systems tend to require substantial vehicle design/structure modifications and/or compromises to accommodate them. There remains a need and challenge to provide a compact and efficient AMT vehicle transmission system.

OBJECT OF INVENTION

It is an object of the present invention to provide an automated manual transmission system for a vehicle that is more compact, less complex, smooth operating and less costly than currently available transmission systems.

SUMMARY OF INVENTION

With such object in view, the present invention provides an automated manual transmission system for a vehicle having a driven wheel comprising: a frame; a prime mover swingably mounted on the frame; a transmission for the prime mover comprising a plurality of gears; a control unit for controlling operation of the transmission; a gear shifting mechanism controlled by the control unit to shift transmission gear; and a clutch actuating mechanism controlled by the control unit wherein said gear shifting and clutch actuating mechanisms of said transmission system are located distal from the prime mover and proximate the driven wheel.

The gear shifting and clutch actuating mechanisms are actuated automatically by the control unit through respective actuators, such as electric or hydraulic

actuators, based on various predefined strategies as determined by the control unit. Electric motors are convenient actuators. Manual intervention from an operator is unnecessary. Such strategies advantageously smooth gear shifts and manage transmission clash events. In one of the embodiments where motors are used, axis extending parallel to drive shafts of each of the clutch actuator motor and gear shift actuator are conveniently arranged substantially perpendicular to each other. However the gear shift motor and clutch actuation motor can be arranged in different layout as per the design requirements.

Use of such transmission system in smaller two and three wheel vehicles such as scooters and other motorcycles is advantageous. Preferably, for such applications, at least a portion of the transmission system is sufficiently compact to be accommodated within a diameter of a rim of the driven wheel and having its centre of gravity located proximate a longitudinal plane passing through a centre of the driven wheel. More particularly, the gear and clutch actuator mechanisms of the transmission system are at least partially accommodated substantially within a diameter of a rim of the driven wheel

Preferably, the automated manual transmission system is a non-synchromesh sequential multi-shaft system providing for a plurality of gear ratios with a shift drive system including a drum shift being used for selecting a particular gear ratio. The automated manual transmission system is conveniently as described in the Applicant's co-pending patent application No. 4942/MUM/2015, the contents of which are hereby incorporated herein by reference. Four, five and six gear ratio options for the transmission system may conveniently be selected dependent on operational requirements. Even when allowance is made for this number of gear ratios employed and the clutch and gear actuation mechanisms provided, the width of the transmission system is comparable or less than that of known CVT/automatic transmission systems for comparable applications. Put

another way, the dimensions of the transmission system on each side of the wheel central plane in transverse direction of vehicle are less than or equal to that of a comparable vehicle having CVT/automatic transmission system. These aspects give better stability and maneuverability for the vehicle.

A conventional clutch cover is fixed to the crankcase which in turn is fixed to the frame and is hence not swingable so a separate swing arm arrangement is provided in such type of engines. A different approach is preferred for the present automated manual transmission system.

The transmission system includes a transmission housing to protect the various transmission components and enable effective lubrication. Desirably, the transmission housing is connected with a crankcase of an engine where used as prime mover. Where the prime mover is swingably mounted, the engine crankcase and transmission housing together form a box section which provides rigidity equivalent to a swing arm. A substantial portion of the transmission housing is positioned above a driven wheel transverse centre axis. The gear shift actuator, and also the clutch actuator, is preferably positioned on an upper outer peripheral surface of the transmission housing, thus not occupying space inside the transmission housing which would increase transmission system bulkiness and cost as well. The gear shift actuator and clutch actuator may each be accommodated by a recess formed in the upper portion of the transmission housing, any such recess having a profile being complementary with contour/structure of the gear shift actuator or clutch actuator.

The clutch actuator is desirably positioned between the centre line of the axle of the driven wheel (typically a rear wheel) and the prime mover. This provides improved weight distribution and protection for the clutch actuating mechanism. This location provides better ground clearance and enhanced damage tolerance

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for the actuator as the probability of impacts with an uneven road surface or debris etc. lying on the road is reduced. A cover may be provided for the clutch actuating mechanism, either to protect it from dust, dirt and debris and/or to provide improved NVH (Noise, vibration, and harshness) characteristics including protection from external shocks. For this purpose, the additional cover may include an insulating material such as one or more layer(s) of insulating foam. The additional cover may also serve as a styling cover designed to aesthetic effect covering the mechanical components and wiring harnesses and so on.

Both the gear shift actuator and clutch actuator are desirably positioned between said centerline of said axle of said driven wheel and said prime mover. Further, the gear shift actuator and clutch actuator are desirably located within a width between a longitudinal plane passing through a centre of said driven wheel and an outermost extent of said clutch actuator. This width may be approximately the same as required for an exhaust system located on the other side of the longitudinal plane. Such symmetry has aesthetic and possible vehicle stability benefits.

Non-synchromesh, preferably clash mesh operation, is advantageously selected to avoid the cost and bulk of synchromesh mechanisms. However, in such type of transmission system there is a significant probability that gears on transmission shafts rotating at the same speed will clash with each other, rather than mesh effectively, during a gear shift phase. To address this problem, a positive drag mechanism, advantageously as described in the Applicant's co-pending Indian Provisional Patent Application No.4588/MUM/2015 and the contents of which are hereby incorporated by reference, is included within the transmission system.

The automated manual transmission system can include a chain or belt drive as part of the transmission. Preferably, to facilitate operation, the direction of rotation of such a chain drive is same as that of the engine and the driven wheel, conventionally a rear wheel in a two wheeled vehicle. In this case, the transmission system includes an intermediate or lay shaft to align direction of rotation of engine and driven wheel which would be different in two shaft transmission systems.

Preferably, the transmission system – when using a drive chain – has a direction of power transfer (from engine to transmission) making the chain upper side the tighter side and the chain lower side the slack side. The transmission system is, as described above, housed within a protective transmission housing, and more specifically the rear portion thereof, made leak proof to enable effective lubrication of transmission system components. The transmission housing is provided with a lubricant sump in which a desired lubricant level is maintained. The sump may require key transmission components to be at least partially immersed in the lubricant.

Where used, the drive chain includes a chain tensioner, desirably positioned on the slack side, to keep the chain at a required tension to enable effective power transfer from engine to gearbox particularly during an acceleration phase. The chain tensioner may include a separate dampening arrangement, such as a hydraulic dampener, to further improve performance. A preferred chain tensioner comprises a tensioner housing mounted on the transmission housing and at least a portion of the tensioner housing is immersed in the lubricant sump. The tensioner housing also comprises a piston loaded with a compression spring from bottom of piston. The compression spring keeps the piston at a pre-defined position when no load is acting on the piston. The piston is movable in response to engine operating conditions, for example under acceleration conditions. The

housing is also provided with one or more bleed holes at the bottom of the tensioner housing which facilitates entry and exit of the lubricant as a hydraulic dampening fluid when required. The chain tensioner is so positioned that it will remain immersed in the lubricant even during coasting conditions.

To this end, one or more bleed hole(s) of the chain tensioner housing allow lubricant flow into the housing and exert pressure on the tension adjusting means to provide continuous dampening to the tensioner under acceleration conditions.

During the acceleration phase, the chain lower side becomes slack due to which load on the piston reduces. As load on piston reduces, the compression spring pushes piston upwards. The piston in turn pushes the tension adjusting means/ the chain guide and keeps the chain under tension. When the piston moves up due to reduced pressure on it, lubrication oil enters the housing through bleed hole(s) provided on the bottom of the housing.

In contrast, during a deceleration phase, the chain drive slack side becomes the tight side (requiring no chain tensioning), the deceleration causes the pressure on the piston to increase and compresses the compression spring which holds the piston in position. This makes the piston move downward and inside the piston housing. As the piston moves within the housing, lubricant oil inside the tensioner housing pushed out through the bleed hole(s). The movement of lubrication oil in and out of the housing as the piston moves up and down provides damping effect. Once acceleration phase is regained, the piston moves up allowing lubricant to flow into the housing through the drain hole(s). The dimensions and location of bleed hole(s) in the tensioner housing may be optimised to achieve the desired dampening force.

In the event the automated manual transmission system is employed in a scooter type vehicle, the gear and clutch actuator(s), when positioned above a driven wheel axle axis, also facilitates positioning under any bonnet portion of the scooter enhancing vehicle aesthetics. Advantageously, in such case, the clutch actuating mechanism is positioned along a centre longitudinal axis of the transmission system, such positioning not requiring increase in the width of the bonnet thus assisting in keeping width of the vehicle compact, and providing improved aesthetics.

Prime movers of various types may be mated with the above described automated manual transmission system including internal combustion engines and electric motors or hybrid or combination thereof. Where the prime mover is an internal combustion engine, an air filter for intake air may be positioned above the transmission housing, the gear shift actuator being located in a suitable space below the air filter. The air filter may have a portion shaped to accommodate the gear shift actuator to save further space.

The automated manual transmission system described above allows improved packaging and performance within a vehicle such as, including cost effectiveness and affordability. At the same time, the automated manual transmission system described herein provides high levels of refinement and drivability for mass market vehicles in dense traffic conditions.

BRIEF DESCRIPTION OF DRAWINGS

A preferred embodiment of the automated manual transmission system of the present invention will now be described with reference to the drawings in which:

Figures 1A and 1B show side views of a two wheeled vehicle showing a sequential automated manual transmission system in accordance with one embodiment of the present invention.

Figure 2 shows an orthogonal view of the sequential automated manual transmission system shown in Figures 1A and 1B excluding its protective housing.

Figure 3A is a side view of the sequential automated manual transmission system shown in Figures 1A, 1B and 2 and including its protective housing.

Figure 3B is a further side view of a cover for the clutch actuator substantially as shown in Figure 3A.

Figure 4 is a plan sectional view of the sequential automated manual transmission system shown in Figures 1A to 3A.

Figure 5A is a plan sectional view of the sequential automated manual transmission system shown in Figures 1A to 4 showing the arrangement of the transmission system and driven wheel.

Figure 5B is a rear view of the sequential automated manual transmission system shown in Figures 1A to 5A showing the arrangement of the transmission system and driven wheel.

Figure 6 is a sectional view of the portion of the housing protecting the chain of the sequential transmission system as shown in Figures 1A to 5.

Figure 7 is a side sectional view of the chain tensioner for the drive chain shown in Figure 6.

Figure 8 is a first sectional view of the clutch actuator mechanism used in the automated manual transmission system as shown in Figures 1A to 5.

Figure 9 is a second sectional view of the clutch actuator mechanism used in the automated manual transmission system as shown in Figures 1A to 5 and 8.

Figure 10 is a third sectional view of the clutch actuator mechanism used in the automated manual transmission system as shown in Figures 1A to 5, 8 and 9.

Figure 11 is a side view of the automated manual transmission system as shown in Figures 1A to 5.

Figure 12A is a side sectional view of the automated manual transmission system as shown in Figures 1A to 5 and 11 with gear shift motor in position.

Figure 12B is a side sectional view of the automated manual transmission system as shown in Figures 1A to 5 and 11 with gear shift motor removed and showing portion of the gear train.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now to Figures 1A to 6, there is shown an automated manual transmission system 10, of non-synchromesh clash mesh type, mounted in a two wheeled scooter type motorcycle 400 for transmitting power from the crankshaft 200 of a swingably mounted single cylinder internal combustion engine 150 to which it is mated to the rear wheel 300 (as conveniently shown in Figure 1 and 5)

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with inflatable tyre 300A and rim 300B through a drive chain 90 and, through operation of the transmission system 10, at a desired gear ratio. Cylinder 400 is shown together with its associated connecting rod 410 connecting its piston to the linkage 415 for providing drive to the crankshaft 200. Magneto 270 is also shown mounted to crankshaft 200. The crankshaft 200 and linkage 415 are mounted within engine crankcase 210 having crankcase Right Hand Side (RHS) 210A and crankcase Left Hand Side (LHS) 210B. Other features of motorcycle 400 include rear sub frame 50 and shock absorber 55.

Rotation of the crankshaft 200 causes rotation of drive sprocket 205 and chain 90. A substantial portion of the chain 90 is enclosed within a chain case portion 220 of transmission housing 20. Chain 90 is lubricated using a lubrication system described below.

Automated manual transmission system 10 requires connection of the engine crankcase 210 with the transmission housing 20, a rear portion 20A of which is separated and made distal from crankcase 210 by the intermediate chain case portion 220 of transmission housing 20 to form a protective housing or casing which is split at flanges 20C. The casing provides a box section and rigidity equivalent to that of a swing arm omitted from the motorcycle 400 in this case. The casing is pivotally mounted to rear sub frame 50 at joint 56.

Transmission system 10 has its centre of gravity CG located proximate, being slightly offset from, a longitudinal plane P passing through the centre of rear wheel 300 (as conveniently shown in Figure 5A) and substantially above the centre horizontal axis CW of rear wheel 300 (as shown in Figure 1B).

Transmission system 10 has gear and clutch actuator mechanisms, G and C, and gear actuator mechanism G is accommodated substantially within a

diameter D of the rim 300B of the driven wheel (i.e. the rear wheel 300). The gear actuator mechanism G includes a gear shift motor 120 positioned above the centre horizontal axis CW of the rear wheel 300 and at least partially accommodated within the wheel rim 300B.

The automated transmission system 10 has a centre of gravity CG located proximate a centre longitudinal axis of the motorcycle 400. The centre of gravity CG is positioned substantially above the centre horizontal axis CW of rear wheel 300.

Mounted within transmission housing rear portion 20A is the rotating output sprocket 95 of drive chain 90. The drive sprocket 205 rotates essentially at engine speed so speed reduction, through the transmission system 10 is required. To that end, the output sprocket 95 is engageable with an input shaft 22 rotatably mounted to the rear transmission housing portion 20A, through operation of clutch 60 by automatically controlled clutch actuator motor 620, required speed being achieved through establishment of a gear ratio. Transmission system 10 is a multi-shaft sequential transmission system having five gear ratios in the illustrated embodiment, gear trains comprising three transmission gears for each of the input shaft 22 (gears 22a-22c), intermediate shaft 23 (gears 23a-23c) and output shaft 24 (gears 24a-24c). The gear trains is substantially accommodated within a diameter of a rim of said driven wheel. As described above, automated manual transmission system 10 employs a chain drive 90. To facilitate operation of transmission system 10, the direction of rotation of the chain drive 90 is made common with the engine (through crankshaft 200) and the rear wheel 300 by including intermediate shaft 23.

Movement between the gear ratios, in sequential manner, involves a gear shift drive system including a shift drum 40. Angular movement of shift drum 40, by

controlled movement on operation of electric gear shift motor 120 (for example a stepper motor), by the transmission control unit, causes its associated forks 47a-47c to controllably slide along cam grooves 40a-40c to move each of the gear trains described above into position to establish the required gear ratio under control of a transmission control unit (not shown) during a gear shift phase.

Construction and operation of transmission system 10 to implement a gear shift is described in further detail in the Applicant's co-pending Application No. 4942/MUM/2015, the contents of which are incorporated by reference.

The arrangement of gear shift and clutch actuators, G and C, and especially the motors 120 and 620, within the transmission system will now be described. It may be noted, referring to Figure 5B, that both actuation motors 120, 160 are kept within the width, W, between the rear wheel 300A and the clutch cover 60B of the clutch actuator C. Figure 5B further shows how actuators G and C, as well as motors 120 and 620 are positioned under bonnet 330 and within the same width, W, X, as is required by the exhaust system 470 on the other side of the longitudinal plane P of vehicle 400. Such symmetrical positioning is aesthetically useful and may contribute to vehicle stability.

The gear shift motor 120 is positioned and connected, by bracket 1204 formed integrally with the crankcase LHS 210B, on an upper outer peripheral surface 1205 of the transmission housing rear portion 20A, thus not occupying space inside the transmission housing 20 which would increase transmission system 10 bulkiness and cost as well. Other portions of the gear shift actuation mechanism must be located inside the transmission housing rear portion 20A. The gear shift motor 120 is also accommodated by a recess 1210 formed in upper portion 1205 of the transmission housing rear portion 20A, the recess 1210 having a profile being complementary with contour/structure of the gear shift motor 120.

The gear shift motor 120, and its associated drive shaft 121, is positioned at a drive end E of clutch actuating mechanism 619, beyond an end of the drive shaft 621 of clutch actuator motor 620. This position may define one end of the transmission system 10. Transmission of driving force from drive shaft 121 to shift drum 40 is via a reduction gear mechanism (not shown).

Gear shift motor 120 and clutch actuator motor 620 are relatively disposed such that the drive axes CC and GC of each motor are disposed substantially perpendicular to each other providing better maneuverability and better balance.

The clutch actuator motor 620, as shown in Figures 1A and 1B, is also positioned in a recess 628 of the chain case portion 220 between the axle 250 of rear wheel 200 and the engine (not shown). Recess 628 is shaped to complement the shape of clutch actuator motor 620. This position and inclusion of recess 628 within chain case portion 220 to accommodate the clutch actuation motor 620 reduces bulk and provides improved weight distribution and protection for the clutch actuator motor 620. This location provides better ground clearance and enhanced damage tolerance for the clutch actuator motor 620 as the probability of impacts with an uneven road surface or debris etc. lying on the road is reduced.

As shown in Figure 3B, an additional cover 665 is provided for the clutch actuator motor 620 and other components of the clutch actuator C, for example locking nut 654, to protect it from dust, dirt and debris and/or to provide improved NVH characteristics including protection from external shocks. For this purpose, the additional cover 665, which could be made from suitable plastic material, includes a layer 668 of insulating material such as insulating foam. The additional cover 665 also includes an outer styling cover 664 designed to aesthetic effect

covering the above mentioned mechanical components and wiring harnesses 660 and so on.

As described above, the transmission system 10 uses a drive chain 90 to transmit torque from the engine to the rear wheel 300. The direction of power transfer (from engine to transmission) makes the chain upper side 90A (shown in outline) the tighter side and the chain lower side 90B the slack side. The transmission system 10 is, as described above, housed within protective transmission housing 20 also made leak proof to enable effective lubrication of transmission system components. The transmission housing 20 is provided with a lubricant sump 225 in which a desired lubricant level 225A is maintained. The lubricant sump 225 enables key transmission components, such as drive chain 90 and particularly its portion 90C, to be at least partially immersed in the lubricant. Motion of the chain drive 90 will also cause lubricant splashing and lubrication of other transmission system components.

Referring to Figures 6 and 7, drive chain 90 includes a chain tensioner 600, positioned on the slack side 90B and mounted to the housing 20 by mounting bracket 603, to keep the drive chain 90 at a required tension to enable effective power transfer from engine to gearbox particularly during an acceleration phase. The chain tensioner 600, as shown in Figures 6 and 7, comprises a housing 602 that encompasses a piston 605 movable within housing. The piston 605 is loaded with a compression spring 610 from bottom due to which the piston 605 is movable within the housing 602 in response to engine operating conditions. The housing is provided with one or more drain hole(s) 608 at its bottom. At least a portion of the housing 602 is immersed in below oil level 225A in lubricant sump 225. The chain tensioner 600 is so positioned that it will remain immersed in the lubricant even during coasting conditions. The housing 602 is configured to facilitate use of the lubricant as a hydraulic dampening fluid when required. To

this end, drain hole(s) 608 on chain tensioner housing 602 allows lubricant flow into the housing 602 and exert pressure on the piston 605 to provide continuous dampening under acceleration conditions.

During the acceleration phase, the chain lower side 90B becomes slack due to which load on the piston 605 reduces. As load on piston 605 reduces, the compression spring 610 pushes piston 605 upwards. The piston 605 in turn pushes the tension adjusting means/ the chain guide 615 and keeps the chain under tension. When the piston 605 moves up due to reduced pressure on it, lubrication oil enters the housing through drain hole(s) 608 provided on the bottom of the housing 602.

In contrast, during a deceleration phase, the chain drive slack side 90B becomes the tight side, the deceleration causes the piston 605 within the chain tensioner housing 602 to be compressed and move downward, causing lubricant to drain from the housing 602 through the drain hole 608. The movement of lubrication oil in and out of the housing 602 as the piston 605 moves up and down provides damping effect. Once an acceleration phase is regained, the piston 605 moves upward allowing lubricant to flow through the drain hole 608 into the housing 602. Such a chain tensioner 600 avoids need for a separate dampening arrangement requiring parts and mounting arrangement which would lead to increased cost and consume space. The dimension and location of the drain hole 608 in the housing 602 is optimised to achieve the desired dampening force. In the illustrated case, the drain hole 608 diameter is 3mm.

Because of the direct drive arrangement with a remote clutch location, the chain drive 90 essentially runs constantly – even when the vehicle 400 is stationary. The need to adequately lubricate and tension the chain 90 is thus exacerbated as

its duty cycle is increased over conventional arrangements. The above described chain tensioner arrangement 600 is therefore advantageous.

The clutch actuation mechanism 619, as described above, comprises an electric clutch actuating motor 620 and a reduction gear train, a preferred embodiment of which will now be described in further detail with reference to Figures 8 and 9. The reduction gear train, enclosed by protective transmission housing rear portion 20A, includes a worm gear 622 formed integral with a worm gear shaft 624 itself coupled, at one end to drive shaft 621 of clutch actuating motor 620. A distal end of worm gear shaft 624 can freely rotate in bush 624B. The worm gear 622 engages with a sector gear 623 slidably and rotatably mounted on the co-axial inner diameter of bearing 680 press fitted in the clutch cover 20B of the transmission housing rear portion 20A.

The clutch actuation mechanism 619 is arranged such that when clutch actuating motor 620 operates, the drive shaft 621 rotates causing the worm gear shaft 624 and its worm gear 622 to rotate. The sector gear 623, being engaged with worm gear 622 also rotates though full rotation is not necessary to operate the clutch 60 between engaged and disengaged positions using the assembly driven by sector gear 623 as described below. The arrangement is self-locking and allows clutch 60 holding in any position along the clutch 60 travel for an indefinite period of time in clutch motor 620 off condition. This provides more flexibility than in a plate-ball type mechanism where, while it is possible to hold the clutch 60 in a position (i.e. with clutch motor off) with the help of detent mechanisms (such as ball slots), the number of positions is limited by the dimensions of the plate-ball mechanism and number of slots and cannot be changed at will. The clutch actuating motor 620 can also be kept relatively small as centre distance between the worm gear 622 and the screw 641 is small (e.g. small centre distance of 49mm) and small screw 641 diameter (20mm). The arrangement saves the

space of stacking the ratio/rotation of the motor drive shaft 621 and the rotation to translation mechanism (sliding screw 641 and its arrangement with respect to clutch cover portion 644A as described above) instead of other layout for e.g. side by side/front to back.

A circlip 629 is provided to confine motion of sector gear 623 within limits. Motion of sector gear 623 need only be sufficient, on conversion from rotation into an axial movement of a push rod 650 through sector gear 623 in directions A to engage and disengage the clutch 60. Push rod 650 is actuated by a sliding screw 641 which must only move axially to maintain the required precision for clutch 60 operation.

Allowance must therefore be made for the following. As the sector gear 623 rotates, the generated torque acts on sliding screw 641. To prevent consequential rotation, the sliding screw 641 includes involute splines 643 for fixing a stopper arm 642 to prevent rotary motion of the sliding screw 641. Stopper arm 642 is guided in slots 644A formed in the clutch cover portion 644, these slots 644A being profiled to avoid rotation of stopper arm 642. Stopper arm 642 is also provided with rollers 629A which rotate inside guide profile 644B to convert sliding friction between guide profile 644B and rollers 629A into rolling friction. This arrangement ensures efficient conversion of rotation of sector gear 623 into axial movement of sliding screw 641 and its associated push rod 650. The worm gear 622 provides a large ratio (66) and it can be made self-locking. The sliding screw 641 can be optimised for required travel and efficiency. In contrast, systems using a sliding screw alone lack such high ratio and have to do away with the self-locking capability or sacrifice screw efficiency. Actuating mechanisms utilising worm gear alone must use a less efficient means of converting rotary motion into translational motion for clutch actuation (such as plate-ball mechanisms).

A clutch position adjuster 652, threadably connected to sliding screw 641 and fastened into position by locking nut 654, is used to impart the sliding motion of the sliding screw 641 to the push rod 650 which enables axial movement of the clutch 60 between engaged and disengaged positions. The thrust on the sector gear 623 is transmitted through bearing 680 to clutch cover portion 644A allowing efficient operation of clutch 60 to take place. Moreover the clutch actuator mechanism 619, as above described, is sufficiently efficient to produce finer linear movement and more precise control by the control unit. As clutch 60 disengagement loads are higher than engagement loads in this case, axial thrust on worm gear shaft 624 is conveniently caused to act on the clutch cover/ bearing 624A during clutch 60 engagement. This ensures that the clutch 60 disengagement torque requirement is not augmented by the axial thrust while keeping the clutch actuation mechanism 619 compact and economic as one side of the worm gear shaft 624 can be kept supported on a simple needle roller bearing (NRB)/ bush 624B.

The clutch actuation mechanism 619 as above described has a number of advantages. Clutch 60 operation is automatically modulated in smooth fashion on take-off and during gear shifting. Clutch 60 holding in a desired position is also much simpler than in a plate-ball type mechanism where the ball must be balanced on an incline in the plate. Clutch actuation mechanism 619 has better wear resistance than a plate-ball mechanism as the entire load is taken by balls with point to point contact as compared to the line/area contact. Clutch actuation mechanism 619 is also a positive drive mechanism with very little chance of slippage as compared to other systems such as a plate-ball mechanism where the ball can slip. This, supplemented with self-locking capability as described above, makes the clutch actuation mechanism safer.

Referring now to Figure 10, there is described one provision for clutch 60 deactivation in case of an emergency, such as a breakdown or stalling of the motorcycle in any gear position. Following removal of additional cover 665, clutch cover 60B is removed by removing screws (not shown) to gain access to clutch adjuster 652. Locking nut 654 is loosened so that adjuster screw 652 can be manually rotated, moving inward towards the push rod 650, pushing the clutch 60 and disengaging it so that the motorcycle can then be pushed to a safe location for further action. The clutch 60 setting can be recalibrated during subsequent maintenance.

Referring now to Figures 11, 12A and 12B, there is described a further provision for placing the transmission system 10 in neutral gear in case of emergency by accessing the gear shift drum 40. First, wiring cables 120A attached to the gear shift motor 120 are removed. Then the gear shift motor 120 is removed from housing 20 by removing screws and mounting plate 1204 and pulling it from the housing.

Once the gear shift motor 120 has been removed, a portion of the reduction gear mechanism 40C becomes visible through the aperture 1206 previously accommodating gear shift motor 120. The gear shift drum 40 can then be rotated manually by accessing it through aperture 1206 and the automated manual transmission system 10 brought into a neutral position. The motorcycle can then be pushed to a safe location for further action. Advantageously, the clutch 60 setting is not disturbed and no recalibration is required during subsequent maintenance.

Even when allowance is made for the number of gear ratios employed and the clutch and gear actuation mechanisms provided, the width of the transmission system 10, with gear and clutch actuator mechanisms positioned as described, is

comparable or less than that of known CVT/automatic transmission systems for comparable motorcycle applications. Put another way, the dimensions of the transmission system 10 on each side of the wheel central plane in the transverse direction of the motorcycle are equal to or less than for a comparable motorcycle fitted with a CVT/automatic transmission system.

Modifications and variations to the automated manual transmission system described in the present specification will be apparent to the skilled reader. Such modifications and variations are deemed within the scope of the present invention. The applicant intends to rely on the provisional specification and drawings associated with provisional specification in support of this application.

WE CLAIM

1. An automated manual transmission system for a vehicle having a driven wheel; a frame; a prime mover swingably mounted on the frame; a transmission for the prime mover comprising a plurality of gears; a control unit for controlling operation of the transmission; a gear shift actuating mechanism controlled by the control unit to shift transmission gear; and a clutch actuating mechanism controlled by the control unit wherein said gear shift and clutch actuating mechanisms of said transmission system are located distal from the prime mover and proximate a driven wheel.
2. The automated manual transmission system as claimed in claim 1 wherein said gear shift and said clutch actuating mechanisms are actuated automatically by the control unit through respective actuators, based on various predefined strategies as determined by the control unit.
3. The automated manual transmission system of claim 2 wherein said actuators are electric motors and said gear shift actuator and clutch actuator each have an axis extending parallel to corresponding drive shafts of each of the clutch actuator motor and gear shift actuator motor, each said axis being arranged substantially perpendicular to the other.
4. The automated manual transmission system as claimed in any one of claims 1 to 3 wherein at least one of said gear shift actuator and said clutch actuator are at least partially accommodated within a diameter of a rim of said driven wheel.

5. An automated manual transmission system as claimed in claim 4 wherein the centre of gravity of the automated transmission system is located proximate to a longitudinal plane passing through a centre of said driven wheel.
6. An automated manual transmission system as claimed in any one of the preceding claims wherein said prime mover is an engine having an engine crankcase and a transmission housing to protect the transmission system wherein said engine crankcase and said transmission housing are connected to form a box section which acts as a swing arm.
7. An automated manual transmission system as claimed in claim 5 or 6 wherein a substantial portion of the transmission housing is positioned above said driven wheel transverse centre axis.
8. An automated manual transmission system as claimed in claim 7 wherein at least one of said gear shift actuator and said clutch actuator is positioned on an upper outer peripheral surface of said transmission housing.
9. An automated manual transmission system as claimed in claim 8 wherein at least one of said gear shift actuator and said clutch actuator are accommodated by a recess formed on said upper outer peripheral surface, said recess preferably having a profile being complementary with contour/structure of the gear shift actuator or clutch actuator.
10. An automated manual transmission system as claimed in any one of claims 2 to 9 as dependent from claim 2 wherein at least one of said gear shift actuator and said clutch actuator is positioned between a centre line of the axle of a driven wheel and said prime mover.

11. An automated manual transmission system as claimed in claim 10 wherein the gear shift actuator and the clutch actuator are positioned between said centerline of said axle of said driven wheel and said prime mover, preferably being located within a width between a longitudinal plane passing through a centre of said driven wheel and an outermost extent of said clutch actuator.
12. An automated manual transmission system as claimed in any one of the preceding claims wherein said transmission includes a chain or belt drive and a direction of rotation of said drive is the same as that of the prime mover and the driven wheel.
13. An automated manual transmission system as claimed in any one of the preceding claims including an intermediate or lay shaft to align direction of rotation of said prime mover and said driven wheel.
14. An automated manual transmission system as claimed in any one of the preceding claims wherein said driven wheel is a rear wheel.
15. An automated manual transmission system as claimed in any one of the preceding claims including a drive chain having a direction of power transfer, from engine to transmission, making a chain upper side the tighter side and a chain lower side the slack side and a chain tensioner for said drive chain wherein said chain tensioner is positioned on the slack side to keep the chain at a required tension to enable effective power transfer from engine to gearbox and wherein said transmission housing is further provided with a lubricant sump in which a desired lubricant level is maintained for lubricating said drive chain.

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16. An automated manual transmission system as claimed in claim 15 wherein said chain tensioner includes a separate dampening arrangement, such as a hydraulic dampener, and preferably comprises a tensioner housing mounted within the transmission housing with at least a portion of the tensioner housing being immersed in the lubricant sump; a piston movable in response to engine operating conditions and loaded with a compression spring from a bottom end of said piston for keeping said piston at a pre-defined position when no load is acting on said piston and wherein said housing is provided with one or more bleed holes at the bottom of said tensioner housing which, through piston movement, facilitates entry and exit of the lubricant as a hydraulic dampening fluid when required, for example under acceleration or deceleration conditions
17. An automated manual transmission system as claimed in claim 16 wherein said chain tensioner is positioned to remain immersed in the lubricant during coasting conditions.
18. An automated manual transmission system as claimed in claim 15 or 16 wherein dimensions and location of said bleed hole(s) in said tensioner housing are selected to achieve the desired dampening force.
19. An automated manual transmission system as claimed in any one of the preceding claims being employed in a scooter type vehicle having a bonnet portion and said gear shifting and clutch actuating mechanisms, being positioned above a driven wheel axle axis, are positioned under said bonnet portion.
20. An automated manual transmission system as claimed in any one of the preceding claims wherein said gear shifting and clutch actuating mechanisms

are located within approximately the same width on one side of a longitudinal plane passing through a centre of said driven wheel as required by an exhaust system located on the other side of said longitudinal plane.

21. An automated manual transmission system as claimed in any one of the preceding claims wherein said clutch actuating mechanism is positioned along a centre longitudinal axis of said transmission system.
22. An automated manual transmission system as claimed in any one of the preceding claims wherein at least one of said gear shift actuator and said clutch actuator are at least partially accommodated within a diameter of a rim of said driven wheel and plurality of transmission gears mounted on plurality of transmission shafts are substantially accommodated within a diameter of a rim of said driven wheel.
23. An automated manual transmission system as claimed in any one of the preceding claims wherein said clutch actuator mechanism comprises a self-locking worm gear formed integral with a worm gear shaft connected at one end to a drive shaft of a clutch actuating motor; and a sector gear engaged with and operable by movement of said worm gear and mounted co-axially over a sliding screw to operate the clutch between engaged and disengaged positions through an assembly driven by said sector gear.
24. An automated manual transmission system as claimed in claim 23 wherein said clutch actuating mechanism includes atleast a bearing and said sliding screw moves co-axially with said clutch bearing.
25. An automated manual transmission system as claimed in any one of the preceding claims comprising a cover for the clutch actuating mechanism,

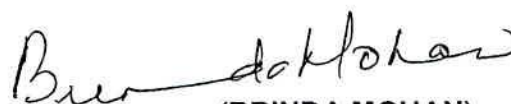
said cover including an insulating material such as one or more layer(s) of insulating foam.

26. An automated manual transmission system as claimed in any one of the preceding claims being a non-synchromesh sequential multi-shaft system providing for a plurality of gear ratios with a shift drive system including a drum shift being used for selecting a particular gear ratio and mated to a prime mover selected from the group consisting of internal combustion engines and electric motors or hybrids or combination thereof.

27. An automated manual transmission system as claimed in claim 26 wherein said prime mover is an internal combustion engine and an air filter for intake air is positioned above the transmission housing and wherein said gear shift actuator is located in a space below the air filter, said air filter preferably having a portion shaped to accommodate said gear shift actuator.

Dated on this the 22nd day of December, 2016.

For BAJAJ AUTO LIMITED,
By its attorney


(BRINDA MOHAN)
INPA269

Application No. : 4864/MUM/2015

Title :AN AUTOMATED MANUAL TRANSMISSION SYSTEM

Applicant name: Bajaj Auto Limited

ABSTRACT

An automated manual transmission system (10) for a vehicle having a driven wheel (300) comprising a frame (50); a prime mover (150) swingably mounted on the frame; a transmission comprising a plurality of gears (22a-22c; 23a-23c; 24a-24c)); a control unit for controlling operation of the transmission system (10); a gear shift actuating mechanism (G) controlled by the control unit to shift transmission gear; and a clutch actuating mechanism (C,619) controlled by the control unit wherein said gear shifting and clutch actuating mechanisms (G,C) of said transmission system (10) are located distal from the prime mover (150) and proximate the driven wheel (300).The automated manual transmission system (10) is desirably of sequential non-synchromesh type.

Figure 1A

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Applicant name: Bajaj Auto Limited

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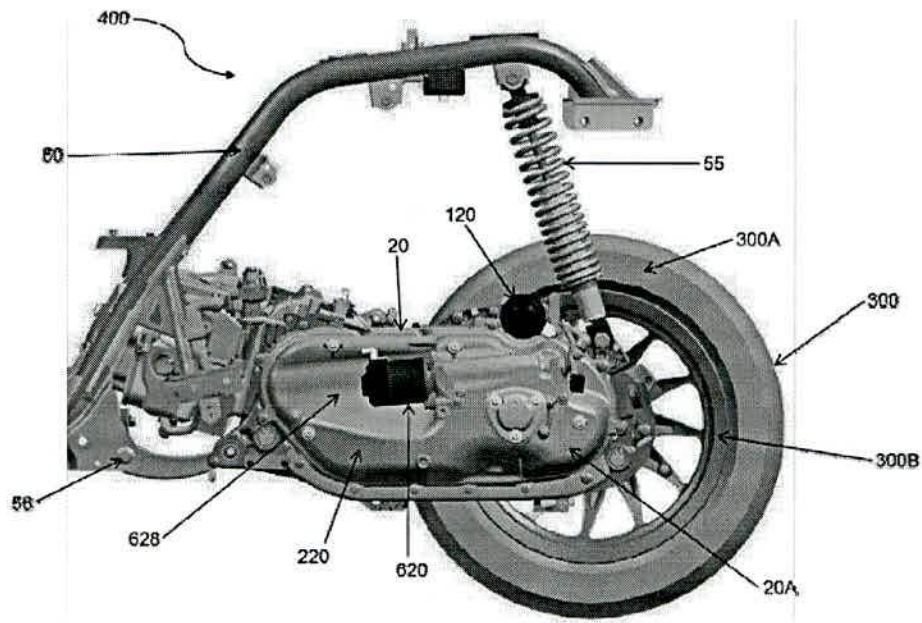


FIGURE 1A

Dated on this the 22nd day of December, 2016.

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Applicant name: Bajaj Auto Limited

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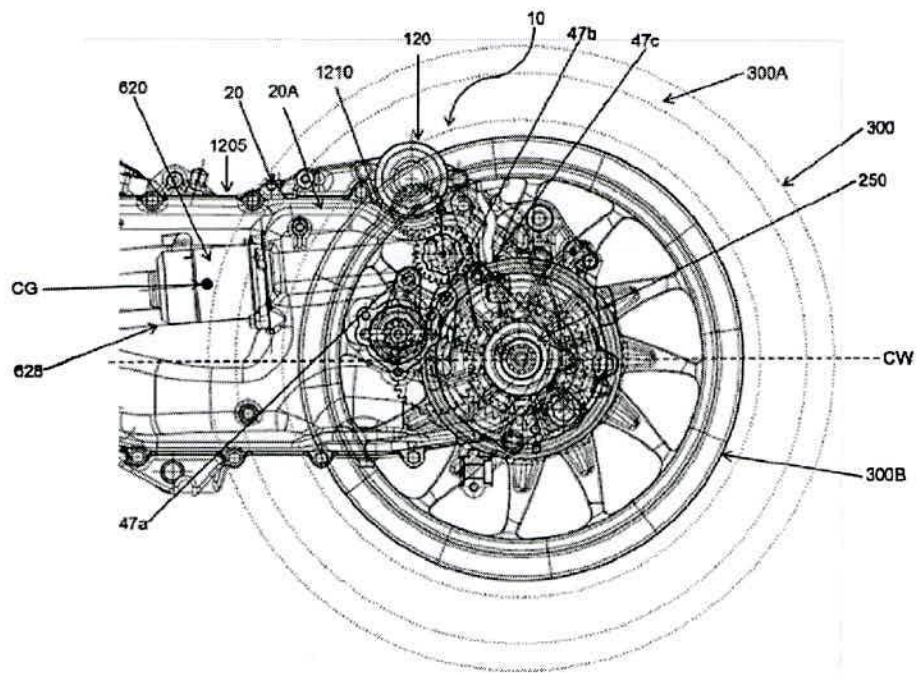


FIGURE 1B

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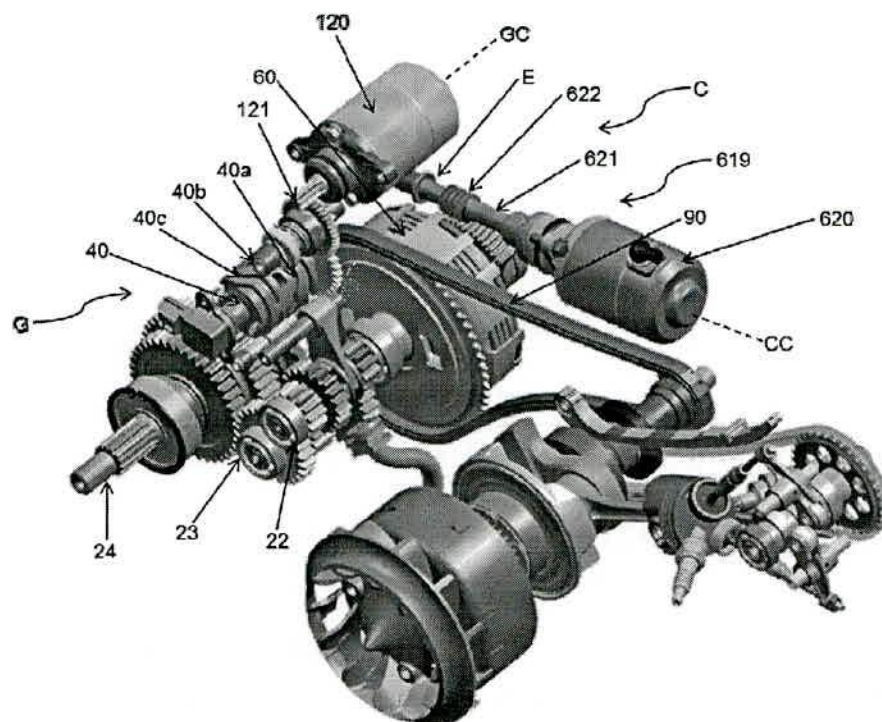


FIGURE 2

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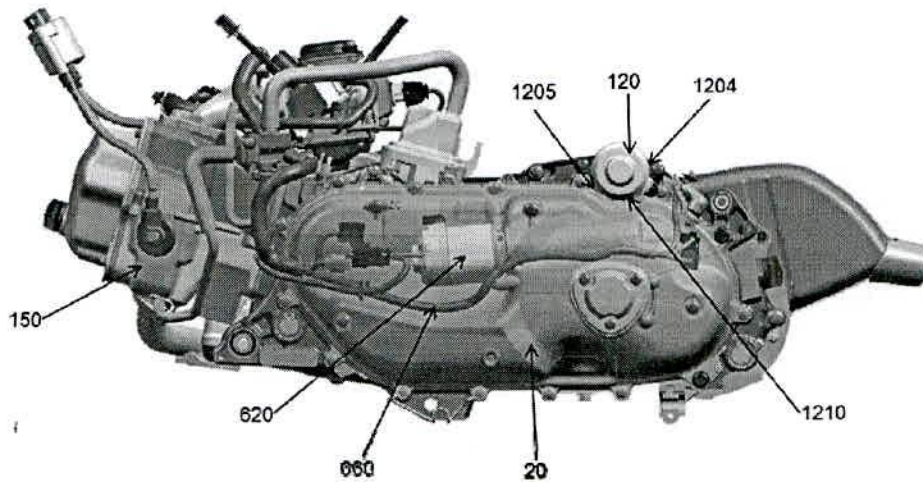


FIGURE 3A

Dated on this the 22nd day of December, 2016.

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Application No. : 4864/MUM/2015
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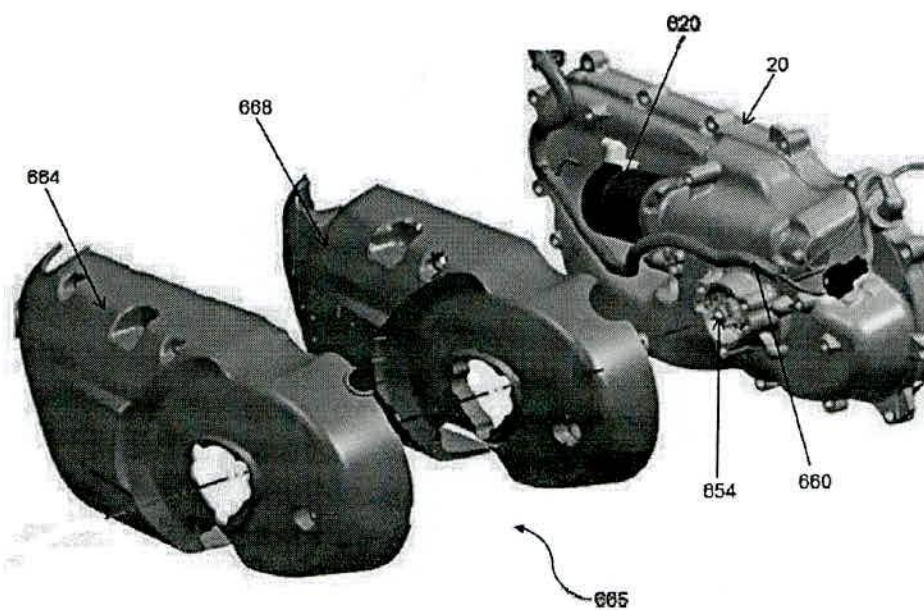


FIGURE 3B

Dated on this the 22nd day of December, 2016.

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Application No. : 4864/MUM/2015
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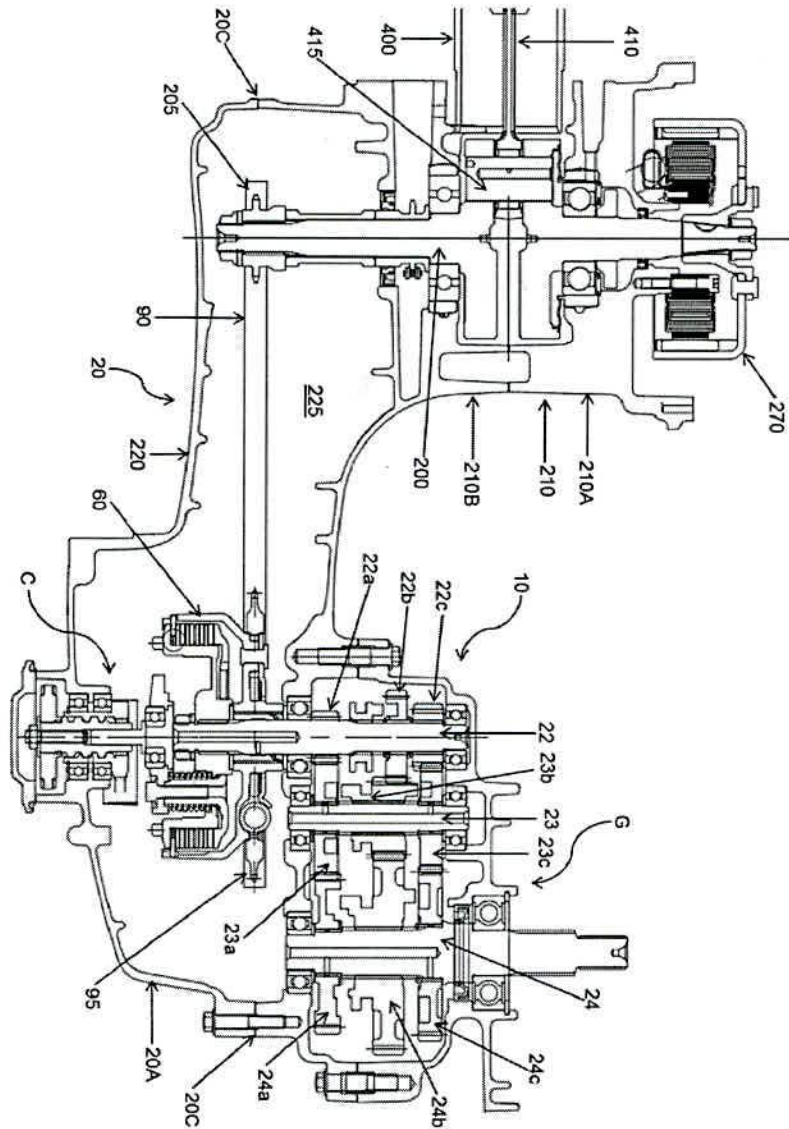


FIGURE 4

Dated on this the 22nd day of December, 2016.

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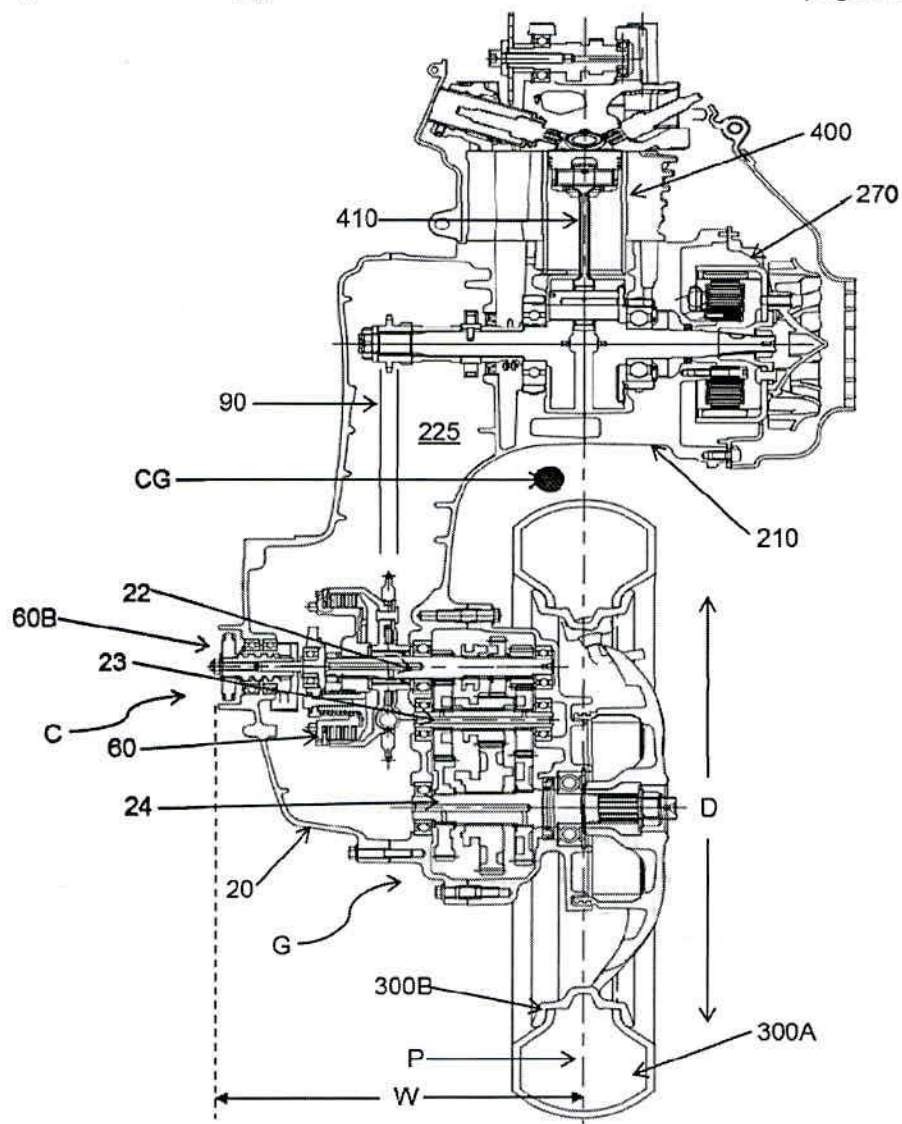


FIGURE 5A

Dated on this the 22nd day of December, 2016.

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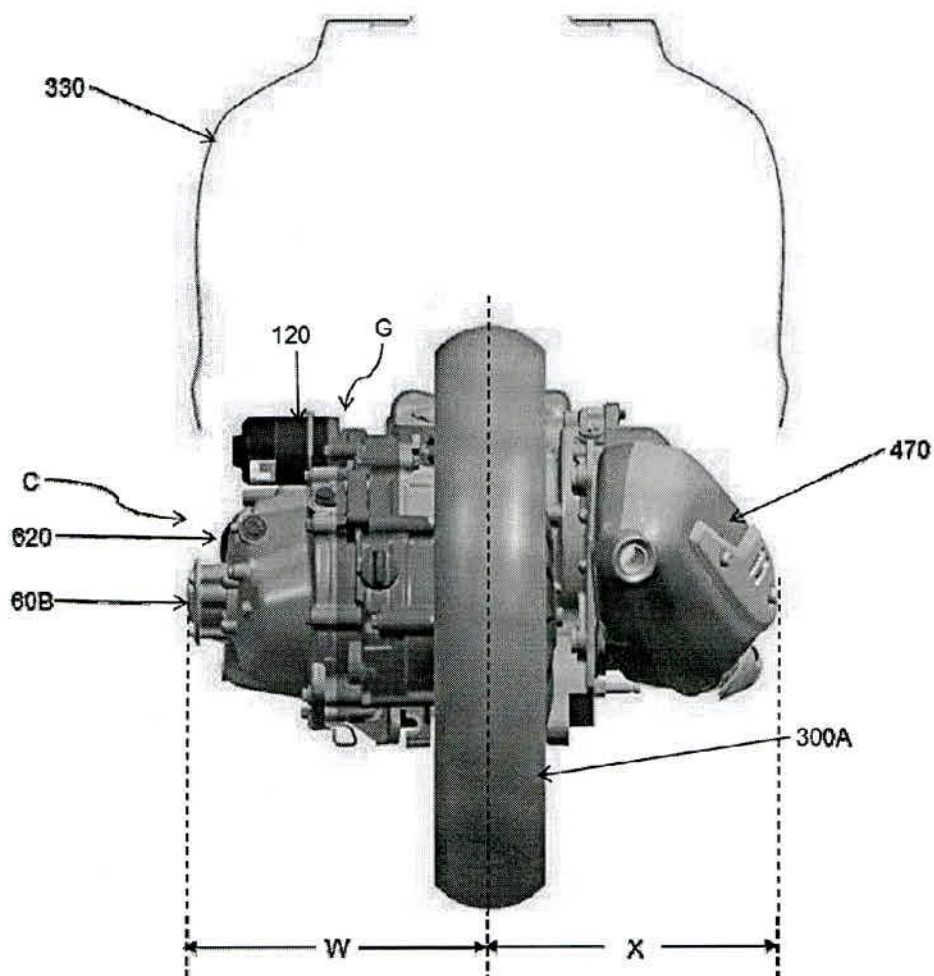


FIGURE 5B

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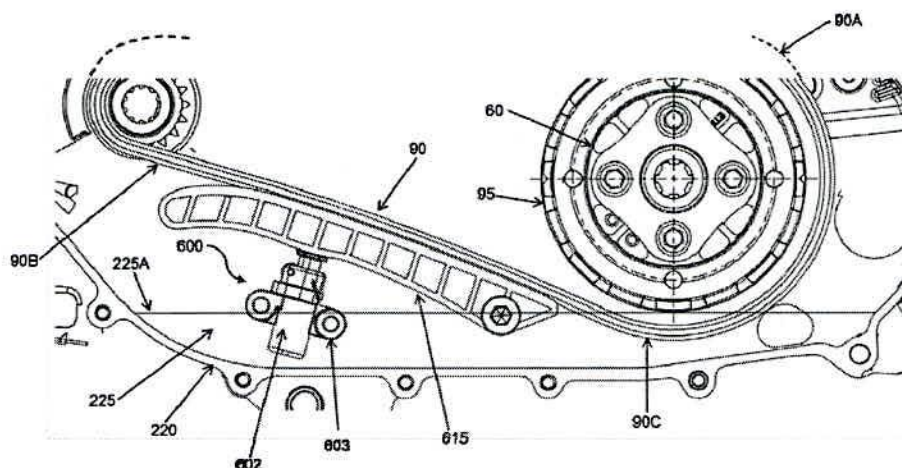


FIGURE 6

Dated on this the 22nd day of December, 2016.

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Application No. : 4864/MUM/2015
Applicant name: Bajaj Auto Limited

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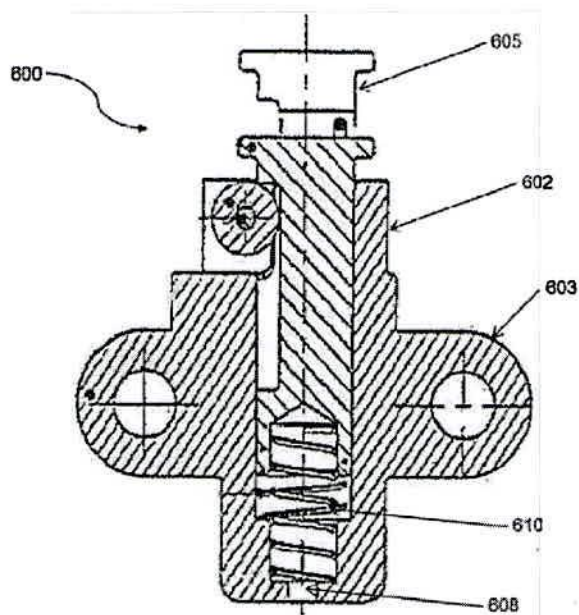


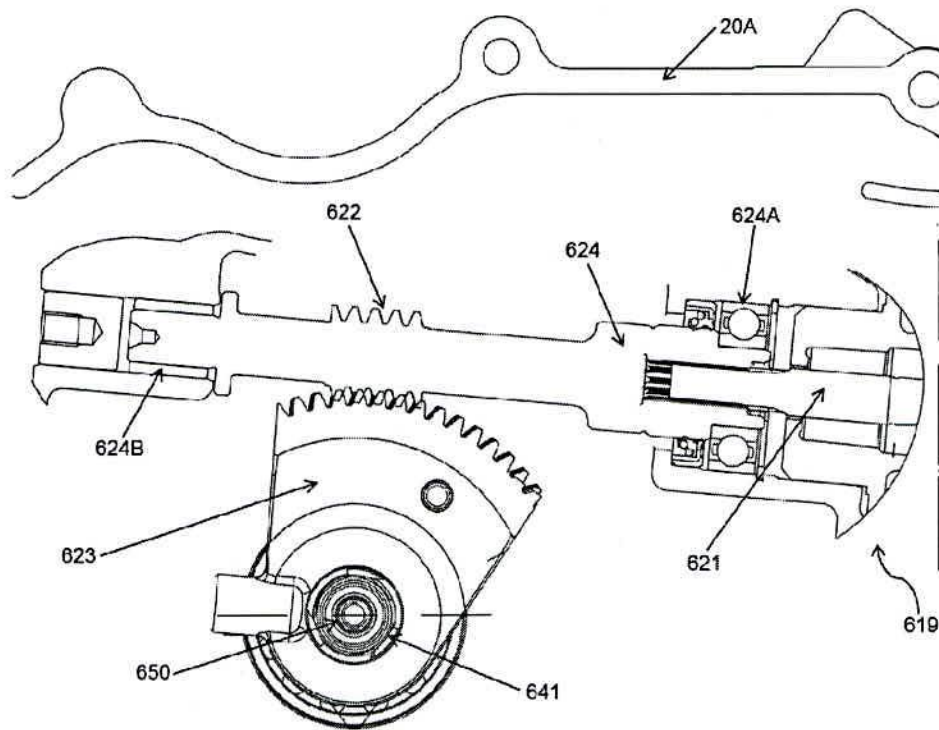
FIGURE 7

Dated on this the 22nd day of December, 2016.

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Application No. : 4864/MUM/2015
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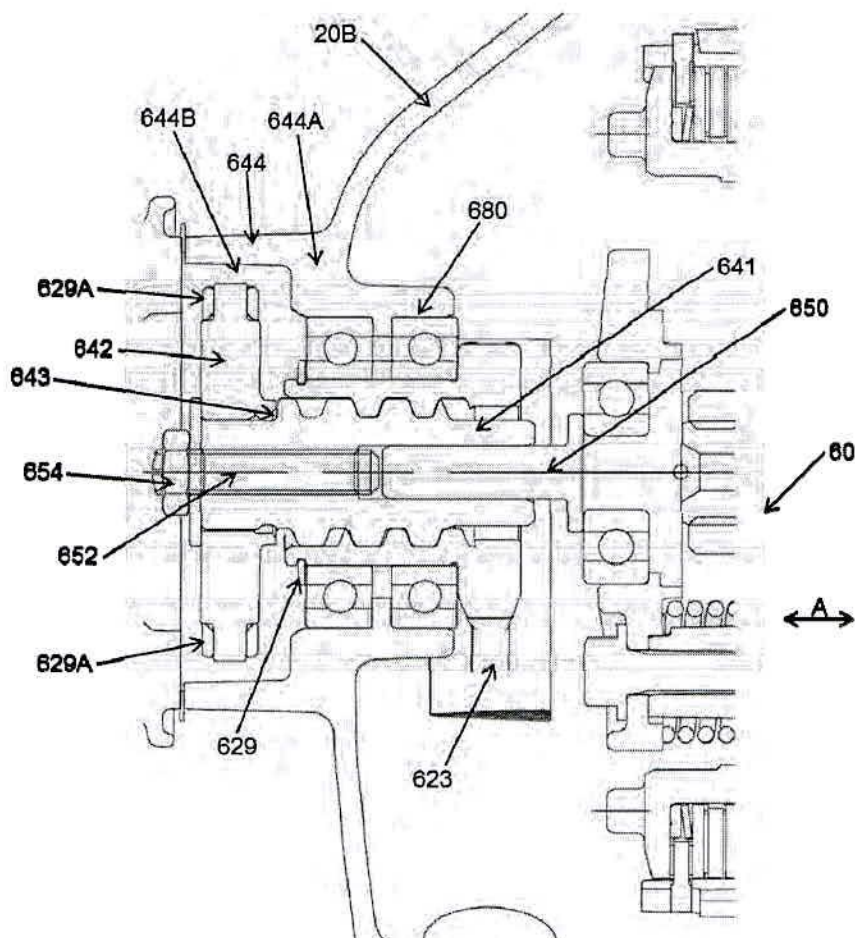


FIGURE 9

Dated on this the 22nd day of December, 2016.

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Application No. : 4864/MUM/2015
Applicant name: Bajaj Auto Limited

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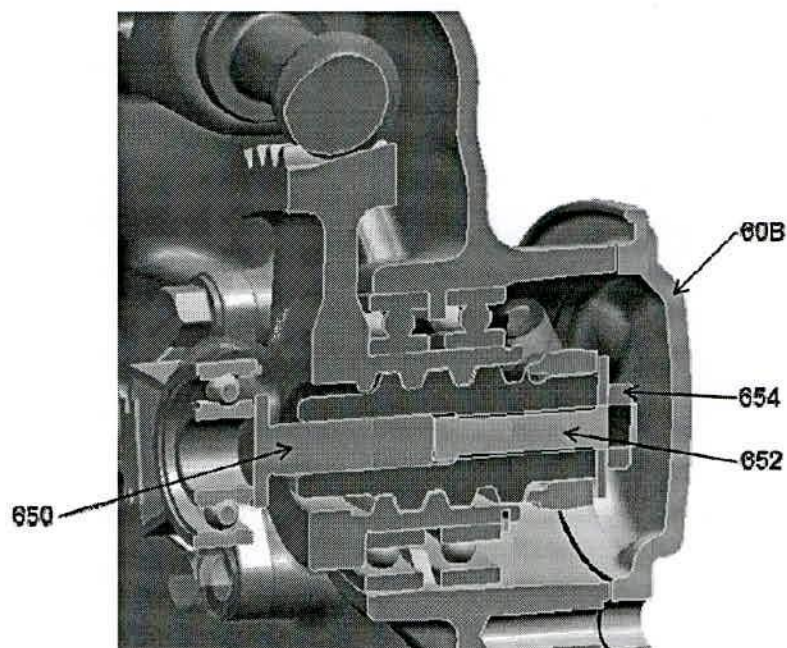


FIGURE 10

Dated on this the 22nd day of December, 2016.

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Application No. : 4864/MUM/2015
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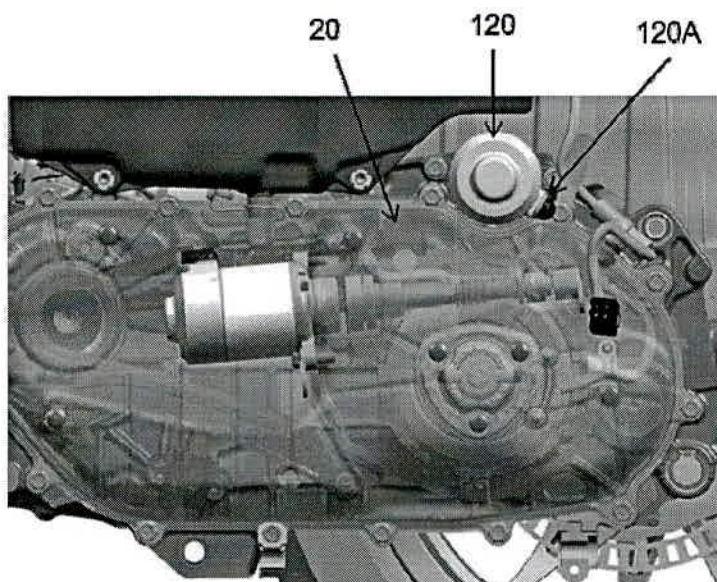


FIGURE 11

Dated on this the 22nd day of December, 2016.

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Applicant name: Bajaj Auto Limited

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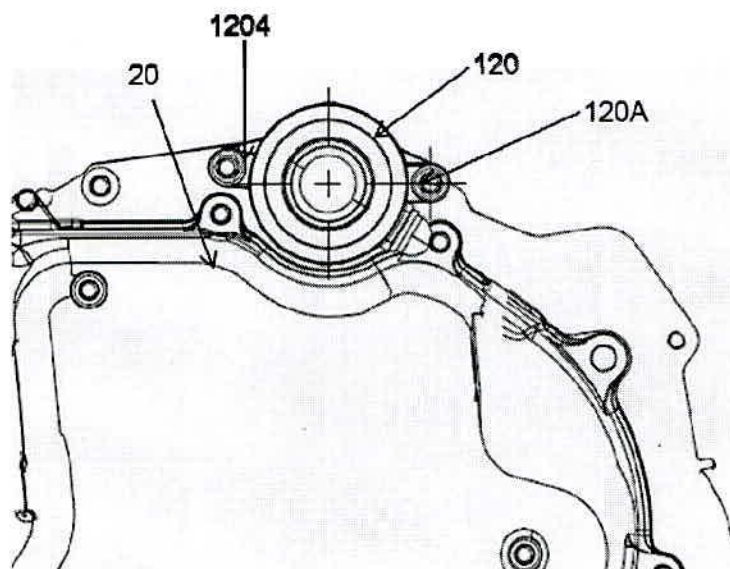


FIGURE 12A

Dated on this the 22nd day of December, 2016.

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Application No. : 4864/MUM/2015
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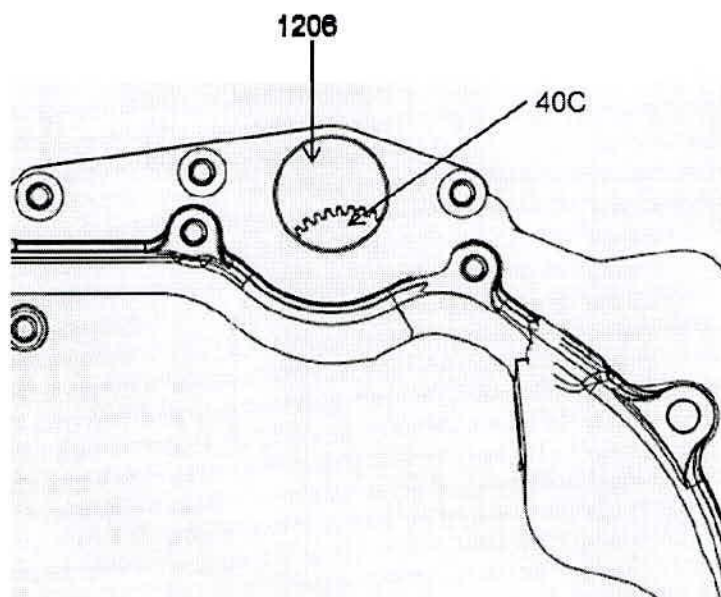


FIGURE 12B

Dated on this the 22nd day of December, 2016.

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