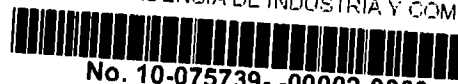


Clarke, Modet

COLOMBIA

P-2610

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO



No. 10-075739- -00002-0000

Fecha: 2010-09-13 15:37:41 Dep. 2020 DIR.NUEVASOR
Tra. 2 PATENTES Eje 1 REGDEPOSITO
Act 4-H RESPUESTAREQUE Folios: 66

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO
DIVISION DE NUEVAS CREACIONES

E. S. D.

Ref.: Expediente No. 10.075.739
Solicitud de Patente a nombre de
BAJAJ AUTO LIMITED

Yo, DILIA MARÍA RODRÍGUEZ D' ALEMAN, identificada como aparece al pie de mi firma, domiciliada en la Carrera 11 No. 86-53, piso 6, obrando como apoderada de la sociedad BAJAJ AUTO LIMITED domiciliada en Maharashtra, India, solicitante de la patente de la referencia, en respuesta al oficio No. 09178 notificado por fijación en lista el día 22 de julio de 2010, atentamente me permito presentar:

1. A pesar de que esa Superintendencia no requirió el documento de cesión, presento el mismo donde consta la cesión del derecho a la patente otorgada por los inventores a favor de mi mandante con la traducción oficial de lo pertinente.
2. Copia certificada de la prioridad reivindicada Nr. 1469/CHE/2009 de 23 de junio de 2009 de la India, con la traducción de lo pertinente.
3. En relación con el título de la solicitud informo que cambio el título de la solicitud a: **"MOTOR DE COMBUSTIÓN INTERNA DE CUATRO TIEMPOS CON DESEMPEÑO MEJORADO QUE COMPRENDE POR LO MENOS UN MEDIO DE IGNICIÓN"**.

Espero con esto haber dado cabal cumplimiento a lo solicitado por ese despacho y de conformidad con lo indicado en los artículos 3º, inciso 3, 35 inciso 2 y 59 inciso 2 del CCA, al analizar este memorial, atentamente ruego se traten todas las cuestiones planteadas con motivo del mismo.

Señor Superintendente,

DILIA MARÍA RODRÍGUEZ D' ALEMAN
C.C. 41.654.882 de Bogotá
T.P. 20824 CSJ

Traducción oficial de un documento que está originalmente en inglés

Hay un sello del Gobierno de la India.

Hay un sello del Consulado de Colombia en Nueva Delhi, con No. 1420/10 fechado el 2 de agosto de 2010 y firmado por Lina Fajardo, Consejera.

Hay dos sellos en caracteres de la India, uno de ellos fechado el 26 de julio de 2010, con No. 198366 que dice en inglés: "La firma del Subsecretario de la Cámara de Comercio - certificado - (firmado)".

Sello redondo: "Ministerio de Asuntos Exteriores - Gobierno de India"

Los sellos de legalización del Ministerio de Relaciones Exteriores de Colombia están fechados el 2(...) de agosto de 2010; su número es "029723".

FIN DE LA TRADUCCIÓN

Certificación:

Certifico que la presente es una traducción auténtica y completa del inglés al español del documento adjunto, la cual he elaborado según mi leal saber y entender.

Documento: "Intellectual Property - Oficina de Patentes"

Fecha: 25 de agosto de 2010.

Traductor: Jorge Enrique Sierra Reyes (Sello y firma digital debidamente registrados ante el Ministerio de Relaciones Exteriores de Colombia)

Licencia # 376 de 1993, expedida por el Ministerio de Justicia.

Dirección: Carrera 15 # 99-13 Of. 411, Bogotá, D.C.

Teléfonos: (571) 218 2308, (571) 623 2925.

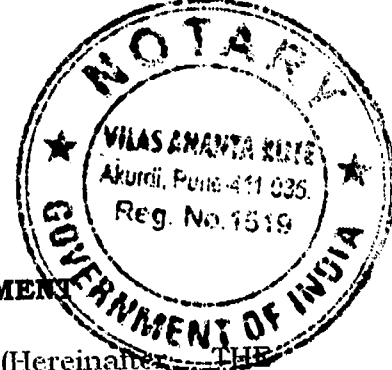
E-mail: tesereser1@yahoo.com

Traducción # 15-899

Clarke, Modet & Co

COLOMBIA

E-MAIL: info@clarkemodet.com.co
SANTAFÉ DE BOGOTÁ, A.A. 93397 COLOMBIA



CESION

El (la) abajo firmante (En adelante EL CEDENTE)

JOSEPH, Abraham
SIVAKUMAR, Ganesan
RAMNATHAN, Hariharan Mysore

Inventor / diseñador con domicilio en: c/o Bajaj Auto Limited, Akurdi Pune, 411 035, India.
c/o Bajaj Auto Limited, Akurdi Pune, 411 035, India.
c/o Bajaj Auto Limited, Akurdi Pune, 411 035, India.

por el presente documento declara que cede todos y cada uno de los derechos que le corresponden o puedan corresponderle sobre la siguiente invención, modelo de utilidad, diseño industrial No. 10.075.739 a: **Bajaj Auto Limited**

con domicilio en Akurdi Pune, 411 035, India.

En prueba de la mutua aceptación de esta cesión ambas partes CEDENTE y CESIONARIO firman el presente documento.

Dado y firmado en
A los Días de De

JOSEPH, Abraham

El Cedente /The Assignor

SIVAKUMAR, Ganesan

El Cedente /The Assignor

BEFORE RAMNATHAN, Hariharan Mysore

El Cedente /The Assignor

VILAS ANANTA KUTE
NOTARY
UNION OF INDIA
Vithalwadi, Akurdi, Pune-35. --

ASSIGNMENT

The undersigned (Hereinafter THE ASSIGNOR)

JOSEPH, Abraham
SIVAKUMAR, Ganesan
RAMNATHAN, Hariharan Mysore

Inventor /designor of domiciled at c/o Bajaj Auto Limited, Akurdi Pune, 411 035, India.
c/o Bajaj Auto Limited, Akurdi Pune, 411 035, India.
c/o Bajaj Auto Limited, Akurdi Pune, 411 035, India.

do hereby declares that it assigns all and each of his rights and privileges on the following invention, industrial design, utility model No. 10.075.739

to **Bajaj Auto Limited**

with domicile in Akurdi Pune, 411 035, India.

As a proof of the mutual acceptance of this assignment, both parties ASSIGNOR and ASSIGNEE sign the present document.

Granted and signed at
on this day of

JOSEPH, Abraham

El Cedente /The Assignor

SIVAKUMAR, Ganesan

El Cedente /The Assignor

RAMNATHAN, Hariharan Mysore

El Cedente /The Assignor

Noted and Registered
at Serial Number



4024110 3

PAGADO IMPUESTO DE TIMBRE 00010
PAGADOS DERECHOS CONSULARES 00020

**CONSULADO DE COLOMBIA
NUEVA DELHI**

No. 1426/10

El suscrito Cónsul de Colombia CERTIFICA
que el señor E. K. PARAMESWARAN
que autoriza el presente documento, ejercía
interimamente en la fecha allí expresada las
funciones de Ministry of External
Affairs (O.I.) New Delhi
y que la firma y sello que en el documento
aparecen como suyos son los que usa y
que en sus actos oficiales.

El suscrito asume responsabilidad alguna
por el contenido del documento.



Lina María Fajardo
LINA FAJARDO
Consejera, EFC

198366

विदेश विभाग
सचिव के रूप में
The Signature of Acting Secretary /
Deputy Secretary / Secretary of Charge
CG Communication Attached

JUL 2010



(E. K. PARAMESWARAN)
(E. K. PARAMESWARAN)
अनुभाग अधिकारी (ओ.आई.)
Section Officer (O.I.)
विदेश विभाग, नई दिल्ली
Ministry of External Affairs, New Delhi

JEFE DE LEGALIZACIONES
BOGOTÁ D.C.

2010 AGO 21 A 3:14

MINISTERIO DE
RELACIONES EXTERIORES

029723
Lina Fajardo
ASISTENTE DE LEGALIZACIONES

RECEIVED
2010 AGO 21 A 3:14

INTELLECTUAL PROPERTY

India

Gobierno de la India
OFICINA DE PATENTES
Ministerio de Comercio e Industria
Departamento de Política y Promoción Industrial

Se certifica por el presente que el adjunto es una copia auténtica de la **Especificación Provisional, Especificación Completa, Resumen y Dibujos** de la solicitud de patente conforme se haya archivado y como se detalla enseguida:

Fecha de solicitud: 23/06/2009

Fecha de radicación de la
especificación completa: 22/06/2010

Solicitud No. 1469/CHE/2009

Solicitantes: Señores Bajaj Auto Limited, Compañía de la India, que tiene su sede comercial en New No. 6, Old No. 157, II Floor, Habibullah Road, T. Nagar, Chennai -600 017, Estado de Tamil Nadu y su oficina registrada en Akurdi, Pune-411 035, Estado de Maharashtra, India.

En constancia de lo anterior he puesto mi firma.

Fecha de este día 15 de julio de 2010.

Día 24 de Asadha, 1932(Saka)

Por autoridad del Contralor General de Patentes, Diseños y Marcas Registradas.

(Firmado) (V. Rengasamy) Subcontralor de Patentes y Diseños


Traductor Oficial
JORGE E. SIERRA REYES
Licencia 376 de 1993 Minjusticia 4

- Oficina de Patentes.

Oficina de Derechos de Propiedad Intelectual.

G.S.T. Road, Guindy

Chennai – 600 032.

FIN DE LA TRADUCCIÓN

Certificación:

Certifico que la presente es una traducción auténtica y completa del inglés al español del documento adjunto, la cual he elaborado según mi leal saber y entender.

Documento: "Intellectual Property - Oficina de Patentes"

Fecha: 25 de agosto de 2010.

Traductor: Jorge Enrique Sierra Reyes (Sello y firma digital debidamente registrados ante el Ministerio de Relaciones Exteriores de Colombia)

Licencia # 376 de 1993, expedida por el Ministerio de Justicia.

Dirección: Carrera 15 # 99-13 Of. 411, Bogotá, D.C.

Teléfono: (571) 218 2308, (571) 628 2925.

E-mail: jeseser1@yahoo.com

Traducción # 15-399

Traductor Oficial

JORGE E. SIERRA REYES

Licencia 376 - 1993 Minjusticia



GOVERNMENT OF INDIA
PATENT OFFICE
MINISTRY OF COMMERCE AND INDUSTRY
Department of Industrial Policy and Promotion

It is hereby certified that annexed here to is a true copy of **Provisional Specification, Complete Specification, Abstract and Drawings** of the patent application as filed and as detailed below:-

Date Of Application : 23/06/2009

Date of filing of
Complete Specification : 22/06/2010

Application No : 1469/CHE/2009

Applicants : M/s. Bajaj Auto Limited, an Indian Company, having its local business at New No. 6, Old No. 157, II Floor, Habibullah Road, T. Nagar, Chennai – 600 017, State of Tamil Nadu and its registered office at Akurdi, Pune – 411 035, State of Maharashtra, India.

In witness there of
I have here unto set my hand

Dated this the 15th day of July 2010
24th day of Asadha, 1932(Saka)

By Authority of
THE CONTROLLER GENERAL OF PATENTS,
DESIGNS AND TRADE MARKS.

(V. RENGASAMY)

DEPUTY CONTROLLER OF PATENTS AND DESIGNS.

PATENT OFFICE
INTELLECTUAL PROPERTY RIGHTS BUILDING
G.S.T. ROAD, GUINDY
CHENNAI – 600 032.

FORM - 2

THE PATENTS ACT, 1970
(39 of 1970)

&

The Patents Rules, 2003

PROVISIONAL SPECIFICATION

(SECTION 10)

TITLE

AN IMPROVED INTERNAL COMBUSTION ENGINE

A P P L I C A N T

We, **Bajaj Auto Limited**, an Indian Company, having its local business at New No. 6, Old No. 157, II Floor, Habibullah Road, T. Nagar, Chennai - 600 017, State of Tamil Nadu, and its registered office at Akurdi, Pune - 411005, State of Maharashtra, India.

The following specification describes the nature of this invention:-

This invention relates to an improved internal combustion engine using lean fuel/air mixtures.

Internal combustion engines are known in which each cylinder is provided with two or more valves namely inlet valve(s) and exhaust valve(s). These valves open in a cavity in the cylinder head conventionally known as a combustion chamber. When two valves are used (ie one inlet and one exhaust valve), these valves are typically sized and arranged "in line" to optimise power output. Figure 1 shows a cylinder head 1000 with inlet and exhaust valves 1001 and 1002 arranged in line for a single spark ignited engine. Figure 2 shows a cylinder head 1010 with inlet and exhaust valves 1011 and 1012 arranged for a dual spark ignited engine in what is conventionally referred to as a hemispherical combustion chamber. The valves 1011 and 1012 are necessarily smaller than valves 1001 and 1002 so the dual spark ignited engine may potentially deliver less power for the same sized engine.

Typically, such engines use a homogeneous air-fuel charge and are provided with only one spark plug per cylinder. One of the disadvantages of such an arrangement is that the process of combustion from spark initiation to completion takes a comparatively long time. At higher engine speeds, the available combustion duration may be insufficient, resulting in a need to use non-optimal (ie increasingly advanced) ignition timing so as to avoid incomplete combustion and consequent loss of power, fuel wastage and increase in emissions. Further disadvantages accrue from the need for richer fuel/air mixtures to achieve better driveability and adequate flame propagation in the combustion chamber and adequate power output and/or reduced knocking particularly if the fuel/air mixture is lean.

These problems may be addressed, to some extent, by employing an engine having two spark plugs. This is counter-intuitive for use in a small bore engine, where flame propagation distances are relatively small and normally sufficient to enable efficient combustion. Furthermore, problems also arise because of the small space available to accommodate the two spark plugs. This could be addressed by locating one of the two spark plugs on the timing side of the engine as described in

the Applicant's Indian Patent No. 195904 dated 16 July 2002 (corresponding to International Patent Publication No. WO 2005/042954 A1) which discloses a small bore twin spark plug engine, operating on four stroke principle, with inlet and exhaust valves in an "in-line" configuration and which is incorporated herein by reference. A protective sleeve is provided for the spark plug to extend through a timing chain cavity so that it is protected from fouling with lubricant and inefficient operation. However, a compromise has to be made in this engine since the "in-line" configuration provides good power output but is substantially less beneficial where fuel economy is a key object. There is ample scope for improvement in terms of combustion effectiveness by use of higher swirl rates of the incoming air-fuel charge.

The Applicant has also described an engine with inlet and exhaust valves in "offset" configuration in its International Patent Publication No. WO 2007/060604 with international publication dated 19 July 2007. In this engine, the spark ignition means are located distal from the timing chain of the engine and so no protective sleeve requires to be provided for one of the spark plugs as in Indian Patent No. 195904. In addition, better charge mixing is achieved through increased swirl in the combustion chamber which may be achieved, at least in part, through the offset valve configuration. Therefore, this engine has been highly advantageous. However, a tendency has been noticed for end gases to remain unburnt adversely affecting emissions and fuel efficiency. A further tendency, arising from the foregoing, is the tendency for knock to occur. Therefore, there is still need for improving the combustion chamber geometry and layout so as to suppress knock and increase combustion efficiency and fuel economy.

It is accordingly an object of the present invention to provide an internal combustion engine operating on the four stroke principle with improved performance over prior engines particularly when operating in lean burn combustion mode.

With this object in view, the present invention provides an internal combustion engine operating on the four stroke principle comprising:

- (a) a combustion chamber having a valve train comprising at least one inlet valve and at least one exhaust valve;
- (b) at least two ignition means located in the combustion chamber; and

(c) drive means for driving the valve train

wherein said ignition means are placed diametrically opposite each other and at least one ignition means is placed in line with the valve train. This engine arrangement allows further use of space within the combustion chamber and this assists combustion efficiency and fuel economy. Still further improvements may be achieved by including other features within the engine as described below.

With the above object in view, the present invention also provides an internal combustion engine operating on the four stroke principle comprising a combustion chamber; a valve train comprised of at least an inlet valve and at least an exhaust valve located in the combustion chamber; at least two ignition means located in the combustion chamber; and a reciprocating piston with a recess on its head wherein said ignition means are placed diametrically opposite each other in the combustion chamber to each generate flame kernels on ignition of a mobile lean fuel air charge present within the combustion chamber, the motion of the lean fuel air charge and propagation of the flame fronts through the combustion chamber being influenced by the recess in the piston head and combustion chamber surface geometry to promote combustion efficiency.

The recess on the piston head may be shaped to create a combustion chamber volume which increases progressively in a direction towards another ignition source. Advantageously the shape and location of the recess in the piston is of a nature that enhances swirl motion of the fuel air charge within the combustion chamber, or at least minimises any negative effects on the swirl motion within the combustion chamber. The recess may be elliptical, ellipsoid, oval or ovoid in shape. Desirably, the major axis of the elliptical, ellipsoid, oval or ovoid recess extends across the head of the piston in a direction between the two spark plugs where two spark plugs are provided.

Desirably, the combustion chamber has pent roof construction or geometry and two ignition means in the form of spark plugs are provided in it. Preferably, the mounting points of the spark plugs, which are desirably directed towards each other, correspond to ends of a joining plane located at the base of the two inclined surfaces of the pent roof chamber. These geometric locations typically correspond to the

portion of largest dimension of the combustion chamber thus assisting optimisation of the combustion process through optimisation of the shape and use of space in the combustion chamber as described below. More specifically, this may be represented by a ratio or proportion between distance between the spark plugs and cylinder bore diameter. It is highly desirable that this ratio be 1 or close to 1. It may be added that such location of the spark plugs prevents the possibility of trapping of end gases behind the spark plug(s), thus reducing the propensity for knocking noticed with a prior art engine as above described. For clarity, a reference to "behind" is to be understood as a reference to a direction which is away from the region between the two plugs where two plugs are used.

Preferably, the projected axes of said ignition means and the major axis of the recess on the piston head intersect at an obtuse angle to each other when viewed from top dead centre. This "open" arrangement optimises combustion processes occurring within the combustion chamber by optimising use of the space within the combustion chamber. More specifically, the flame fronts propagate and develop through a greater open space than in previous proposals, where – for example – the spark plugs rather than being directed toward each other had an angled orientation which provided less opportunity for flame fronts propagating from the spark plugs to intersect along a broad front rather than at a point. This greater use of combustion chamber space increases combustion efficiency.

This engine, desirably a single cylinder engine, has a configuration of components in the combustion chamber which optimizes the shape and use of space within the combustion chamber increasing the amount of space available for a flame front to be initiated by ignition of a fuel air charge within the combustion chamber and to propagate and develop to combust the charge. The importance of even incremental increases in effective combustion chamber volume and shape by optimising the placement and arrangement of ignition means, or spark plugs, is difficult to overestimate. For example, in International Publication No. WO 2007/080604, discussed above, the location and orientation of the spark plugs necessitate mounting on raised mounts or bosses. The Applicant has found that removal of these mounts or bosses reduces the amount of combustion chamber

volume which is behind the spark plug to the point where combustion performance for lean fuel/air mixtures is appreciably improved. To that end, at least one of the ignition means or spark plugs is mounted flush with a surface of the combustion chamber to obtain this benefit. Desirably, at least the spark plug closest to the inlet valve – particularly in the swirl direction – is mounted flush with the combustion chamber surface.

The valves may, in some embodiments of the engine, conveniently be positioned in an "offset" arrangement resulting in space available for the flame kernels to progress towards each other duly assisted by the swirl created by combusting gases within the above configured combustion chamber. Due assistance is provided by a recess on the piston head having a long or major axis in the direction of the line of intersection of the planes of the pent-roof shaped combustion chamber. This results in a combustion chamber with the majority of its volume contained within a central volume which could, for purposes of visualisation, be described as an elongate volume, of for example approximately circular cross section though another possible form is prismatic, such as triangular prismatic section, with the axis of such volume being in the same direction as the recess in the piston. The shape and position of the recess in the piston also provides for the creation of one or more squish zones between the piston and the cylinder head resulting in the combusting gases being squeezed as the piston moves towards the top dead centre position to cause a so-called "squish" motion. Such squish motion is enhanced by provision of one or a plurality of squish zones or areas in the roof of the combustion chamber; for example, two squish areas may be provided, these zones having an approximately crescent shape, with the resulting squish flow being directed towards a central region of the combustion chamber.

Other motions of importance to the fluid dynamics for the engine of the invention are a combined tumble and swirl ("inclined tumble"). Tumble and swirl are rotational flows which cause mixing of fuel and air within an engine. Tumble is induced in the Applicant's engine by selecting an appropriate entry angle for the inlet valve particularly at the inlet port. Arrangement of the airbox and the nature of fuel delivery to the engine are influences on the entry angle and the engine is packaged

such that the entry angle will permit formation of a tumbling flow. As parallel an alignment of an axis of the inlet port relative to a longitudinal axis of the combustion chamber as may be achieved is preferred to maximise the tumbling effect. The further swirl rotational flow is induced by offset configuration of inlet and exhaust valves. The combination of tumbling and swirling flows in the Applicant's engine enables enhanced charge mixing and better combustion stability and driveability.

The lean burn mode of operation, where the air fuel ratio is in the range 15:1 to 17:1 is important for the engine. Lean burn promotes engine fuel economy and may also be useful in the control of certain types of engine emission. However, it is important that combustion duration be sufficiently rapid to ensure efficient engine running. The multiple spark plug configuration is important to this objective as is the location of the two or more ignition means, or spark plugs, in the combustion chamber. The diametrically opposed placement of the spark plugs also ensures sufficiently fast flame propagation with the entire combustion chamber volume typically being covered in less time, than for a single spark plug, with near complete combustion of the lean fuel/air mixture and the ability to use optimal spark timing for best engine performance without inducing knock or increasing emissions outputs.

The engine of the invention is advantageously a small bore engine. Typical characteristics of a small bore, small capacity or small displacement engine for use in the practice of the invention include a swept cylinder volume ranging from 75 cc to 225 cc, preferably in the range 100cc to 200cc (more preferably 100cc to 150cc), and cylinder bore diameter 45 mm to 70 mm, employed as prime movers for operation of two or three wheeled vehicles or other motorised vehicles, particularly motorcycles. Notably, the small bore engine of the invention advantageously does not require a water cooling system to operate effectively. Such an engine is advantageously a single cylinder engine which may be a two valve overhead cam four stroke engine.

The drive means for the valves may be a timing chain. The drive means, such as a timing chain, may be located in a drive means cavity provided with a lubricant supply. As a spark plug to be located in the combustion engine, likely being

in line with the valve train, may advantageously and typically need to extend through the drive means cavity, given the very limited space available for accommodating the spark plugs in a small bore engine, particularly, a protective sleeve may be provided for the spark plug to avoid lubricant affecting spark plug function.

As noise and harshness may also affect engine performance, the spark plugs may be operated in accordance with the strategy described in the Applicant's co-pending PCT Application No. WO 2007032020, the contents of which are hereby incorporated by reference, and in which a control unit for the engine retards or stops operation of an ignition means, or spark plug, in response to the rate of rise of combustion pressure as proxied by rate of rise of engine speed or engine acceleration, or engine speed, rising above an acceptable threshold value.

The engine may be fuel injected or carburetted and applied to any of a range of applications. A typical application would be in a two wheel vehicle such as a motorcycle. The engine is advantageously a 2 valve engine.

The engine has improved combustion efficiency, as measured by lesser occurrence of knock, low emissions, and improved fuel economy. Improved driveability is also an advantage of the engine. These advantages arise in no small part from the more optimum arrangement of spark plugs and valves, together with the influence of geometry – as above described – within the combustion chamber of the small bore engine.

The internal combustion engine of the present invention may be more fully understood from the following non-limiting description of a preferred embodiment thereof made with reference to the accompanying drawings in which:

Figure 3 is a bottom view of the cylinder head of a prior art internal combustion engine;

Figure 3a is a top view of the cylinder head of a prior art internal combustion engine;

Figure 4 is a bottom view of the cylinder head of an internal combustion engine in accordance with a preferred embodiment of the invention;

Figure 4a is a sectional view of combustion chamber illustrating mounting of the spark plugs according to prior art;

Figure 4b is a sectional view of combustion chamber illustrating mounting the spark plugs according to invention;

Figure 5 is a bottom schematic section view of (A) a prior art engine; and (B) an engine of one embodiment of the present invention;

Figure 6 is a side schematic section view of (A) a prior art engine; and (B) an engine of one embodiment of the present invention; and

Figure 7 is a sectional view through the piston of a preferred embodiment of the invention.

Referring now to Figure 3, there is shown the bottom of a cylinder head 14 of a small bore internal combustion engine 100 of the kind above described with reference to swept cylinder volume and cylinder diameter. The cylinder head 14 includes a combustion chamber 110 having an inlet valve 23 and an exhaust valve 24 arranged in a offset manner in the combustion chamber and therefore necessarily of smaller size than conventional. The smaller sized valves deliver less power but to the benefit of generating beneficial levels of swirl so as to facilitate substantially improved fuel economy, perhaps at least 5% over comparable vehicles that do not incorporate the present invention.

Combustion chamber 110 has a pent-roof construction. A pent-roof combustion chamber is a combustion chamber having an upper surface in the shape of a slanted or sloped roof comprising two inclined and diverging surfaces. The engine works on the four stroke principle, with the inlet valve 23 and exhaust valve 24 timing being controlled by a timing chain (not shown).

Dual spark plugs 40 and 42, each spark plug being of conventional manufacture, are fitted in the cylinder head 14. Spark plugs 40 and 42 are located in the combustion chamber 110 and promote ignition and combustion of lean fuel/air mixtures, or charges, allowing operation of the engine 100 in a lean burn combustion

mode to improve fuel economy. It may be noted that the spark plugs 40 and 42 are mounted on raised mounts or bosses 43.

As seen in Figure 3, the combustion chamber 110 may be considered to be divided into quadrants. The intake and exhaust valves 23 and 24 may be considered to reside in diagonally opposed quadrants notwithstanding some overlap of the valves 23 and 24 with other quadrants. Such a valve configuration is an "offset" configuration, normally associated with lesser power output but better fuel economy than for "in line" valve configurations. Spark plugs 40 and 42 reside in the remaining diagonally opposed quadrants of combustion chamber 110 and do not extend through the timing chain cavity and so do not require to be designed or protected to avoid contact with lubricant in that cavity.

The inlet and exhaust valves 23 and 24 of engine 100 are actuated by a rocker arm assembly 18 as illustrated in Figure 3a, more detail of which is described in the Applicant's International Patent Publication No. WO 2007/050604 with international publication date 19 July 2007, the contents of which are hereby incorporated herein by reference. This rocker arm assembly 18 is configured to provide a greater space for location of the twin spark plugs 40 and 42 and facilitates the location of spark plugs 40 and 42 distal, away from, the timing chain cavity (Figure 3) of engine 100.

Referring now to Figure 4, the components located within combustion chamber 110 are the same as discussed for Figure 3 with the exception that, in Figure 4, reference numerals other than for the engine 100 and combustion chamber 110 are preceded by the numeral "1". Therefore, two spark plugs 140 and 142 are still provided and these spark plugs 140,142 play the same role, in igniting a fuel/air charge, as spark plugs 40 and 42. Inlet and exhaust valves 123 and 124 are still present and are still located in an offset configuration. However, there are some significant differences in arrangement and location of the spark plugs 140 and 142 from spark plugs 40 and 42. These differences in location are important to achievement of improved flame front propagation through improved use or

optimisation of the use of space within the combustion chamber 110. These differences will now be described.

First, both spark plugs 140 and 142 are mounted diametrically opposite, or diametrically opposed, to and facing towards each other. Accordingly, sparks initiate at two diametrically opposed points, igniting the fuel air mixture and forming flame fronts that propagate quickly thus providing an increased combustion rate of the fuel air charge within the combustion chamber, certainly as compared to that for a single spark plug engine, and toward each other covering the entire volume of the combustion chamber 110 achieving near complete combustion of the lean fuel air mixture. This is valuable to achievement of fuel economy which is the prime object of use of a lean fuel air mixture. In contrast, if power output were the key concern, as it is in the prior art, a rich fuel air mixture would be preferred but would lead to increased fuel consumption and most likely increased emissions (eg hydrocarbon emissions).

Second, neither of spark plugs 140 and 142 are located on raised mounts or bosses. Rather, both of spark plugs 140 and 142 are mounted flush with the surface of the combustion chamber 110. This has the benefit of maximising the amount of combustion chamber volume in front of the respective plug. The detailed comparative views are illustrated in Figs. 4a and 4b wherein Fig. 4a shows the spark plugs are located on raised mounts or bosses 43 and Fig. 4b shows both of spark plugs 140 and 142 are mounted flush with the surface of the combustion chamber 110 according to the invention. This ensures that more of the combustion chamber is forward of the spark plug ignition point and that the flame front is not required to burn in a direction back behind the spark plug and towards a combustion chamber surface. This is sufficient to obtain an improvement in the propagation and development of flame fronts initiated following ignition of a lean fuel/air mixture at the two spark plugs 140 and 142, this being important to the achievement of improved fuel economy and/or emissions reduction as the engine 100 is operated in lean burn combustion mode.

Third, and by reference to Figs. 4 to 7, it may be noted that spark plugs 140 and 142 are located at a greater distance from each other – and directed towards each other – in engine B, in accordance with a preferred embodiment of the invention, than in engine A. This separation distance may approach the cylinder bore diameter, it being noted that the mounting points of spark plugs 140 and 142 are located approximately at the periphery of the cylinder bore in engine B. Expressed as a ratio, the ratio of this separation distance to cylinder bore diameter approaches 1. This is to be compared to the prior art arrangement where it is noted that this separation distance ratio is noticeably below 1. This aspect also ensures that a maximum proportion of the combustion zone lies between the plugs. The propagation and development of flame fronts progressing along close to the widest extent of the combustion chamber 110 allows for a greater use of the space within combustion chamber 110 for the flame kernels and fronts to propagate, develop and intersect, along a wide front rather than a point, with resultant increase in combustion efficiency and fuel economy. To elaborate further, the flame fronts may be conveniently visualised to radiate from each of the spark plugs 140, 142 in the form of circular arcs centred at each of the spark plugs. By placing the spark plugs in accordance with the invention the radius of the flame front arcs, at the time that the flame fronts intersect approximately in the central portion of the combustion chamber, is maximised and therefore approximates a line (or a plane if the analogy is visualised in 2 dimensions) across the combustion chamber 110. This ensures that there is a short time between the combustion at the centre of the chamber and at the surrounding combustion chamber surface. This can be contrasted to the situation wherein the spark plugs are closer together (the comparison is illustrated by Figs. 5 and 6) and which are at a smaller radius at the time of intersection resulting in an initial intersection “point” rather than a line and wherein this intersection point continues to migrate outwardly towards the combustion chamber surface at a noticeably slower rate than is the case described above with reference to the invention. Also, in engine B, the spark plugs 140 and 142 may be visualised as being mounted at mounting points corresponding to the ends of an imaginary joining plane located at the base of the two inclined surfaces of the pent roof combustion chamber 110. The spark plugs 140 and 142 may also be visualised as being located at the base of a combustion chamber 110 of triangular prismatic cross

section. Such location, illustrated in Fig. 6, effectively prohibits trapping of end gases behind the spark plugs 140 and 142, in zones 130 that might otherwise create a tendency for knocking.

Fourth, spark plug 140 is located to extend through the valve driving means or timing chain cavity 150 as this allows an optimised use of space in the combustion chamber 110 again assisting the achievement of superior flame front development and progression with improved combustion performance. Spark plug 140 may be provided with a sleeve to protect it from lubricant present within the timing chain cavity 150.

Fifth, the provision of a recess 162 in the piston head 160, as conveniently shown in Fig. 7, acts to enhance the combustion process and the fluid dynamics during the combustion process. Recess 162 is of oval shape. The major axis of the oval recess 162 extends across the piston head 160 in a direction between the two spark plugs 140 and 142. This serves to create a combustion chamber volume that increases from each of the spark plugs 142, 143 towards the centre of the combustion chamber. The recess 162 also assists in maintaining effective swirl motion of the fuel air charge, as piston 160 rises, or at least minimises any adverse effects resulting from having a recess in the piston head. In addition, recess 162 is of a nature that provides the formation of a "squish" zone between the cylinder head and the surface of the piston as indicated by regions 115 in Fig 7. As piston 160 rises in the cylinder towards top dead centre (TDC), the fuel air charge is compressed particularly into the two crescent shaped squish areas or zones 115 and the resulting charge is "squished" towards the centre of the combustion chamber, thus promoting increased mixing of the fuel air charge. Thus, the charge motion, and propagation of the flame fronts through the combustion chamber 110 is influenced by the geometry of the recess 162 in the piston head 160 and combustion chamber surface geometry, including the squish areas 115 and the remainder of the combustion chamber surface geometry to promote combustion efficiency. As well as improvement in fuel economy, the tendency for knock – caused by presence of end gases in the combustion chamber 110 – is also reduced since there is less

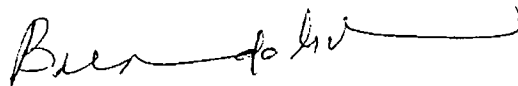
probability of end gas trapping in a non-ignited zone of combustion chamber 110, for example behind one or both spark plugs 140 and 142.

Here again, the orientation of the spark plugs 140 and 142, being directed more towards each other than in the engine of Fig. 3, is important. Projected axes of spark plugs 140 and 142 intersect with an angle between the axes being significantly greater than in the prior art engine. Further, the projected axes of spark plugs 140 and 142 and the major axis of the recess 162 on the piston head 160 intersect at a high obtuse angle to each other when viewed from top dead centre. This "open" arrangement optimises combustion processes occurring within the combustion chamber 110 by optimising use of the space within the combustion chamber 110. More specifically, the flame fronts propagate and develop through a greater space than in previous proposals, where – for example – the spark plugs rather than being directed toward each other had an angled orientation which provided less opportunity for flame fronts to intersect across a wide flame front. This greater use of combustion chamber space increases combustion efficiency and reduces tendency for knock.

Modifications and variations to the internal combustion engine of the present invention may be apparent to the skilled reader of this disclosure. Such modifications and variations are deemed within the scope of the present invention.

Dated on this the 23rd day of June, 2009.

For **BAJAJ AUTO LIMITED,**
By its Attorney,



(ARUNACHALAM APPAJI MOHAN)
(BRINDA MOHAN)

Applicant's Name : **BAJAJ AUTO LIMITED**

Total no. of sheets: 10

Sheet no. : 1

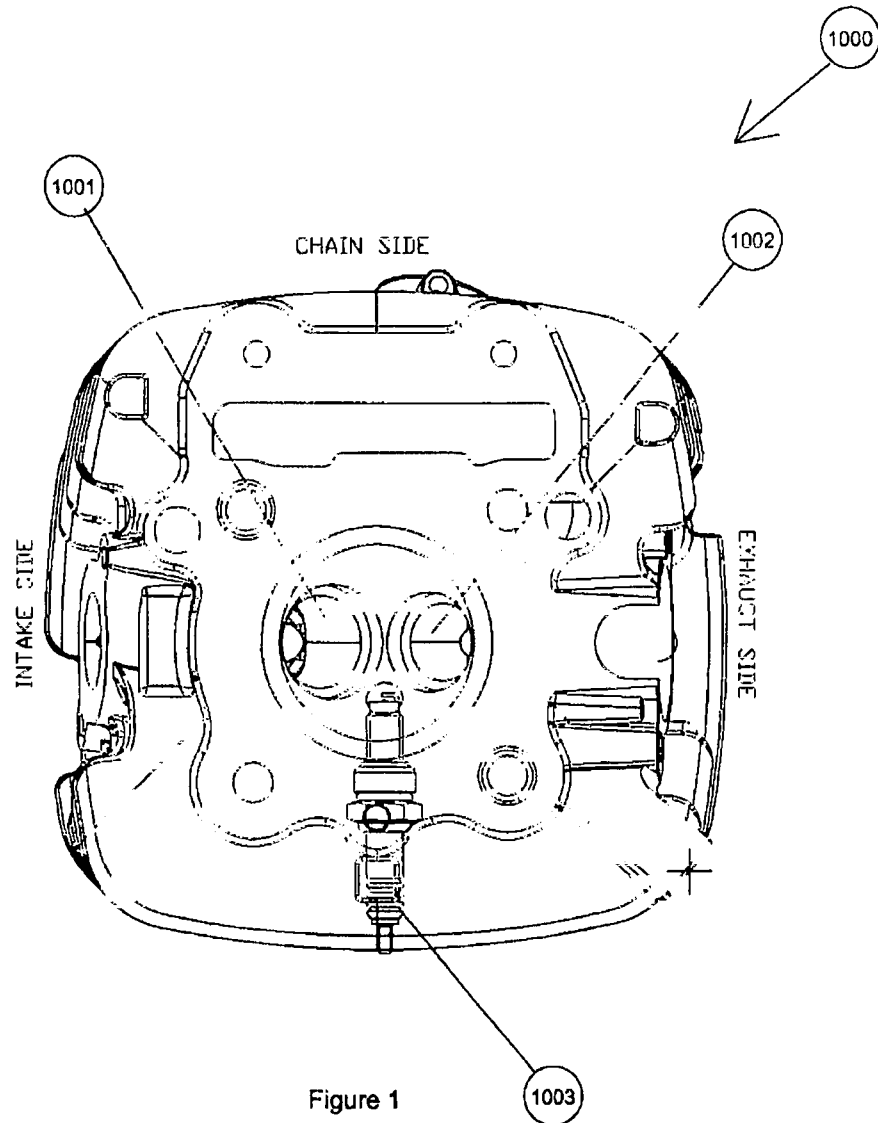


Figure 1

For **BAJAJ AUTO LIMITED,**

By its Attorney,

Brinda Mohan

(ARUNACHALAM APPAJI MOHAN)
(BRINDA MOHAN)

Applicant's Name : **BAJAJ AUTO LIMITED**

Total no. of sheets: 10
Sheet no. : 2

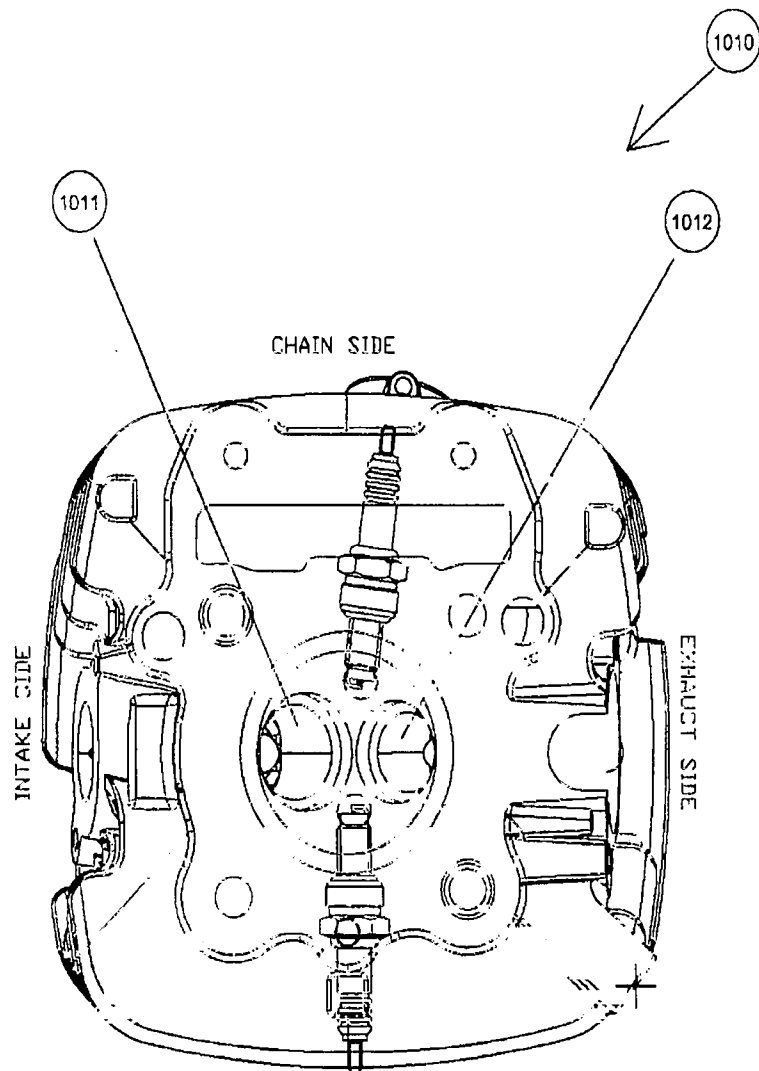


Figure 2

For **BAJAJ AUTO LIMITED**,
By its Attorney,

Brinda Mohan

(**ARUNACHALAM APPAJI MOHAN**)
(**BRINDA MOHAN**)

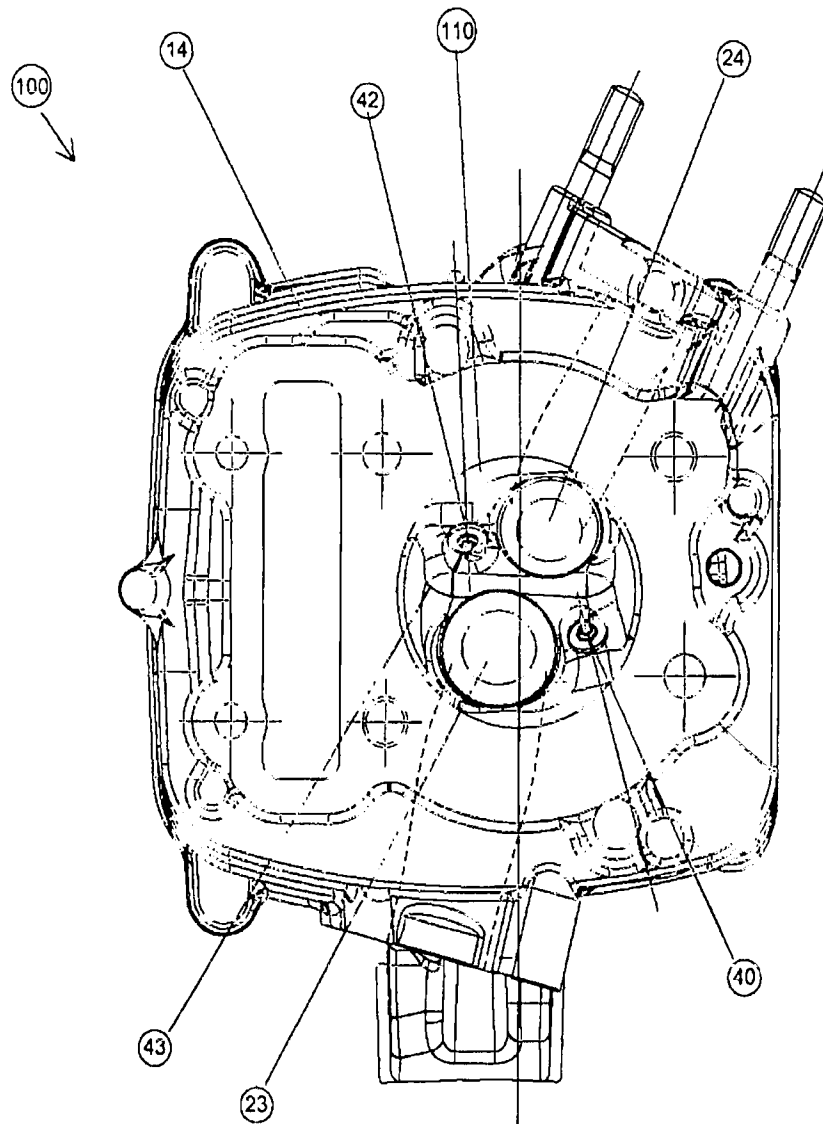


Figure 3

For **BAJAJ AUTO LIMITED**,
By its Attorney,

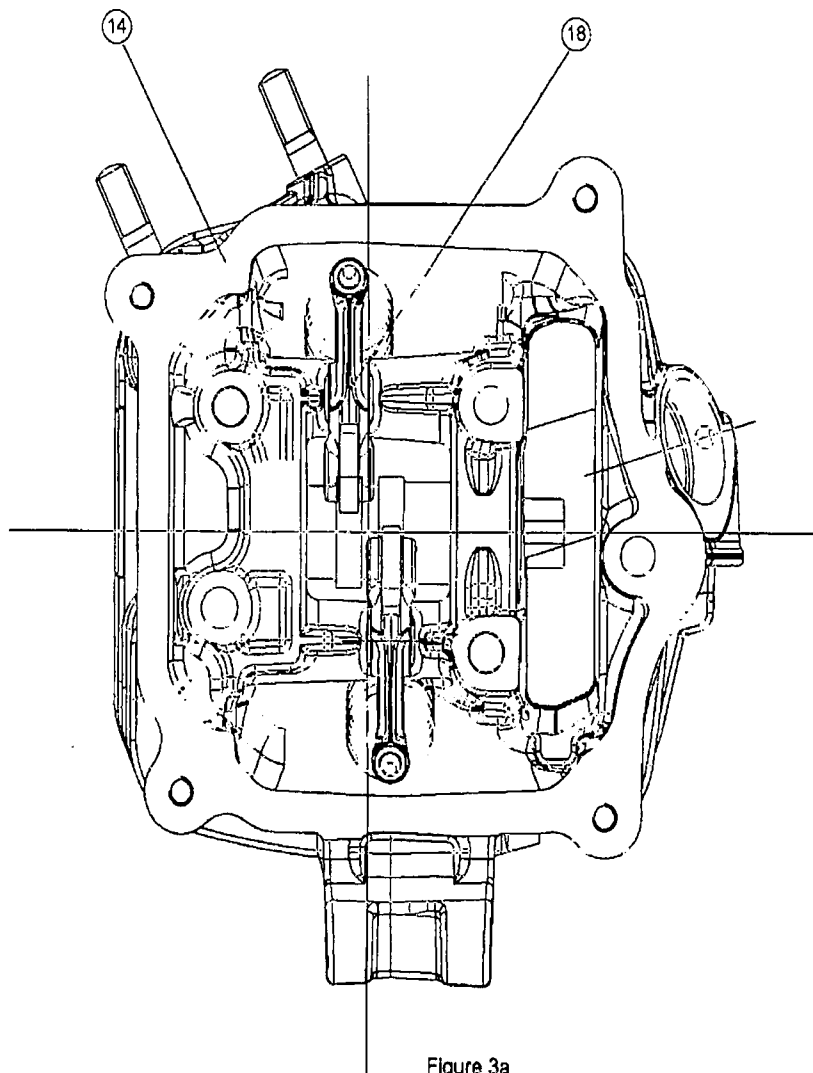
Brinda Mohan

(ARUNACHALAM APPAJI MOHAN)
(BRINDA MOHAN)

Applicant's Name : **BAJAJ AUTO LIMITED**

Total no. of sheets: 10

Sheet no. : 4



For **BAJAJ AUTO LIMITED**,
By its Attorney,

Brinda Mohan
(ARUNACHALAM APPAJI MOHAN)
(BRINDA MOHAN)

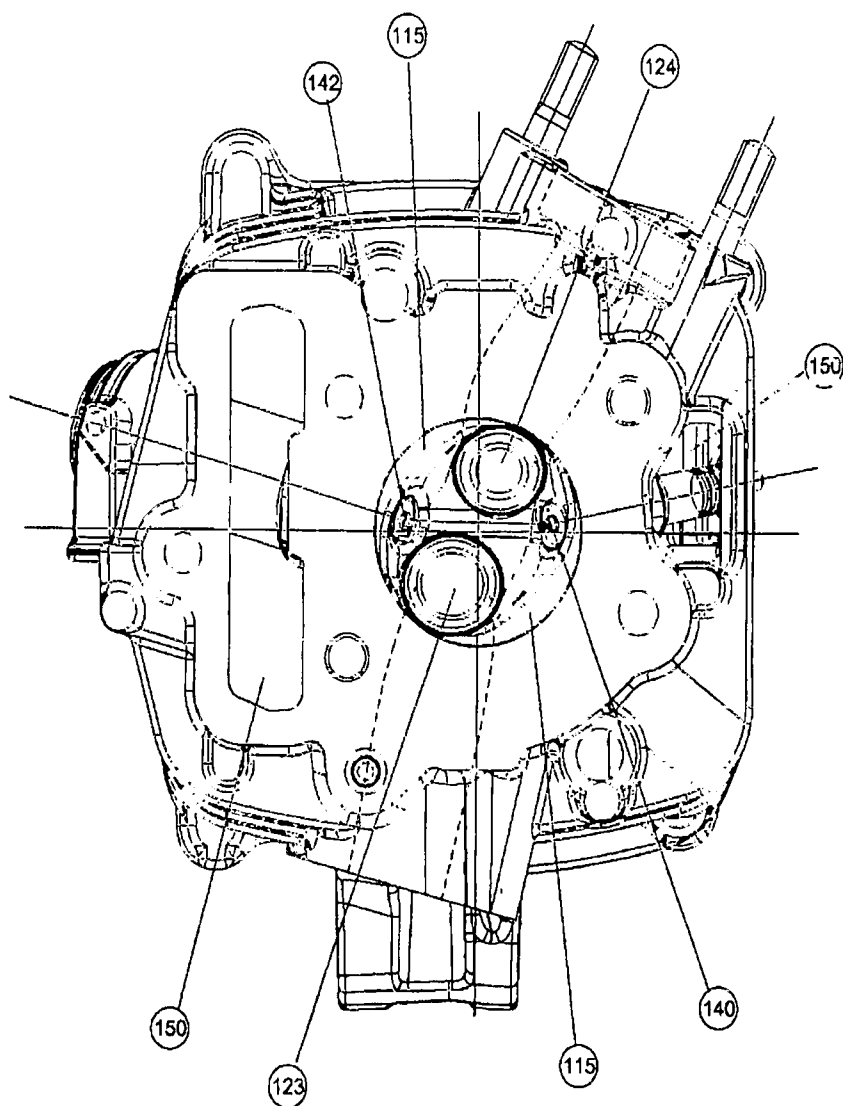


Figure 4

For **BAJAJ AUTO LIMITED**,
By its Attorney,

Brinda Mohan

(ARUNACHALAM APPAJI MOHAN)
(BRINDA MOHAN)

Applicant's Name : **BAJAJ AUTO LIMITED**

Total no. of sheets: 10

Sheet no. : 6

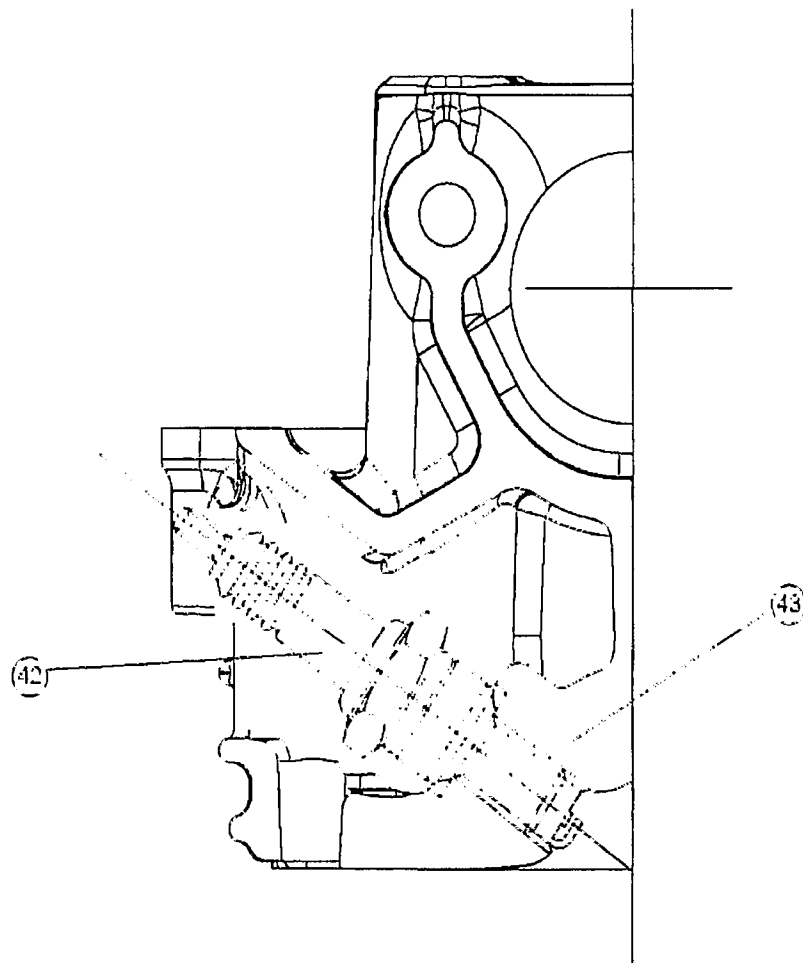


Figure 4a

For **BAJAJ AUTO LIMITED**,
By its Attorney,

Brinda Mohan
(ARUNACHALAM APPAJI MOHAN)
(BRINDA MOHAN)

Applicant's Name : **BAJAJ AUTO LIMITED**

Total no. of sheets: 10

Sheet no. : 7

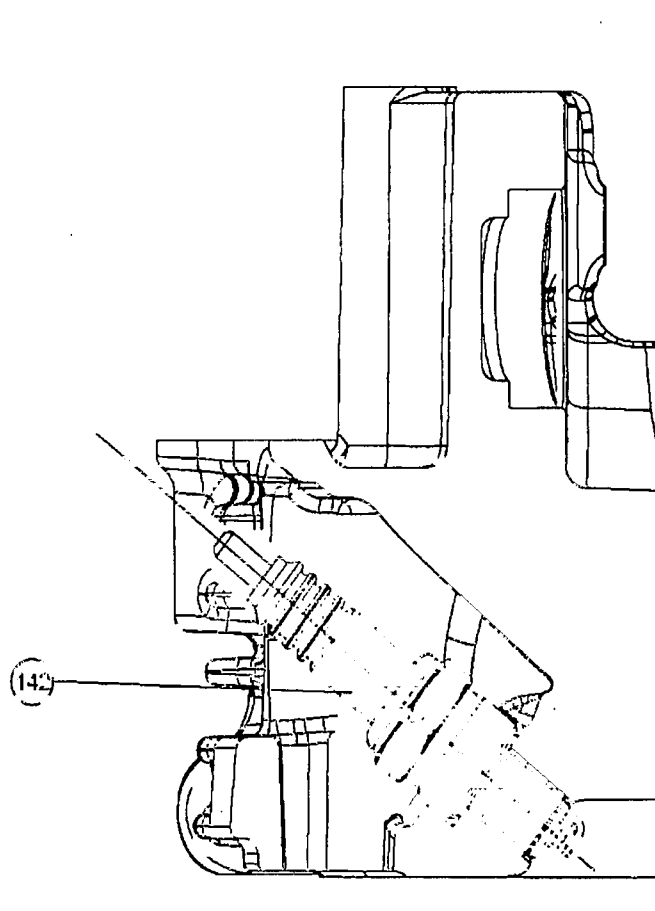


Figure 4b

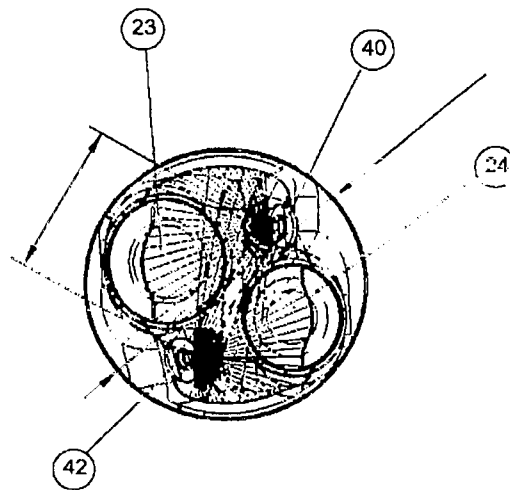
For **BAJAJ AUTO LIMITED**,
By its Attorney,

Brinda Mohan

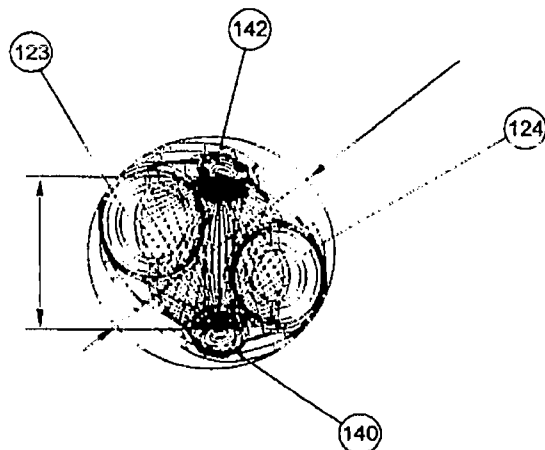
(ARUNACHALAM APPAJI MOHAN)
(BRINDA MOHAN)

Applicant's Name : **BAJAJ AUTO LIMITED**

Total no. of sheets: 10
Sheet no. : 8



"A"

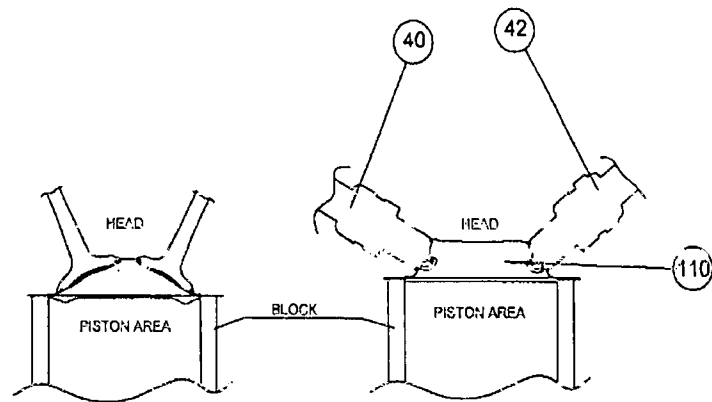


"B"

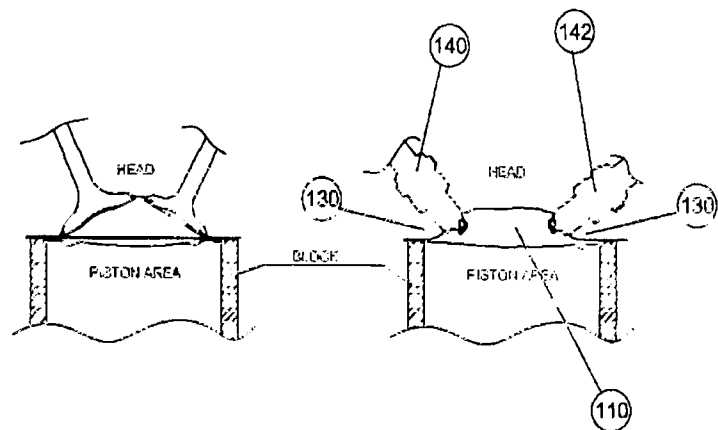
Figure 5

For **BAJAJ AUTO LIMITED**,
By its Attorney,

(ARUNACHALAM APPAJI MOHAN)
(BRINDA MOHAN)



"A"



"B"

Figure 6

For **BAJAJ AUTO LIMITED**,
By its Attorney,

Brinda Mohan
(ARUNACHALAM APPAJI MOHAN)
(BRINDA MOHAN)

Applicant's Name : **BAJAJ AUTO LIMITED**

Total no. of sheets: 10

Sheet no. : 10

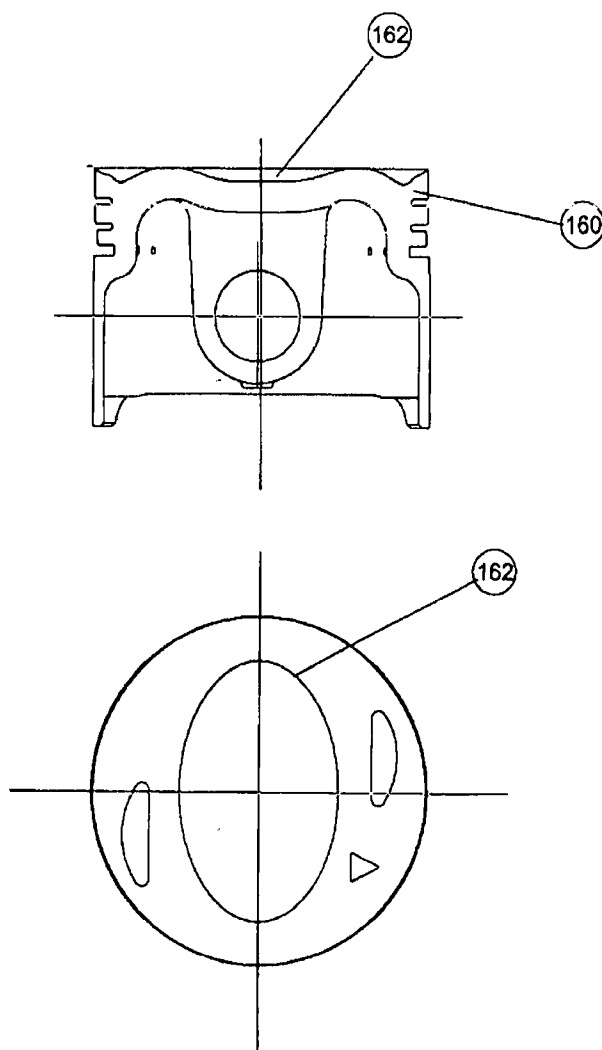


Figure 7

For **BAJAJ AUTO LIMITED**,
By its Attorney,

Brinda Mohan
(ARUNACHALAM APPAJI MOHAN)
(BRINDA MOHAN)

FORM - 2

THE PATENTS ACT, 1970
(39 of 1970)
&
The Patents Rules 2003

COMPLETE SPECIFICATION
(SECTION 10 & rule 13)

TITLE

AN IMPROVED INTERNAL COMBUSTION ENGINE

APPLICANT

We, **Bajaj Auto Limited**, an Indian Company, having its principal place of business at New No. 6, Old No. 157, II Floor, Habibullah Road, T. Nagar, Chennai - 600 017, State of Tamil Nadu, India, and its registered office at Aburdi, Pune - 411 035, State of Maharashtra, India.

The following specification describes and ascertains the nature of this invention and the manner in which it is to be performed:-

22 JUN 2010

ORIGINAL

14.6.9 / 24.6.2009

22.6.09

This invention relates to an improved internal combustion engine particularly suitable for operation using lean fuel/air mixtures.

Internal combustion engines are known in which each cylinder is provided with two or more valves namely inlet valve(s) and exhaust valve(s). These valves open in a cavity in the cylinder head conventionally known as a combustion chamber. When two valves are used (ie one inlet and one exhaust valve), these valves are typically sized and arranged "in line" to optimise power output. Figure 1 shows a cylinder head 1000 with inlet and exhaust valves 1001 and 1002 arranged in line for a single spark ignited engine. Figure 2 shows a cylinder head 1010 with inlet and exhaust valves 1011 and 1012 arranged for a dual spark ignited engine in what is conventionally referred to as a hemispherical combustion chamber.

Typically, such engines use a homogeneous air-fuel charge and are provided with only one spark plug per cylinder. One of the disadvantages of such an arrangement is that the process of combustion from spark initiation to completion takes a comparatively long time. At higher engine speeds, the available combustion duration may be insufficient, resulting in a need to use non-optimal (ie increasingly advanced) ignition timing so as to avoid incomplete combustion and consequent loss of power, fuel wastage and increase in emissions. Further disadvantages accrue from the need for richer fuel/air mixtures to achieve better driveability and adequate flame propagation in the combustion chamber and adequate power output and/or reduced knocking particularly if the fuel/air mixture is lean.

These problems may be addressed, to some extent, by employing an engine having two spark plugs. This is counter-intuitive for use in a small bore engine, where flame propagation distances are relatively small and normally sufficient to enable efficient combustion. Furthermore, problems also arise because of the small space available to accommodate the two spark plugs. This could be addressed by locating one of the two spark plugs on the timing side of the engine as described in the Applicant's Indian Patent No. 195904 dated 16 July 2002 (corresponding to International Patent Publication No. WO 2005/042954 A1) which discloses a small bore twin spark plug engine, operating on four stroke principle, with inlet and exhaust

valves in an "in-line" configuration and which is incorporated herein by reference (and illustrated in Fig. 2). A protective sleeve is provided for the spark plug extending through a timing chain cavity so that it is protected from fouling with lubricant and resultant inefficient operation. However, a compromise has to be made in this engine since the "in-line" configuration provides good power output but is substantially less beneficial where fuel economy is a key object. There is ample scope for improvement in terms of combustion effectiveness by use of higher swirl rates of the incoming air-fuel charge.

The Applicant has also described an engine with inlet and exhaust valves in "offset" configuration in its International Patent Publication No. WO 2007/080604 with international publication dated 19 July 2007 and illustrated here in Fig. 3. In this engine, the spark ignition means are located distal from the timing chain of the engine and so no protective sleeve requires to be provided for one of the spark plugs as in Indian Patent No. 185904. In addition, better charge mixing is achieved through increased swirl in the combustion chamber which may be achieved, at least in part, through the offset valve configuration. Therefore, this engine has been highly advantageous. However, a tendency has been noticed for end gases to remain unburnt adversely affecting emissions and fuel efficiency. A further tendency, arising from the foregoing, is the tendency for knock to occur. Therefore, there is still need for improving the combustion chamber geometry and layout so as to suppress knock and increase combustion efficiency and fuel economy.

It is accordingly an object of the present invention to provide an internal combustion engine operating on the four stroke principle with improved performance over prior engines particularly when operating in lean burn combustion mode.

With this object in view, the present invention provides a four stroke internal combustion engine comprising:

- a combustion chamber with at least one inlet valve and at least one exhaust valve; and at least two ignition means; and

- a cylinder bore, defined by a cylinder bore wall, having a piston reciprocable within said cylinder bore

wherein said combustion chamber is a volumetric extension of said cylinder bore, the combustion chamber being defined by side walls and having an open planar base contiguous with said cylinder bore wall and at least one ignition means is substantially located at a first side wall at or adjacent to said base of said combustion chamber.

Such an engine arrangement, and in particular the design of the combustion chamber allows good use of space within the combustion chamber, during a combustion process, this assisting combustion efficiency and fuel economy. The combustion chamber is a pent roof combustion chamber with combustion efficiency enhanced through the particular location of the spark plug(s). The combustion chamber may also be elongate with a transverse axis being generally perpendicular to a centre axis of the cylinder bore.

The use of, conveniently, two ignition means, or spark plugs, assists combustion efficiency to some extent. However, location of at least one of those ignition means at a first side wall at or adjacent the base of the combustion chamber enhances combustion efficiency still further. Greatest advantage is achieved where a second or further ignition means is located at a second side wall at or adjacent to the base of the combustion chamber. The object is to maximise the distance across which flame fronts propagate across the combustion chamber and enhances utilisation of available combustion chamber volume. This enhances combustion efficiency, particularly where a combustible fuel charge is lean.

Benefit is also achieved by having two, though more could be included, ignition means, or spark plugs, located diametrically opposite each other. Preferably, too, the mounting points of the ignition means, which are desirably directed towards each other, correspond to ends of a joining plane located at the base, the open planar base referred to earlier, of the pent roof combustion chamber. These geometric locations typically correspond to the portion of largest dimension of the combustion chamber thus assisting optimisation of the combustion process through optimisation of the shape and use of space in the combustion chamber as described below. More specifically, this may be represented by a ratio or proportion

between separation distance between the ignition means and cylinder bore diameter. It is highly desirable that this ratio be 1 or close to 1. It may be added that such location of the ignition means prevents the possibility of trapping of end gases behind them, thus reducing the propensity for knocking noticed with a prior art engine as above described. For clarity, a reference to "behind" is to be understood as a reference to a direction which is away from the region between the two plugs where two plugs are used.

Combustion efficiency is also enhanced where a head of the piston is provided with a recess. The recess on the piston head may be shaped to create an additional combustion chamber volume which increases progressively towards a centre axis of the cylinder bore in a direction from one ignition means towards the other ignition means. Advantageously, the shape and location of the recess in the piston is of a nature that enhances swirl motion of the fuel air charge within the combustion chamber, or at least minimises any negative effects on the swirl motion within the combustion chamber. The recess may be elliptical, ellipsoid, oval or ovoid in shape. Desirably, the major axis of the elliptical, ellipsoid, oval or ovoid recess extends across the head of the piston in a direction between two ignition means.

Preferably, the projected axes of said ignition means and the major axis of the recess on the piston head all intersect at an obtuse angle to each other when viewed from top dead centre. This "open" arrangement optimises combustion processes occurring within the combustion chamber by optimising use of the space within the combustion chamber. More specifically, the flame fronts propagate and develop through a greater open space than in previous engines, where – for example – the ignition means rather than being directed toward each other had an angled orientation which provided less opportunity for flame fronts propagating from the spark plugs to intersect along a broad front rather than at a point. This greater use of combustion chamber space increases combustion efficiency.

This engine, desirably a single cylinder engine, has a configuration of components in the combustion chamber which optimises the shape and use of space within the combustion chamber increasing the amount of space available for a

flame front to be initiated by ignition of a fuel air charge within the combustion chamber and to propagate and develop to combust the charge. The importance of even incremental increases in effective combustion chamber volume and shape by optimising the placement and arrangement of ignition means, or spark plugs, is difficult to overestimate. For example, in International Publication No. WO 2007/080604, discussed above, the location and orientation of the spark plugs necessitate mounting on raised mounts or bosses. The Applicant has found that removal of these mounts or bosses reduces the amount of combustion chamber volume which is behind the spark plug to the point where combustion performance for lean fuel/air mixtures is appreciably improved. To that end, at least one, but even more preferably both, of the ignition means or spark plugs is (are) mounted flush with a surface of one of the side walls of the combustion chamber to obtain this benefit. Desirably, at least the ignition means or spark plug closest to the inlet valve – particularly in the swirl direction – is mounted flush with the combustion chamber surface.

The valves may, in some embodiments of the engine, conveniently be positioned in an "offset" arrangement resulting in space available for the flame kernels to progress towards each other duly assisted by the swirl created by combusting gases within the above configured combustion chamber. Due assistance is provided by a recess on the piston head having a long or major axis in the direction of the line of intersection of the planes of the pent-roof shaped combustion chamber. This results in a combustion chamber with the majority of its volume contained within a central volume which could, for purposes of visualisation, be described as an elongate volume, with the axis of such central volume being in the same direction as the recess in the piston. The shape and position of the recess in the piston also provides for the creation of one or more squish zones between the piston and the cylinder head resulting in the combusting gases being squeezed as the piston moves towards the top dead centre position to cause a so-called "squish" motion. Such squish motion is enhanced by provision of one or a plurality of squish zones in the roof of the combustion chamber; for example, two squish zones may be provided, these zones having an approximately crescent shape, with the resulting squish flow being directed towards a central region of the combustion chamber.

Other motions of importance to the fluid dynamics for the engine of the invention are a combined tumble and swirl ("inclined tumble"). Tumble and swirl are rotational flows which cause mixing of fuel and air within an engine. Tumble is induced in the Applicant's engine by selecting an appropriate entry angle for the inlet valve particularly at the inlet port. Arrangement of the airbox and the nature of fuel delivery to the engine are influences on the entry angle and the engine is packaged such that the entry angle will permit formation of a tumbling flow. As parallel an alignment of an axis of the inlet port relative to a longitudinal axis of the combustion chamber as may be achieved is preferred to maximise the tumbling effect. The further swirl rotational flow, which may be in clockwise direction, is induced by offset configuration of inlet and exhaust valves. The combination of tumbling and swirling flows in the Applicant's engine enables enhanced charge mixing and better combustion stability and driveability.

The lean burn mode of operation, where the air fuel ratio is in the range 15:1 to 17:1 is important for the engine. Lean burn promotes engine fuel economy and may also be useful in the control of certain types of engine emission. However, it is important that combustion duration be sufficiently rapid to ensure efficient engine running. The multiple spark plug configuration is important to this objective as is the location of the two or more ignition means, or spark plugs, at the base of the combustion chamber. Diametrically opposed placement of the ignition means at opposed side walls at or adjacent to the base of the combustion chamber also ensures sufficiently fast flame propagation with the entire combustion chamber volume typically being covered in less time, than for a single ignition means, with near complete combustion of the lean fuel/air mixture and the ability to use optimal spark timing for best engine performance without inducing knock or increasing emissions outputs.

In another aspect, the present invention provides an internal combustion engine operating on the four stroke principle comprising:

- (a) a combustion chamber having a valve train comprising at least one inlet valve and at least one exhaust valve;
- (b) at least two ignition means located in the combustion chamber; and
- (c) drive means for driving the valve train

wherein said ignition means are placed diametrically opposite each other at a base of the combustion chamber and at least one ignition means is placed in line with the valve train. This engine arrangement allows further use of space within the combustion chamber and this assists combustion efficiency and fuel economy.

The engine of the invention is advantageously a small bore engine. Typical characteristics of a small bore, small capacity or small displacement engine for use in the practice of the invention include a swept cylinder volume ranging from 75 cc to 225 cc, preferably in the range 100cc to 200cc (more preferably 100cc to 150cc), and cylinder bore diameter 45 mm to 70 mm, employed as prime movers for operation of two or three wheeled vehicles or other motorised vehicles, particularly motorcycles. Notably, the small bore engine of the invention advantageously does not require a water cooling system to operate effectively. Such an engine is advantageously a single cylinder engine which may be a two valve overhead cam four stroke engine.

The drive means for the valves may be a timing chain. The drive means, such as a timing chain, may be located in a drive means cavity provided with a lubricant supply. As an ignition means to be located in the combustion engine, likely being in line with the valve train, may advantageously and typically need to extend through the drive means cavity, given the very limited space available for accommodating the ignition means in a small bore engine, particularly, a protective sleeve may be provided for the ignition means – here in the form of a spark plug – to avoid lubricant affecting spark plug function.

As noise and harshness may also affect engine performance, the spark plugs may be operated in accordance with the strategy described in the Applicant's co-pending PCT Application No. WO 2007032020, the contents of which are hereby incorporated by reference, and in which a control unit for the engine retards or stops operation of an ignition means, or spark plug, in response to the rate of rise of combustion pressure as proxied by rate of rise of engine speed or engine acceleration, or engine speed, rising above an acceptable threshold value.

The engine may be fuel injected or carburetted and applied to any of a range of vehicle applications. A typical application would be in a two wheel vehicle such as a motorcycle but use in 3 or even 4 wheeler vehicle types is possible. The engine is advantageously a 2 valve engine though this does not exclude a greater number of valves.

The engine has improved combustion efficiency, as measured by lesser occurrence of knock, low emissions, and improved fuel economy. Improved driveability is also an advantage of the engine. These advantages arise in no small part from the more optimum arrangement of spark plugs and valves, together with the influence of geometry – as above described – within the combustion chamber of the small bore engine.

The internal combustion engine of the present invention may be more fully understood from the following non-limiting description of a preferred embodiment thereof made with reference to the accompanying drawings in which:

Figure 3 is a bottom view of the cylinder head of a prior art internal combustion engine;

Figure 3a is a top view of the cylinder head of a prior art internal combustion engine;

Figure 4 is a bottom view of the cylinder head of an internal combustion engine in accordance with a preferred embodiment of the invention;

Figure 4a is a sectional view of combustion chamber illustrating mounting of the spark plugs according to prior art;

Figure 4b is a sectional view of combustion chamber illustrating mounting the spark plugs according to the preferred embodiment of the invention;

Figure 5 is a bottom schematic section view of (A) a prior art engine; and (B) an engine of the preferred embodiment of the present invention, the views being provided for the purposes of comparison;

Figure 6 is a side schematic section view of (A) a prior art engine; and (B) an engine of the preferred embodiment of the present invention, the views being provided for the purposes of comparison; and

Figure 7 is a sectional view through the piston of the preferred embodiment of the invention.

Figure 8 provides a range of isometric schematic views (a) to (d) of a combustion chamber used in an engine in accordance with the preferred embodiment of the present invention and showing components including spark plugs and valves.

Figure 9 provides a range of isometric schematic views (a) to (d) of the combustion chamber illustrated in Figure 8 but without components for further and better illustration of the shape of the combustion chamber.

Referring now to Fig. 3, there is shown the bottom of a cylinder head 14 of a small bore four stroke internal combustion engine 100 of the kind above described with reference to swept cylinder volume and cylinder diameter. The cylinder head 14 includes a combustion chamber 110 having an inlet valve 23 and an exhaust valve 24. The inlet valve 23 and exhaust valve 24 timing is controlled by a timing chain (not shown).

Combustion chamber 110 has a pent-roof construction. A pent-roof combustion chamber is a combustion chamber having an upper surface in the shape of a slanted or sloped roof comprising at least two inclined and downwardly divergent, or upwardly convergent, surfaces or side walls. The side walls do not meet at a sharp apex, that is they do not converge along a line, but are rather are each of curved geometry that may terminate in a planar or slightly rounded surface at the top of combustion chamber 110.

Dual spark plugs 40 and 42, each spark plug being of conventional manufacture, are fitted in the cylinder head 14. Spark plugs 40 and 42 are located in the combustion chamber 110 and promote ignition and combustion of lean fuel/air mixtures, or charges, allowing operation of the engine 100 in a lean burn combustion mode to improve fuel economy. It may be noted that the spark plugs 40 and 42 are mounted on raised mounts or bosses 43.

As seen in Fig. 3, the combustion chamber 110 may be considered to be divided into quadrants. The intake and exhaust valves 23 and 24 may be considered to reside in diagonally opposed quadrants notwithstanding some overlap of the valves 23 and 24 with other quadrants. Such a valve configuration is an

"offset" configuration associated with better fuel economy than for "in line" valve configurations because of the ability to generate beneficial levels of "swirl". Substantially improved fuel economy, perhaps at least 5% over comparable vehicles that do not incorporate offset configuration, may be achieved. Spark plugs 40 and 42 reside in the remaining diagonally opposed quadrants of combustion chamber 110 and do not extend through the timing chain cavity and so do not require to be designed or protected to avoid contact with lubricant in that cavity.

The inlet and exhaust valves 23 and 24 of engine 100 are actuated by a rocker arm assembly 18 as illustrated in Fig. 3a, more detail of which is described in the Applicant's International Patent Publication No. WO 2007/020604 with international publication date 19 July 2007, the contents of which are hereby incorporated herein by reference. This rocker arm assembly 18 is configured to provide a greater space for location of the twin spark plugs 40 and 42 and facilitates the location of spark plugs 40 and 42 distal, away from, the timing chain cavity (Fig. 3) of engine 100.

Referring now to Figs. 4 to 8, the components located within combustion chamber 110 – of pent roof construction – are the same as discussed for Fig. 3 with the exception that, in Fig. 4, reference numerals other than for the engine 100 and combustion chamber 110 are preceded by the numeral "1". Combustion chamber 110, which forms a volumetric extension of cylinder bore 108, has side walls 112 contiguous with the cylinder bore wall 109.

Two spark plugs 140 and 142 are provided and these spark plugs 140,142 play the same role, in igniting a fuel/air charge, as spark plugs 40 and 42 described above. Inlet and exhaust valves 123 and 124 are still present and are still located in an offset configuration. However, there are some significant differences in arrangement and location of the spark plugs 140 and 142 from spark plugs 40 and 42. These differences in location are important to achievement of improved flame front propagation through improved use or optimisation of the use of space within the combustion chamber 110. These differences will now be described with reference to Figs. 4 to 8.

First, both spark plugs 140 and 142 are mounted diametrically opposite, or diametrically opposed, to and facing towards each other as shown in Figs. 4 and 8.

The spark plugs 140 and 142 are directed towards each other. Accordingly, sparks initiate at two diametrically opposed points, igniting the fuel air mixture and forming flame fronts that propagate quickly thus providing an increased combustion rate of the fuel air charge within the combustion chamber 110, certainly as compared to that for a single spark plug engine, and toward each other covering the entire volume of the combustion chamber 110 and achieving near complete combustion of the lean fuel air mixture. This is valuable to achievement of fuel economy which is the prime object of use of a lean fuel air mixture. In contrast, if power output were the key concern, as it is in the prior art, a rich fuel air mixture would be preferred but would lead to increased fuel consumption and most likely increased emissions (eg hydrocarbon emissions).

Second, neither of spark plugs 140 and 142 are located on raised mounts or bosses. Rather, both of spark plugs 140 and 142 are mounted at downwardly diverging, or upwardly converging, side walls 112 of the combustion chamber 110, these side walls 112 having the same curved geometry as noted in the case of Fig. 3. These side walls 112 are contiguous with a cylinder bore wall 109, combustion chamber 110 forming a volumetric extension of the cylinder bore 108. It may also be observed that spark plugs 140 and 142 are mounted at or very closely adjacent to the base 111 of the combustion chamber 110. This base 111 is planar, and being contiguous with the cylinder bore wall 109, and communicating cylinder bore 108 with combustion chamber 110 is open.

The spark plugs 140 and 142 are also mounted flush with the side walls 112 of the combustion chamber 110 as shown in Fig. 4b.

This arrangement for spark plugs 140 and 142 has the benefit of maximising the amount of combustion chamber volume in front of the spark plugs. The detailed comparative views are illustrated in Figs. 4a and 4b wherein Fig. 4a shows the spark plugs are located on raised mounts or bosses 43 while Fig. 4b shows that the spark plugs 140 and 142 are located flush with the combustion chamber side walls 112. This preferred embodiment ensures that more of the combustion chamber 110 is forward of the spark plug ignition point and that the flame front is not required to burn in a direction back behind each spark plug 140, 142 and back towards a combustion chamber surface at side walls 112. This is sufficient to obtain an improvement in the propagation and development of flame fronts initiated following ignition of a lean

fuel/air mixture at the two spark plugs 140 and 142, this being important to the achievement of improved fuel economy and/or emissions reduction as the engine 100 is operated in lean burn combustion mode.

Third, and by reference to Fig. 6 in particular, it may be noted that spark plugs 140 and 142 are located at a greater separation distance from each other – and directed towards each other – in engine B, in accordance with a preferred embodiment of the invention, than in engine A. This separation distance may approach the dimension of the cylinder bore diameter, it being noted that the mounting points of spark plugs 140 and 142 are located approximately at the periphery of the cylinder bore in engine B. Expressed as a ratio, the ratio of this separation distance to cylinder bore 108 diameter approaches 1. This is to be compared to the prior art arrangement where it is noted that this separation distance ratio is noticeably below 1. This aspect also ensures that a maximum proportion of the combustion zone lies between the spark plugs 140 and 142. The propagation and development of flame fronts progressing from each spark plug 140 and 142 along close to the widest extent of the combustion chamber 110 allows for a greater use of the space within combustion chamber 110 for the flame kernels and fronts to propagate, develop and intersect, along a wide front rather than a point, with resultant increase in combustion efficiency and fuel economy. The shape of the combustion chamber 110, illustrated particularly in Figs. 8 and 9 promotes such flame front propagation. To elaborate further, the flame fronts may be conveniently visualised to radiate from each of the spark plugs 140, 142 in the form of circular arcs centred at each of the spark plugs. By placing the spark plugs 140, 142 in accordance with the invention the radius of the flame front arcs, at the time that the flame fronts intersect approximately in the central portion of the combustion chamber 110, is maximised and therefore approximates a line (or a plane if the analogy is visualised in 3 dimensions) across the combustion chamber 110. This ensures that there is a short time between the combustion at the centre of the chamber 110 and combustion at the surrounding combustion chamber surface 112. This can be contrasted to the situation wherein the spark plugs 140, 142 are closer together (the comparison is illustrated by Figs. 5 and 6) and which are at a smaller radius at the time of intersection resulting in an initial intersection "point" rather than a line and wherein this intersection point continues to migrate outwardly towards the

combustion chamber surface at a noticeably slower rate than is the case described above with reference to the invention. Also, in engine B, the spark plugs 140 and 142 are mounted at mounting points 117 corresponding to the ends of an imaginary joining plane located at the base 111 of the side walls 112 of pent roof combustion chamber 110, the shape of which is particularly illustrated in Figs. 8 and 9.

The location of spark plugs 140 and 142 substantially at, or very closely adjacent, the base 111 of a combustion chamber 110 is relevant to achievement of the benefits of the described engine. Such location, illustrated in Fig. 6, effectively prohibits trapping of end gases behind the spark plugs 140 and 142, in zones 130 that might otherwise create a tendency for knocking.

Fourth, spark plug 140 is located to extend through the valve driving means or timing chain cavity 150 as this allows an optimised use of space in the combustion chamber 110 again assisting the achievement of superior flame front development and progression with improved combustion performance. Spark plug 140 may be provided with a sleeve to protect it from lubricant present within the timing chain cavity 150.

Fifth, the provision of a recess 162 in the piston head 160, as conveniently shown in Figs. 7 (a) and (b), acts to enhance the combustion process and the fluid dynamics during the combustion process. Recess 162 is of oval shape. The major axis 163 of the oval recess 162 extends across the piston head 160 in a direction between the two spark plugs 140 and 142 (which is also a direction "in-line" with the valve drivetrain, ie, in line with the camshaft axis). This serves to create a combustion chamber volume that increases from each of the spark plugs 140, 142 towards the centre of the combustion chamber 110. The recess 162 also assists in maintaining effective swirl motion of the fuel air charge, as piston 161 rises, or at least minimises any adverse affects resulting from having a recess 162 in the piston head 160. A clockwise swirl rotational flow direction is indicated in Fig. 5.

In addition, recess 162 is of a nature that provides the formation of a "squish" zone between the cylinder head and the surface of the piston 161 as indicated by areas 115 in Fig 7 (b). As piston 160 rises in the cylinder towards top dead centre (TDC), the fuel air charge is compressed particularly into the two crescent shaped squish zones or areas 115 and the resulting charge is "squished" with a resulting squish flow towards the central region of the combustion chamber 110, thus

promoting increased mixing of the fuel air charge. Thus, the charge motion, and propagation of the flame fronts through the combustion chamber 110 is influenced by the geometry of the recess 162 in the piston head 160 and combustion chamber surface geometry, including the squish areas 115 and the remainder of the combustion chamber surface geometry to promote combustion efficiency. As well as improvement in fuel economy, the tendency for knock – caused by presence of end gases in the combustion chamber 110 – is also reduced since there is less probability of end gas trapping in a non-ignited zone of combustion chamber 110, for example behind one or both spark plugs 140 and 142.

Here again, the orientation of the spark plugs 140 and 142, being directed more towards each other than in the engine of Fig. 3, is important. Projected axes of spark plugs 140 and 142 intersect with an angle between the axes, an obtuse angle, being significantly greater than in the prior art engine. Further, the projected axes of spark plugs 140 and 142 and the major axis of the recess 162 on the piston head 160 intersect at a high obtuse angle to each other when viewed from top dead centre. This "open" arrangement optimises combustion processes occurring within the combustion chamber 110 by optimising use of the space within the combustion chamber 110. More specifically, the flame fronts propagate and develop through a greater effective volume of the combustion chamber 110 than in previous combustion chamber designs, where – for example – the spark plugs rather than being directed toward each other had an angled orientation which provided less opportunity for flame fronts to intersect across a wide flame front. This greater use of combustion chamber space increases combustion efficiency and reduces tendency for knock.

Modifications and variations to the internal combustion engine of the present invention may be apparent to the skilled reader of this disclosure. Such modifications and variations are deemed within the scope of the present invention. For example, although the combustion chamber 110 may have a sharper geometry than the curved geometry imparted by the curving upwardly convergent side walls 112 discussed above. In such case, the combustion chamber 110 could take a prismatic shape, for example a triangular prismatic shape.

WE CLAIM:

1. A four stroke internal combustion engine comprising:
 - a combustion chamber with at least one inlet valve and at least one exhaust valve; and at least two ignition means; and
 - a cylinder bore, defined by a cylinder bore wall, having a piston reciprocable within said cylinder bore
 - wherein said combustion chamber is a volumetric extension of said cylinder bore, the combustion chamber being defined by a plurality of side walls and an open planar base contiguous with said cylinder bore wall and at least one ignition means is substantially located at a first side wall at or adjacent to said base of said combustion chamber.
2. An engine of claim 1 wherein said combustion chamber is of pent roof design.
3. An engine of claim 1 or 2 wherein a second ignition means is located at a second side wall at or adjacent to the base of the combustion chamber.
4. An engine of claim 3 wherein said ignition means are located in said first and second side walls diametrically opposite each other.
5. An engine of any one of the preceding claims wherein mounting points of said ignition means correspond to ends of a joining plane located at said base of said combustion chamber.
6. An engine of any one of the preceding claims wherein at least two said ignition means are directed towards each other.
7. An engine of any one of the preceding claims wherein a ratio or proportion between separation distance between the ignition means and cylinder bore diameter is 1 or close to 1.
8. An engine of any one of the preceding claims wherein the head of the piston is provided with a recess.
9. An engine of claim 8 wherein said recess on the piston head is shaped to create an additional combustion chamber volume which increases progressively towards a centre axis of the cylinder bore in a direction from one ignition means towards another ignition means.

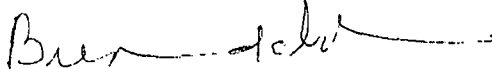
10. An engine of claim 9 wherein shape and location of the recess in the piston enhances swirl motion of the fuel air charge within the combustion chamber.
11. An engine of claim 10 wherein said recess is elliptical, ellipsoid, oval or ovoid in shape.
12. An engine of claim 11 wherein a major axis of said elliptical, ellipsoid, oval or ovoid recess extends across the head of the piston in a direction between two ignition means.
13. An engine of any one of claims 9 to 12 wherein projected axes of said ignition means and the major axis of the recess on the piston head intersect at an obtuse angle to each other when viewed from top dead centre.
14. An engine of any one of the preceding claims wherein at least one of the ignition means is mounted flush with a surface of a said side wall of the combustion chamber.
15. An engine of claim 14 wherein at least the ignition means closest to the inlet valve is mounted flush with said surface of a said side wall of said combustion chamber.
16. An engine of claim 15 wherein said ignition means closest to the inlet valve is closest in the swirl rotational flow direction.
17. An engine of any one of the preceding claims wherein said inlet and exhaust valves are positioned in said combustion chamber in an offset arrangement.
18. An engine of any one of claims 9 to 17 wherein shape and position of said recess in said piston head creates squish zone(s) between piston and cylinder head.
19. An engine of claim 18 wherein two squish zones are provided, these zones having an approximately crescent shape so that resulting squish flow is directed towards a central region of said combustion chamber.
20. An internal combustion engine operating on the four stroke principle comprising:
 - (a) a cylinder head comprising a combustion chamber and a valve train comprising at least one inlet valve and at least one exhaust valve;
 - (b) at least two ignition means located in the combustion chamber; and
 - (c) drive means for driving the valve train

wherein said ignition means are placed diametrically opposite each other at a base of said combustion chamber and at least one ignition means is placed in line with the valve train.

21. An engine of any one of the preceding claims wherein said side walls are upwardly convergent.
22. An engine of any one of the preceding claims being a single cylinder engine.
23. An engine of claim 22 operated in lean burn mode.
24. An engine of any one of the preceding claims being a small bore engine.
25. An engine of any one of the preceding claims wherein an ignition means is a spark plug.
26. A vehicle incorporating an engine as claimed in any one of the preceding claims.

Dated this the 22nd day of June 2010.

For **BAJAJ AUTO LIMITED**,
By its Attorney,


(**ARUNACHALAM APPAJI MOHAN**)
(**BRINDA MOHAN**)

Applicant's Name : **BAJAJ AUTO LIMITED**
Application no.: 1469/CHE/2009

ABSTRACT:

A four stroke internal combustion engine comprises:

a combustion chamber (110) with at least one inlet valve (123) and atleast one exhaust valve (124); and at least two ignition means (140, 142); and

a cylinder bore (108), defined by a cylinder bore wall (109), having a piston reciprocable within said cylinder bore (108).

The combustion chamber (110) is a volumetric extension of the cylinder bore (108) and is defined by a plurality of side walls (112). The combustion chamber (11) has an open planar base (111) contiguous with the cylinder bore wall (109). At least one ignition means (140, 142) is substantially located at a first side wall (112) at or adjacent to the base (111) of the combustion chamber (110). The geometry of the combustion chamber (110) together with the location of the at least one spark plug (140, 142) promotes combustion efficiency and fuel economy.

Applicant's Name : **BAJAJ AUTO LIMITED**
Application no.: 1469/CHE/2009

Total no. of sheets: 12
Sheet no. : 1

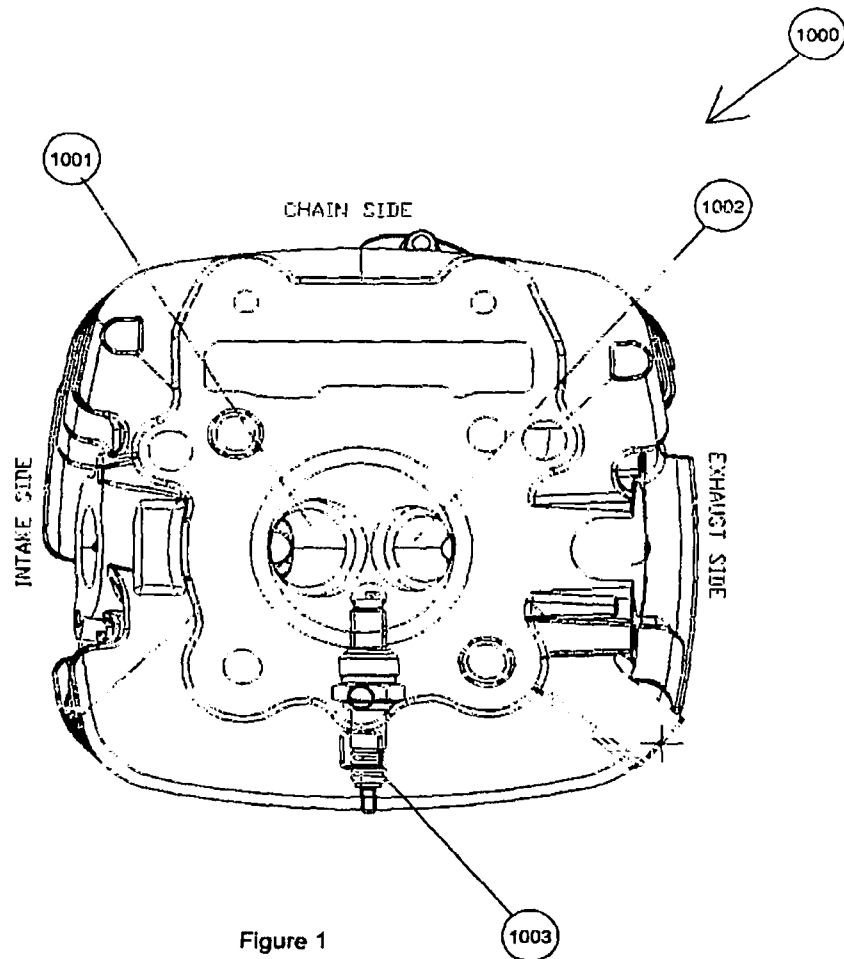


Figure 1

For Bajaj Auto Limited,
By its Attorney,

Brinda Mohan

(ARUNACHALAM APPAJI MOHAN)
(BRINDA MOHAN)

Applicant's Name : **BAJAJ AUTO LIMITED**
Application no.: 1469/CHE/2009

Total no. of sheets:12
Sheet no. : 2

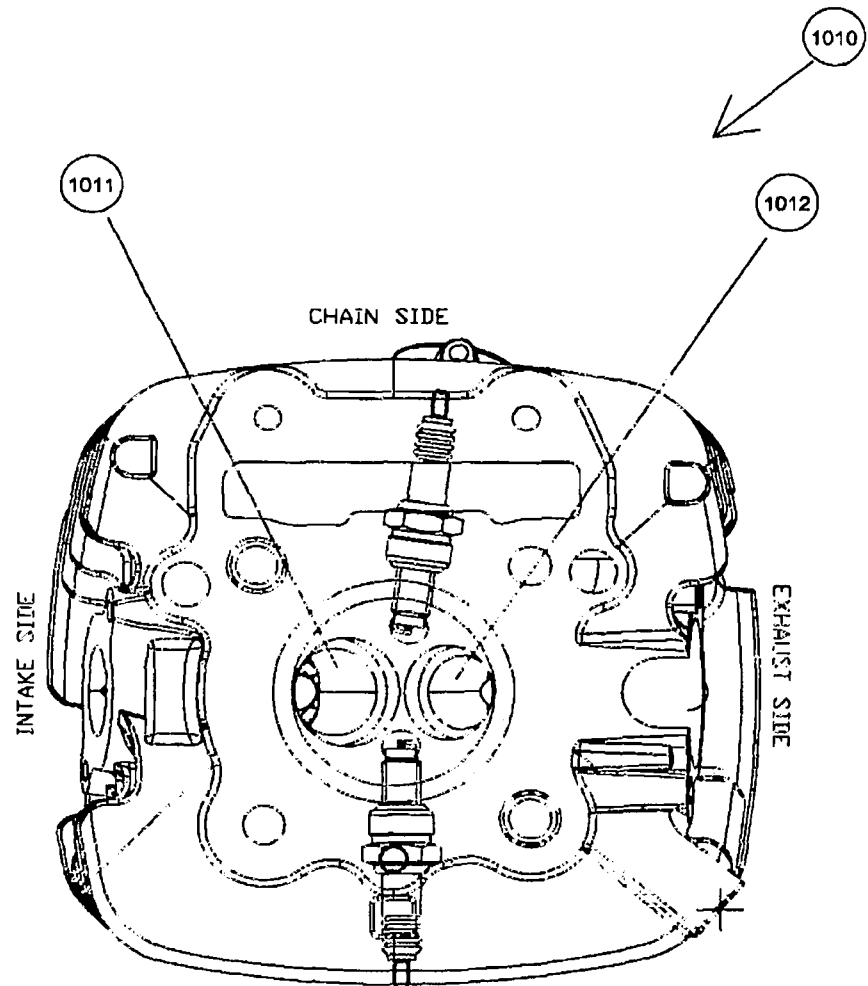


Figure 2

For **Bajaj Auto Limited,**
By its Attorney,

Brinda Mohan

(**ARUNACHALAM APPAJI MOHAN**)
(**BRINDA MOHAN**)

Applicant's Name : **BAJAJ AUTO LIMITED**
Application no.: 1469/CHE/2009

Total no. of sheets: 12
Sheet no. : 3

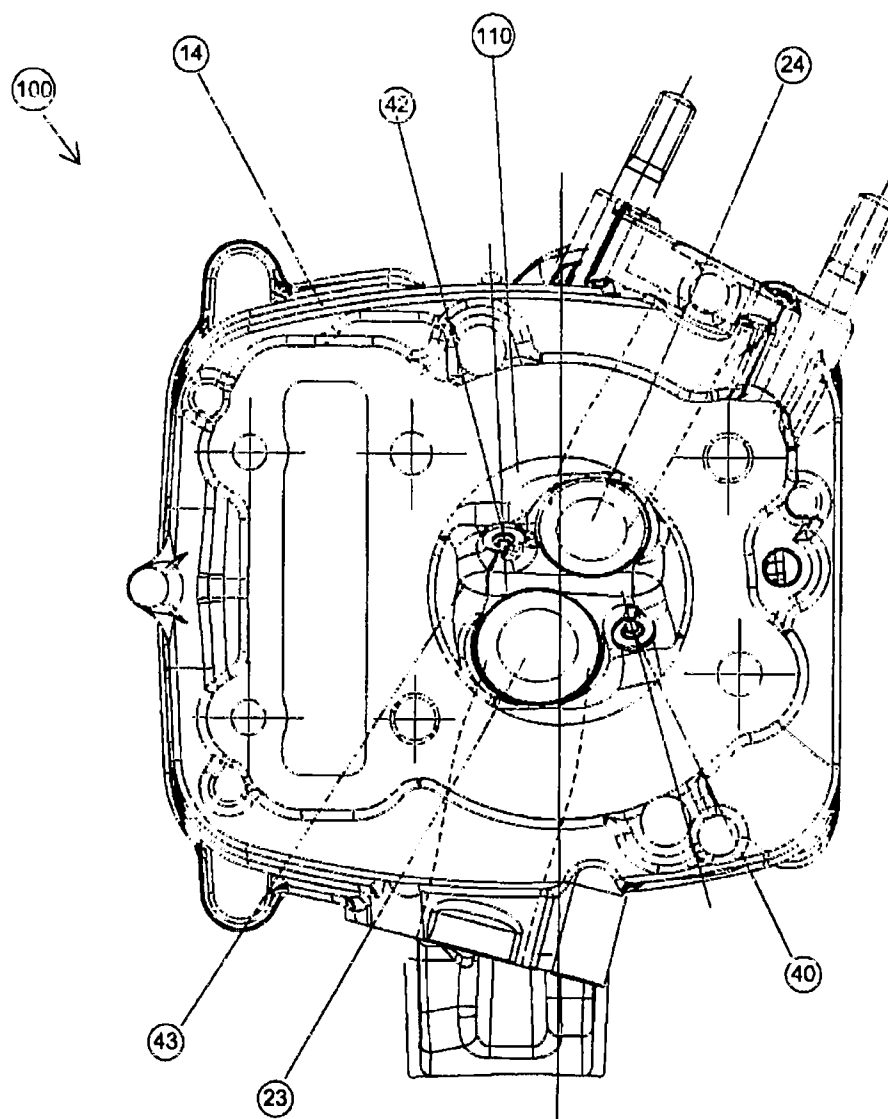


Figure 3

For Bajaj Auto Limited,
By its Attorney,

Brinda Mohan
(ARUNACHALAM APPAJI MOHAN)
(BRINDA MOHAN)

Applicant's Name : **BAJAJ AUTO LIMITED**
Application no.: 1-669/CHE/2009

Total no. of sheets: 12
Sheet no. : 4

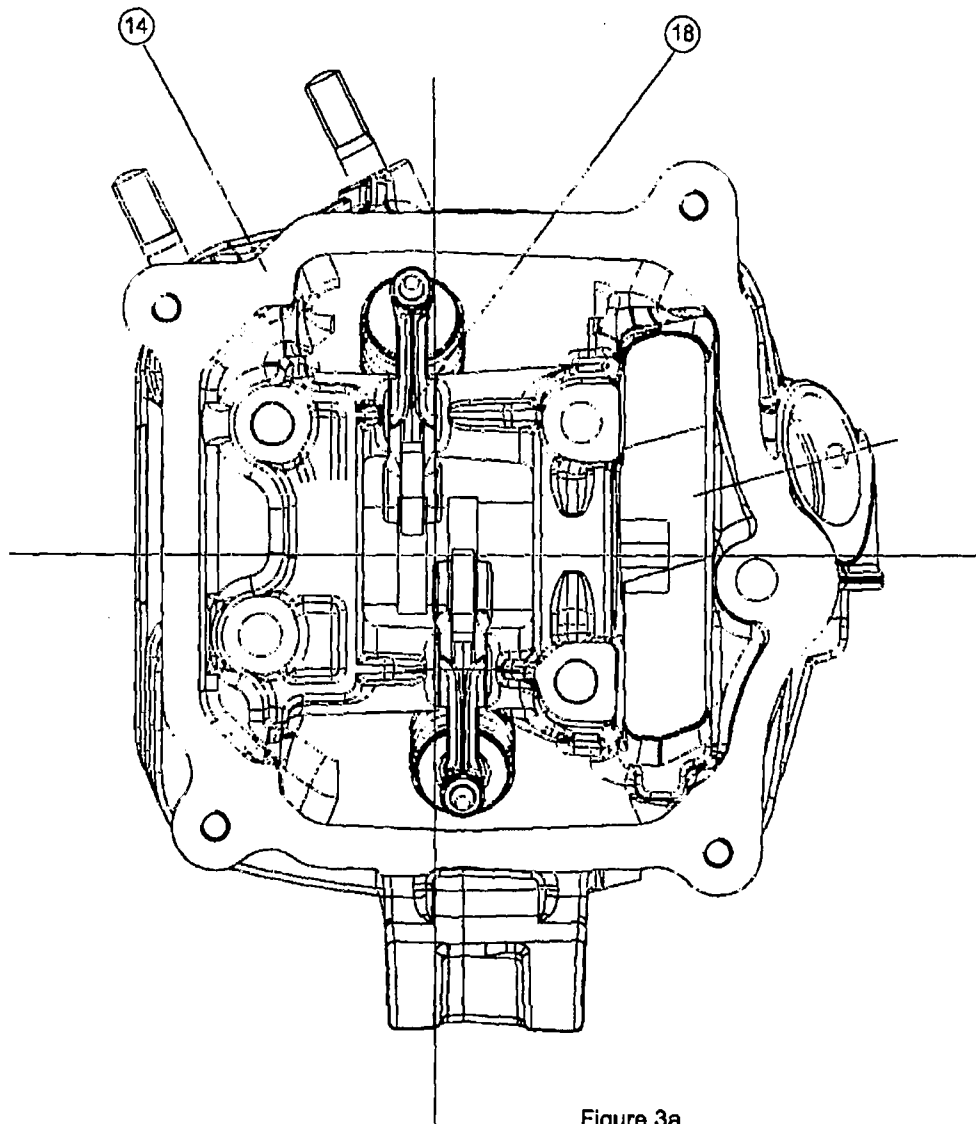


Figure 3a

For Bajaj Auto Limited,
By its Attorney,

Brinda Mohan

(ARUNACHALAM APPAJI MOHAN)
(BRINDA MOHAN)

Applicant's Name : **BAJAJ AUTO LIMITED**
Application no.: 1469/CHE/2009

Total no. of sheets: 12
Sheet no. : 5

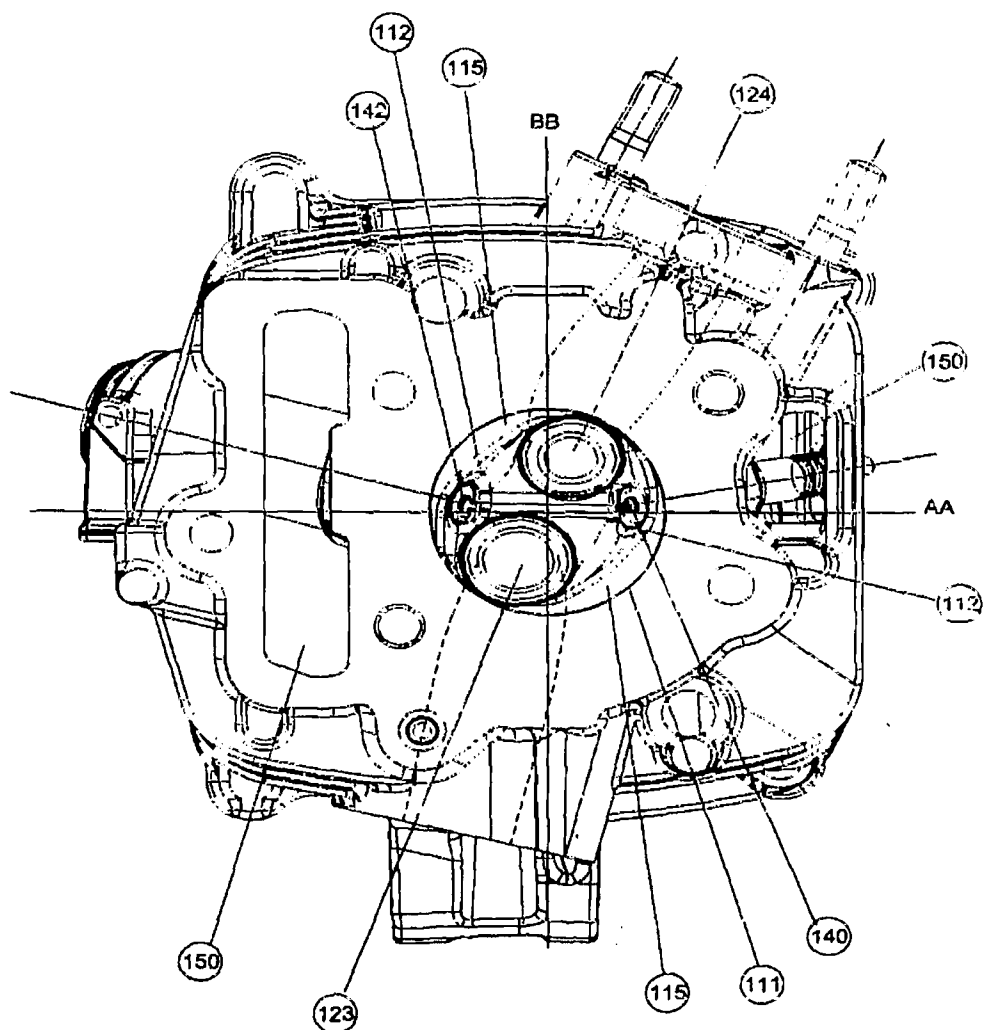


Figure 4

For Bajaj Auto Limited,
By its Attorney,

Brinda Mohan

(ARUNACHALAM APPAJI MOHAN)
(BRINDA MOHAN)

Applicant's Name : **BAJAJ AUTO LIMITED**
Application no.: 1463/CHE/2009

Total no. of sheets: 12
Sheet no. : 6

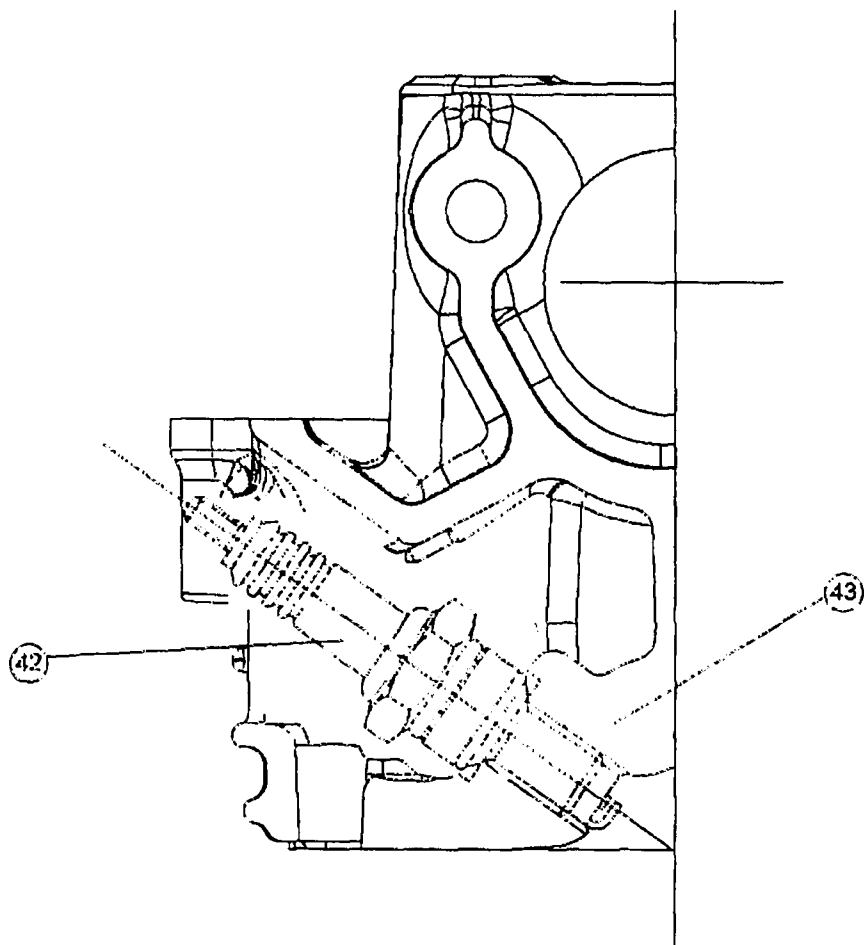


Figure 4a

For **Bajaj Auto Limited**,
By its Attorney,

Brinda Mohan

(ARUNACHALAM APPAJI MOHAN)
(BRINDA MOHAN)

Applicant's Name : **BAJAJ AUTO LIMITED**
Application no.: 1469/CHE/2009

Total no. of sheets: 12
Sheet no.: 7

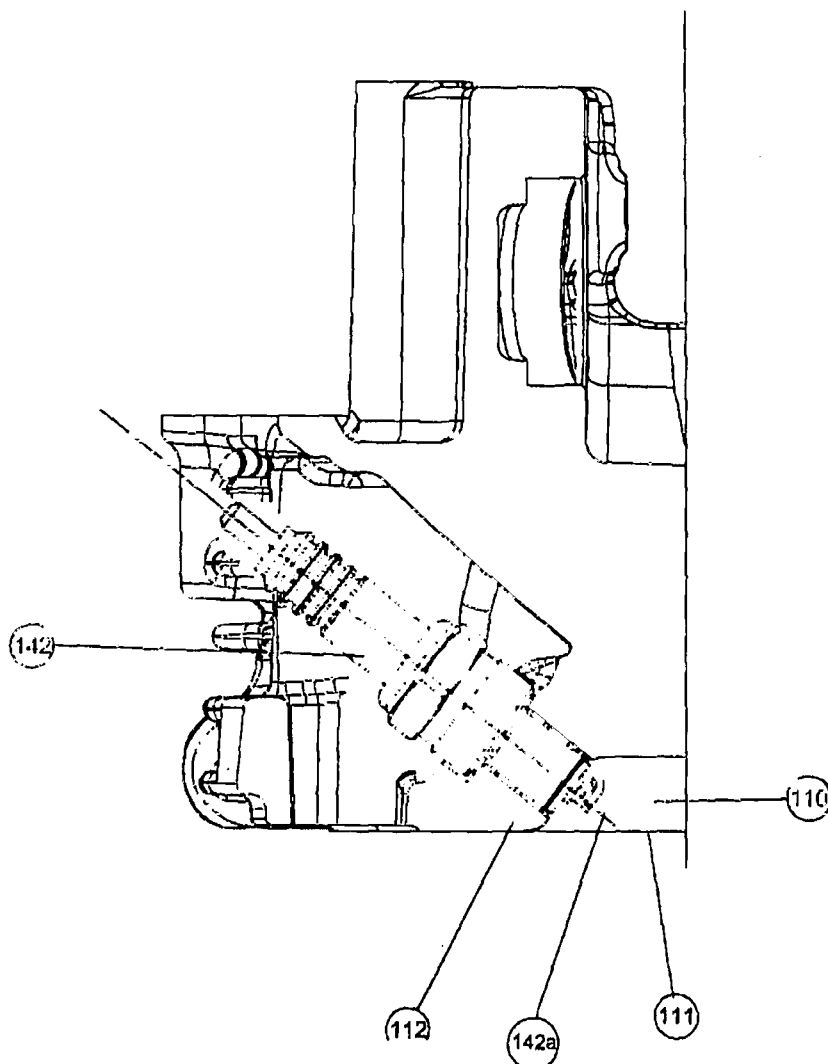


Figure 4b

For **Bajaj Auto Limited**,
By its Attorney,

Brinda Mohan

(ARUNACHALAM APPAJI MOHAN)
(BRINDA MOHAN)

Applicant's Name : **BAJAJ AUTO LIMITED**
Application no.: 1469/CHE/2009

Total no. of sheets: 12
Sheet no. : 8

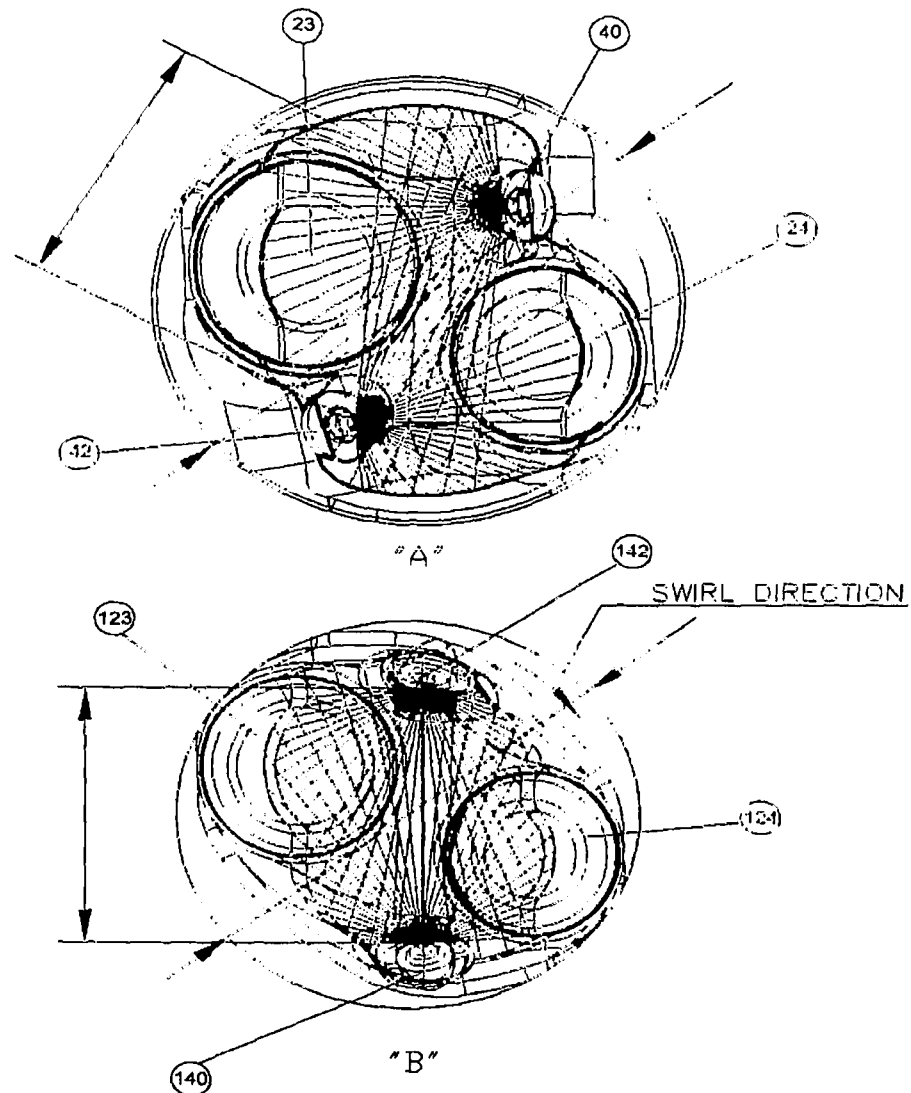


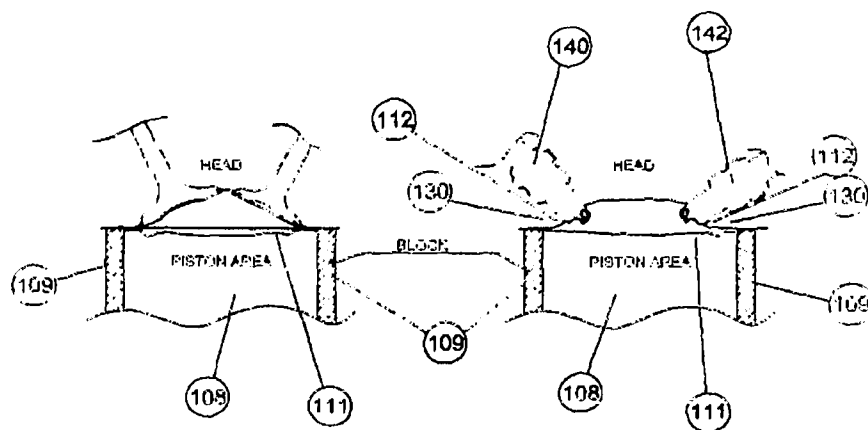
Figure 5

For **Bajaj Auto Limited**,
By its Attorney,

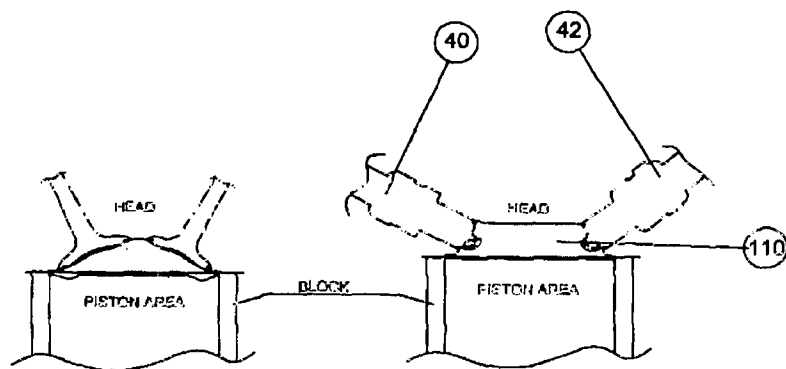
Brinda Mohan
(ARUNACHALAM APPAJI MOHAN)
(BRINDA MOHAN)

Applicant's Name : **BAJAJ AUTO LIMITED**
Application no.: 1469/CHE/2009

Total no. of sheets: 12
Sheet no. : 9



"A"



"B"

Figure 6

For Bajaj Auto Limited,
By its Attorney,

Brinda Mohan

(ARUNACHALAM APPAJI MOHAN)
(BRINDA MOHAN)

Applicant's Name : **BAJAJ AUTO LIMITED**
Application no.: 1469/CHE/2009

Total no. of sheets: 12
Sheet no. : 10

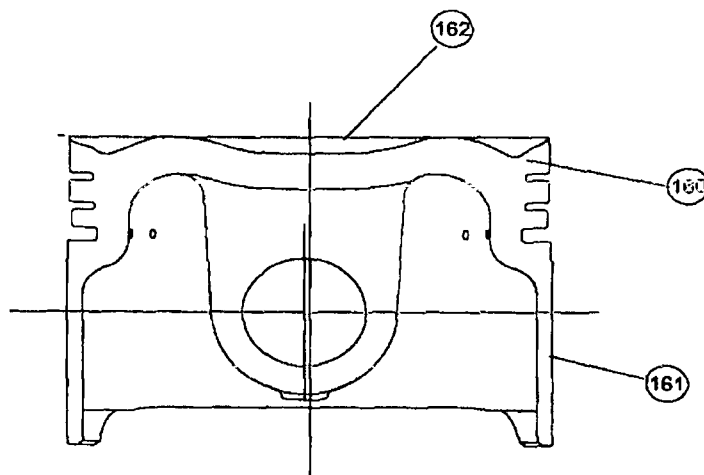


Figure 7a

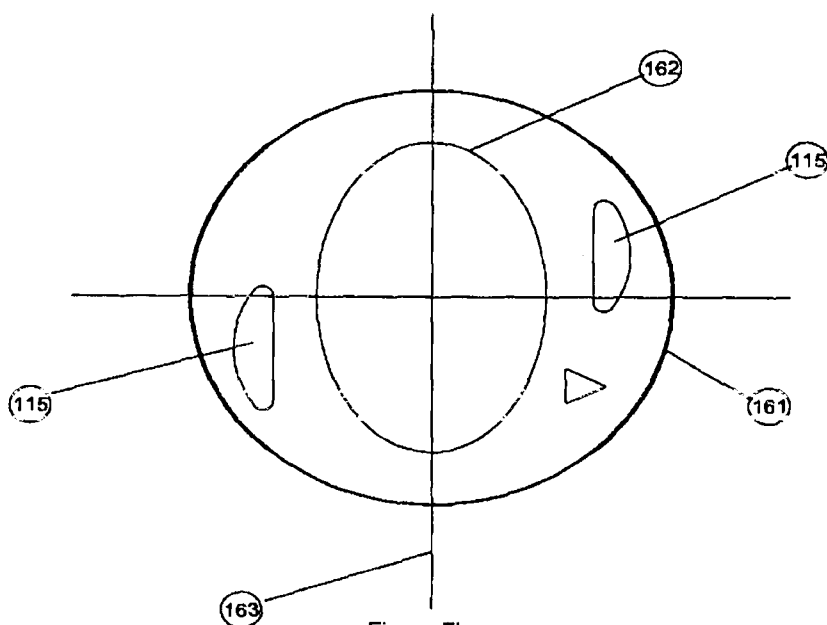


Figure 7b

For Bajaj Auto Limited,
By its Attorney,

Brinda Mohan

(ARUNACHALAM APPAJI MOHAN)
(BRINDA MOHAN)

Applicant's Name : **BAJAJ AUTO LIMITED**
Application no. : 1469/CHE/2009

Total no. of sheets: 12
Sheet no. : 11

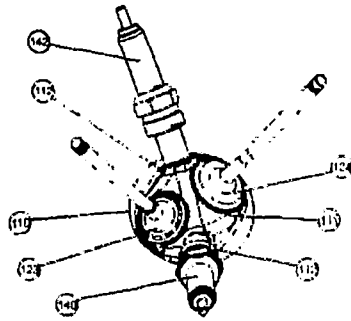


Figure 8a

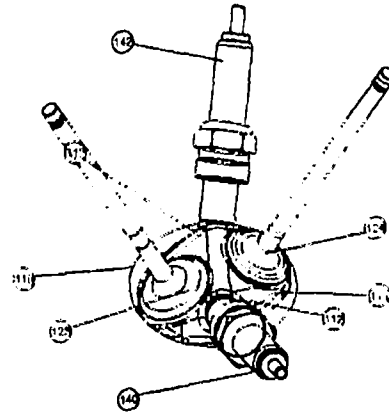


Figure 8b

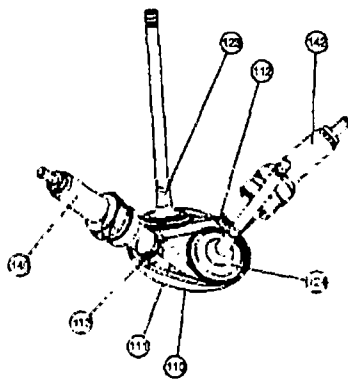


Figure 8c

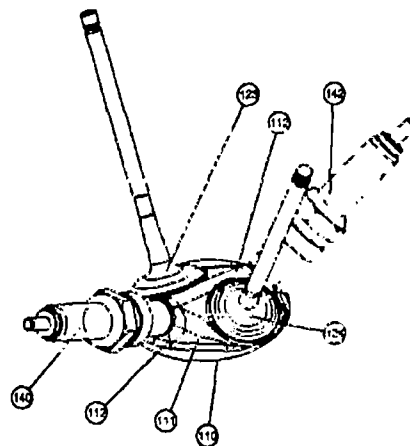


Figure 8d

For Bajaj Auto Limited,
By its Attorney,

Brinda Mohan

(ARUNACHALAM APPAJI MOHAN)
(BRINDA MOHAN)

Applicant's Name : **BAJAJ AUTO LIMITED**
Application no.: 1469/CHE/2009

Total no. of sheets: 12
Sheet no. : 12

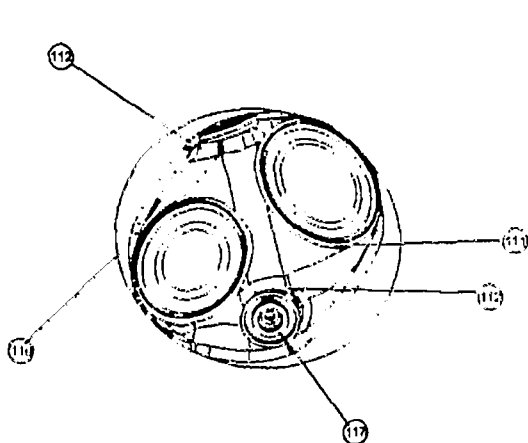


Figure 9a

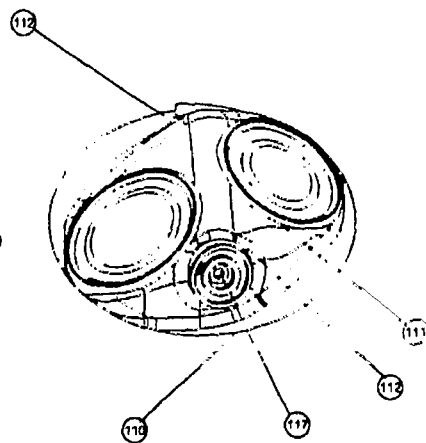


Figure 9b

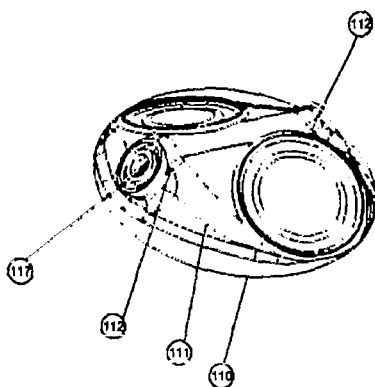


Figure 9c

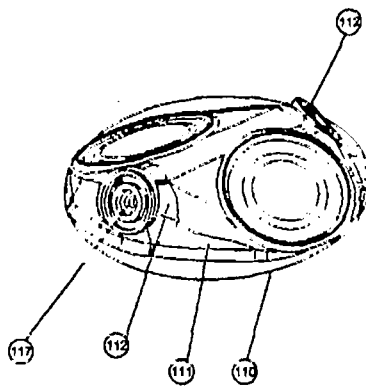


Figure 9d

For Bajaj Auto Limited,
By its Attorney,

Brinda Mohan

(ARUNACHALAM APPAJI MOHAN)
(BRINDA MOHAN)

REIVINDICACIONES

1. Un motor de combustión interna de cuatro tiempos que comprende:

5 una cámara de combustión con por lo menos una válvula de entrada y por lo menos una válvula de escape; y por lo menos dos medios de ignición; y

un agujero de cilindro, definido por una pared de agujero de cilindro, que tiene un pistón alternante
10 dentro dicho agujero de cilindro

donde dicha cámara de combustión es una extensión volumétrica de dicho agujero de cilindro, la cámara de combustión se define por una pluralidad de paredes laterales y una base plana abierta contigua a dicha
15 pared de agujero de cilindro

y por lo menos unos medios de ignición que se ubican sustancialmente en una primer pared lateral en o
adyacente a dicha base de dicha cámara de combustión.

20 2. Un motor de la reivindicación 1 donde dicha cámara de combustión es de diseño de techo deprimido

3. Un motor de la reivindicación 1 o 2 en donde un segundo medio de ignición se ubicada en una segunda pared lateral en o adyacente a la base de la cámara de
25 combustión.

4. Un motor de la reivindicación 3 en donde dichos medios de ignición se ubican en dichas primeras y segundas paredes laterales diametralmente opuestas una a la otra.
- 5 5. Un motor de una cualquiera de las reivindicaciones precedentes en donde puntos de montaje de dichos medios de ignición corresponden a extremos de un plano de unión ubicados en dicha base de dicha cámara de combustión.
- 10 6. Un motor de una cualquiera de las reivindicaciones precedentes en donde por lo menos dos de dichos medios de ignición se dirigen uno hacia el otro.
- 15 7. Un motor de una cualquiera de las reivindicaciones precedentes en donde una tasa o proporción entre la distancia de separación entre los medios de ignición y el diámetro de agujero de cilindro es 1 o cerca de 1.
- 20 8. Un motor de una cualquiera de las reivindicaciones precedentes en donde la cabeza del pistón está provista con una cavidad.
- 25 9. Un motor de la reivindicación 8 en donde dicha cavidad en la cabeza del pistón es aguda para crear un volumen de cámara de combustión adicional que se incrementa progresivamente hacia un eje central del agujero de cilindro en una dirección de los medios de ignición hacia otros medios de ignición.

10. Un motor de la reivindicación 9 en donde la forma y la ubicación de la cavidad en el pistón mejora el movimiento de la turbulencia de la carga de combustible
5 aire dentro de una cámara de combustión.
11. Un motor de la reivindicación 10 en donde dicha cavidad tiene formar elíptica, elipsoide, ovalada u ovoide.
- 10 12. Un motor de la reivindicación 11 en donde el eje principal de dicha cavidad elíptica, elipsoide, ovalada u ovoide se extiende a través de la cabeza del pistón en una dirección entre dos medios de ignición.
- 15 13. Un motor de una cualquiera de las reivindicaciones 9 a 12 en donde los ejes proyectados de dichos medios de ignición y el eje principal de la cavidad en la cabeza del pistón se intersectan en un ángulo obtuso uno al otro cuando se ven desde el centro muerto superior.
- 20 14. Un motor de una cualquiera de las reivindicaciones precedentes en donde por lo menos uno de los medios de ignición se monta a ras con una superficie de dicha pared lateral de la cámara de combustión.
- 25 15. Un motor de la reivindicación 14 en donde por lo menos los medios de ignición más cercanos a la válvula de

entrada se montan a ras con dicha superficie de dicha pared lateral de dicha cámara de combustión.

- 5 16. Un motor de la reivindicación 15 en donde dichos medios de ignición cercanos a la válvula de entrada están más cercanos en la dirección de flujo rotacional de la turbulencia.
- 10 17. Un motor de una cualquiera de las reivindicaciones precedentes en donde dicha válvula de entrada y escape se posicionan en dicha cámara de combustión en una disposición desfasada.
- 15 18. Un motor de una cualquiera de las reivindicaciones 8 a 17 en donde la forma y la position de dicha cavidad en dicha cabeza de pistón crea zonas "squish" entre la cabeza del pistón y la cabeza del cilindro.
- 20 19. Un motor de la reivindicación 18 en donde se proporcionan dos zonas "squish", estas zonas tienen una forma aproximadamente creciente de tal manera que resulta un flujo "squish" que se dirige hacia una región central de dicha cámara de combustión.
- 25 20. Un motor de combustión interna que opera en el principio de cuatro tiempos que comprende:
- (a) una cabeza de cilindro que comprende una cámara de combustión y un tren de válvulas que comprende por lo

menos una válvula de entrada y por lo menos una válvula de escape;

5 (b) por lo menos dos medios de ignición ubicados en la cámara de combustión; y

(c) medios de control para controlar el tren de válvulas en donde dichos medios de ignición se colocan diametralmente opuestos uno al otro en una base de dicha
10 cámara de combustión y por lo menos unos medios de ignición se colocan en línea con el tren de válvulas.

21. Un motor de una cualquiera de las reivindicaciones precedentes en donde dichas paredes laterales son
15 convergentes hacia arriba.

22. Un motor de una cualquiera de las reivindicaciones precedentes es un motor de un cilindro.

20 23. Un motor de la reivindicación 22 operado en el modo de quema de combustible delgado.

24. Un motor de una cualquiera de las reivindicaciones precedentes es un motor de agujero pequeño.

25 25. Un motor de una cualquiera de las reivindicaciones precedentes en donde el medio de ignición es una bujía.

26. Un vehículo que incorpora un motor como se reivindica en una cualquiera de las reivindicaciones precedentes.
30

2020
Bogotá D.C.,

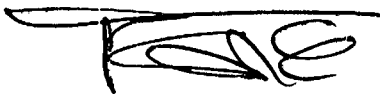
Doctor(a)
RODRIGUEZ D' ALEMAN DILIA MARIA
Apoderado(a) y/o Representante de
BAJAJ AUTO LIMITED

REFERENCIA	Radicación No. 10 75739
	Trámite 2
	Evento 1
	Actuación 416
	Oficio No. 12908
	Folios 1

Teniendo en cuenta que la solicitud de privilegio de patente que se tramita bajo el expediente indicado en la referencia, reúne los requisitos de forma establecidos en los artículos 26 y 27 de la Decisión 486 de la Comisión de la Comunidad Andina, y en las demás disposiciones vigentes sobre la materia, se envía el extracto de la solicitud a la Oficina de Comunicaciones para efecto de su publicación en la Gaceta de Propiedad Industrial, conforme lo establece el artículo 40 de la misma Decisión.

Siendo manifestación expresa del interesado, la solicitud no será publicada antes de los seis (6) meses contados a partir de la fecha de presentación, por lo tanto la publicación en este caso no se hará antes del día 23 del mes de Diciembre de 2010.

Cúmplase
Dado en Bogotá DC, **28 ABR. 2011**



JOSE LUIS SALAZAR LOPEZ
Director de Nuevas Creaciones (C)

jfernand