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(54) **AN IMPROVED EXHAUST SYSTEM OF A SINGLE CYLINDER FOUR STROKE SPARK IGNITION ENGINE**

VERBESSERTES ABGASSYSTEM FÜR EINEN EINZYLINDRIGEN VIER-TAKT-OTTOMOTOR

SYSTEME D'ÉCHAPPEMENT AMÉLIORÉ POUR MOTEUR À EXPLOSION QUATRE TEMPS ET UN SEUL CYLINDRE

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Description

[0001] The present invention relates to a vehicle comprising an exhaust system for improving the torque characteristics of an engine, in particular of a single cylinder four stroke spark ignition engine.

[0002] The invention further relates to improvement in an exhaust system of a vehicle, in particular in vehicles using a single cylinder four stroke spark ignition engine, which results in enhanced performance.

[0003] More particularly the invention enables an improvement in the torque production of the engine at lower engine speeds. For example, the applicant has designed engines utilizing the invention in which torque improvements have been made at engine speeds ranging from 3000 to 5000 RPM, which is typically a normal vehicle driving zone, while still achieving high power outputs at higher engine speeds. This invention is especially useful to engines used as prime movers for two and three wheeled vehicles. For simplicity of explanation, a reference to "vehicles" in this specification should be taken to be a reference to vehicles using single cylinder, four stroke, 'spark ignition engines and a reference to 'engines' in this specification is meant for single cylinder, four stroke, spark ignition engines.

[0004] Vehicles are generally equipped with an exhaust system in order to achieve desired performance characteristics of the engine, reduce noise of combustion from of the engine and to allow products of combustion of air-fuel mixture to escape to the atmosphere in a defined direction. For example, a simple motorcycle exhaust system consists of header pipe, a muffler and if necessary, a guard or heat shield. The header pipe may be of single diameter or with one or more steps of different diameters. One end of the exhaust system is attached to the exhaust port of the engine and other end is at the rear of vehicle. The exhaust system is neatly packaged within the space available in the motorcycle.

[0005] One of the difficulties experienced with conventional exhaust systems for the above mentioned engines is that when the exhaust system is designed to achieve desired performance levels, adequate compromise between available torque at lower speeds and performance at higher speeds is difficult. Hence, to achieve better performance, particularly maximum net power at higher engine speeds, it is often necessary to sacrifice the better torque availability at lower engine speeds.

[0006] Yet another difficulty is that the improvement in performance, usually, is associated with increase in noise level which is undesirable and may also exceed statutory limits.

[0007] In order to overcome at least some of the above problems, the applicants have invented an exhaust system wherein higher torque is produced at lower engine speeds whilst still retaining the desired engine performance and torque at higher engine speeds and also maintaining desirable noise levels. This is achieved by connecting a chamber of predetermined volume, externally

to the header pipe (stepped or otherwise) of the exhaust system at a point preferably between 40% to 60% of developed length of the header pipe from the face of exhaust flange along the length of said header pipe either directly or through a connecting tube. Conveniently, the location of the chamber is selected to accommodate it within available space in motorcycle and without sacrificing the ground clearance.

[0008] Usually, if a typical known engine is tuned to have a maximum net power at 8000 RPM, then a good engine can achieve a peak torque at 6000 RPM. In this case, the torque at 3500 RPM would be approximately 15% lower than the peak torque. This leads to poor drivability of vehicle at low engine speeds, while giving good performance at higher engine speeds. On the contrary, if the engines were to be tuned to achieve peak torque at lower speeds, for instance 5000 RPM, the peak power would occur at approximately 7000 RPM but would normally be of lesser value. Based on a comparison using the same vehicle gear ratios, this would mean that the vehicles with such engines would have better low speed drivability but poorer high-speed performance.

[0009] In order to achieve better performance of this engine, the applicants' improved exhaust system according to this invention enables at least two torque peaks to be produced in the torque vs. engine speed relationship.

[0010] In a certain embodiment of the invention, one of the torque peaks occurs at approximately 4500 engine RPM and second at approximately 6000 engine RPM. In such an application, it was found that the exhaust system enables availability of torque at 3500 RPM to be within 5% of the peak torque at 6000 RPM.

[0011] The improved exhaust system according to the present invention works on the principles of pulse tuning of the exhaust system. The chamber of a pre-determined volume is connected directly or by a tube of pre-determined diameter and length to header pipe at a developed distance preferably ranging from 40% to 60% of the total developed length of header pipe from the face of the exhaust flange. The two torque peaks are produced by the combination of reflection of pressure waves at the end of header pipe and that at the mouth of chamber.

[0012] In the past, various inventions were carried out in the field of exhaust systems. However, their teachings are very different to the present invention, for an example:

1) US4779415: Illustrates use of a Helmholtz resonator attached to the exhaust manifold of a multicylinder engine for the purposes of noise suppression. Multicylinder engines are subject to very different exhaust gas dynamics as compared to single cylinder engines. The overlapping exhaust pulsations of a multicylinder engine create opportunities for exhaust tuning effects, which are not available to single cylinder engines.

2) JP11-062547: Illustrates the use of Helmholtz resonators in an engine exhaust system which teaches

to create specific frequency of waves by resonator effect by means of Helmholtz resonator, which silences the system resonance. As for the above case, the teachings are also illustrated with reference to multi-cylinder engine applications.

3) US 3,254,484 describes means for manipulating sound pressure waves in relation to the intake and exhaust systems of internal combustion engines. This document further describes means for manually or automatically adjusting the effective acoustical length of the exhaust and intake systems of an engine while the engine is operating. As a consequence, this invention requires an exhaust system of variable effective acoustical length which is coordinated to match the engine speed.

[0013] Therefore, there are no teachings in these patents directed to torque enhancement and the special requirements for single cylinder engines, in clear contradiction to the applicants' teachings.

[0014] The invention will now be further elaborated with reference to following figures enclosed with this specification: -

Fig 1 - Illustrates a typical exhaust system of engines according to the prior art.

Fig 1A - Illustrates top view of location of typical exhaust system in motorcycle according to prior art

Fig 1B - Illustrates side view of the location of typical exhaust system in motorcycle according to prior art

Fig 2 - Illustrates torque curve of a typical engine according to the prior art.

Fig 3 - Illustrates an exhaust system incorporating a chamber according to the present invention.

Fig 3A: - Illustrates top view of location of typical exhaust system in motorcycle according to the present invention.

Fig 3B: - Illustrates side view of location of typical exhaust system in motorcycle according to the present invention

Fig 4 - Illustrates details of joining the chamber to header pipe of exhaust system of engine according to the present invention.

Fig 5 - Illustrates typical torque curve of engine fitted with improved exhaust system according to the present invention.

[0015] In one embodiment, an improved exhaust system according to the invention comprises of a header

pipe small (11), an exhaust flange (12), a connecting tube (13), a chamber (14), a tube (16), a header pipe large (17), a nipple (19), a washer (20), a bolt (21) and bracket (18).

[0016] Fig.1, 1 A and 1B illustrate a typical exhaust system and its location according to the prior art. It consists of header pipe (1) one end of which is assembled with flange (2). The flange (2) is connected to cylinder head (not shown) of the engine with suitable bolts or studs and nuts. The other end of the header pipe is either welded or assembled to the muffler (3). Exhaust gases from the cylinder head are led to the said header pipe and then to the muffler and then released to the atmosphere. The heat shield (4) provided on the muffler guards the rider and pillion from the heat of the exhaust system. This exhaust system is well known and does not need any detailed explanation.

[0017] Fig 2 illustrates typical wide open throttle torque curve of a typical engine fitted with the exhaust system according to prior art. It is observed from the curve that the peak torque is occurring at around 6500 engine RPM.

[0018] Figs 3, 3A, 3B and 4, illustrate an improved exhaust system according to the invention having a chamber (14), a connecting pipe (13) connecting said chamber to tube (16), said tube (16) being positioned between a front header pipe (11) and rear header pipe (17), the header pipe (11) being provided with an exhaust flange (12) and said rear header pipe (17) is connected to the said muffler (15).

[0019] As an alternative to using the tube (16) as an intermediate connector between the front header pipe (11) and rear header pipe (17) the connecting pipe (13) could be welded directly to header pipe (1) as shown in fig (1).

[0020] As an alternative to connecting the said connecting tube (13) and said chamber (14) to the header pipe (1), the said chamber (14) could be welded directly to header pipe (1) as shown in fig (1).

[0021] As shown in Figs 3, 3A, 3B and 4 the header pipe (1) is split as a front header pipe (11) and a rear header pipe (17). The ends of said front and rear header pipes connecting to the engine exhaust and the said muffler are identical to the header pipe (1). The developed length of said front header pipe (11) is decided considering the parameters like engine power, torque requirement at various engine revolutions, diameter of the pipe etc. In order to strengthen the fitment of chamber (14)/ a tube (16) is welded joining the rear header pipe (17) and the said chamber (14). The muffler (15) is connected to rear header pipe (17). The said connecting tube (13) is provided at a point, preferably 40% to 60% of developed length of header pipe (that is the combined length of the front and rear header pipes and connecting tube) from the face of said exhaust flange (12) along the length of the said header pipe. The connecting tube (13) or tube (16) is provided with a nipple (19). The other end of nipple is threaded which is closed by means of a washer (20) and a bolt (21). The said washer and bolt can be removed

to allow for the convenient measurement of exhaust gas emission values by a suitable instrument. Bracket (18) is provided between the chamber (14) and rear header pipe from strength considerations.

[0022] The chamber (14) is of a pre-determined volume and is made of two sheet metal halves welded together. Conveniently, reinforcing dimples (25) are added to the top surface (24) of the chamber (14) to provide rigidity and reduce noise caused by the vibration of this surface. An additional convenient feature of the present embodiment is the location of the bottom surface (26) of the chamber (14) to be slightly higher and sloped downwards towards the connecting pipe 13. This allows for any accumulated moisture to drain from the chamber (14) back into the exhaust system.

[0023] The length of connecting pipe (13) is so chosen that the desired result of improvement in torque characteristics is achieved and the said chamber is well located beneath the motorcycle in available space without sacrificing ground clearance. This is a very simple matter of design and in some cases can be readily determined with non-inventive trial and error.

[0024] Fig 3A and 3B illustrates a typical such location. The shape of the chamber and construction can vary with location on motorcycle.

[0025] Fig 5 illustrates typical wide open throttle torque performance curves of the engine fitted with the exhaust system according to depicted embodiment of the invention with respect to the engine speed in RPM. It can be observed that the torque of the engine between the speed range of 3000 to 5000 RPM which is the normal vehicle driving zone for a typical motorcycle has substantially improved, while maintaining substantially the original torque at engine speeds beyond 7000 RPM which is important for the performance of the engine. The applicants have carried out substantial testing and concluded that improvement in torque of a typical engine in the speed range between 3000 to 5000 RPM is of the order of 5 to 7%. Also, the vehicles do meet statutory requirements of noise level.

[0026] An improved exhaust system for vehicles as described herein and as illustrated in the drawings accompanying herewith and having variations and modifications well within the knowledge of a person skilled in the art without deviating from scope of the invention are within the scope of the present invention and its embodiments.

Claims

1. A vehicle comprising an exhaust system for improving the torque characteristics of an engine, the exhaust system comprising a fixed length exhaust manifold having a first end (12) connected to an exhaust port of said engine, a chamber (14) of predetermined volume, a muffler (15) and a header pipe (1) connecting said first end (12) of said exhaust

manifold and said muffler (15) **characterised in that** said engine is a single cylinder four stroke engine and said chamber (14) is an engine torque improvement chamber (14) to improve torque in a selected lower engine speed range and is connected to header pipe (1) and positioned externally of said header pipe (1) between said first end (12) of the exhaust manifold and said muffler (15) at a point between 40% and 60% along the developed length of header pipe (1).

2. A vehicle as claimed in claim 1 wherein said header pipe (1) comprises a front header pipe connected to said first end (12) of the exhaust manifold and a rear header pipe (17) connected to said muffler (15), said front header pipe (11) and said rear header pipe (17) being interconnected with a joining tube (16) to which said chamber (14) is fitted with a connecting tube (13) of predetermined volume.

3. A vehicle as claimed in any one of the preceding claims wherein the said chamber (14) operatively improves torque in an engine speed range from 3,000 RPM and 5,000 RPM.

4. A vehicle as claimed in any one of the preceding claims wherein the said improvement in torque in a lower engine speed range is achieved whilst retaining torque in a higher engine speed range.

5. A vehicle as claimed in any one of the preceding claims wherein said exhaust system is applied to a two or three wheeled vehicle.

6. A vehicle as claimed in any one of the preceding claims, wherein said exhaust system is applied to a two wheeled vehicle, said vehicle having its wheels aligned along a longitudinal axis of the vehicle, an engine being disposed between said wheels and the chamber (14) being located below the engine.

7. A vehicle as claimed in any one of the preceding claims wherein said chamber (14) has a flat shape wherein its vertical dimensions are significantly smaller than its horizontal dimensions.

8. A vehicle as claimed in any one of the preceding claims wherein said chamber (14) made of sheet metal having said predetermined volume.

9. A vehicle as claimed in any one of the preceding claims wherein said chamber (14) is rectangular in shape having an upper half and a lower half, said two halves being joined to each other to form said predetermined volume.

10. A vehicle as claimed in any one of the preceding claims wherein said chamber (14) has a bottom sur-

face (26) sloped downwards towards connecting tube (13) for accumulated moisture to drain from chamber (14) back into the connecting tube (13).

11. A vehicle as claimed in any one of the preceding claims wherein said chamber (14) is horizontally located below the engine maintaining ground clearance and not extending beyond the width of the vehicle.
12. A vehicle as claimed in any one of the preceding claims wherein said connecting tube (13) is provided with a nipple to allow measurement of exhaust gas emission values.
13. A vehicle as claimed in claim 2 wherein said joining tube (16) is provided with a nipple to allow measurement of exhaust gas emission values.
14. A vehicle as claimed in claim 2 wherein a strengthening bracket (18) is provided between said chamber (14) and said rear header pipe (17).
15. A vehicle as claimed in any one of the preceding claims wherein said chamber (14) is connected to header pipe (1) by a connecting tube (13) and improvement of torque characteristics is dependent on the length of connecting tube (13).
16. A vehicle as claimed in claim 15 wherein said chamber (14) is connected to header pipe (1) by a connecting tube (13) and improvement of torque characteristics is dependent on the length, diameter and volume of connecting tube (13).

Patentansprüche

1. Fahrzeug mit einer Auspuffanlage, um die Drehmomentkennlinie eines Motors zu verbessern, wobei die Auspuffanlage einen Auspuffkrümmer mit fester Länge umfasst, der an einem ersten Ende (12) mit einem Auspuffanschluss des Motors verbunden ist, eine Kammer (14) mit einem vorbestimmten Volumen, einen Auspuffdämpfer (15) und ein Verteilerrohr (1), das das erste Ende (12) des Auspuffkrümmers und den Auspuffdämpfer (15) verbindet, **gekennzeichnet dadurch, dass** der Motor ein Einzylinder-Viertaktmotor ist und die Kammer (14) eine das Motordrehmoment verbessernde Kammer (14) ist, um das Drehmoment in einem ausgewählten unteren Motordrehzahlbereich zu verbessern, und an das Verteilerrohr (1) angeschlossen ist und außen am Verteilerrohr (1) zwischen dem ersten Ende (12) des Auspuffkrümmers und dem Auspuffdämpfer (15) an einem Punkt zwischen 40% und 60% entlang des Längsverlaufs des Verteilerrohrs (1) positioniert ist.
2. Fahrzeug nach Anspruch 1, bei dem das Verteilerrohr (1) ein vorderseitiges Verteilerrohr umfasst, das mit dem ersten Ende (12) des Auspuffkrümmers verbunden ist, und ein rückwärtiges Verteilerrohr (17), das mit dem Auspuffdämpfer (15) verbunden ist, wobei das vorderseitige Verteilerrohr (11) und das rückwärtige Verteilerrohr (17) durch ein Verbindungsrohr (16) miteinander verbunden sind, an das die Kammer (14) mit einem Verbindungsrohr (13) mit einem vorbestimmtem Volumen angebracht ist.
3. Fahrzeug nach einem der vorangehenden Ansprüche, bei dem die Kammer (14) operativ das Drehmoment in einem Motordrehzahlbereich von 3.000 U/Min und 5.000 U/Min verbessert.
4. Fahrzeug nach einem der vorangehenden Ansprüche, bei welchem die Verbesserung des Drehmoments in einem unteren Motordrehzahlbereich erreicht wird, während das Drehmoment in einem höheren Motordrehzahlbereich beibehalten wird.
5. Fahrzeug nach einem der vorangehenden Ansprüche, bei dem die Auspuffanlage an einem zwei- oder dreirädrigen Fahrzeug angebracht ist.
6. Fahrzeug nach einem der vorangehenden Ansprüche, bei dem besagte Auspuffanlage an einem zweirädrigen Fahrzeug angebracht ist, wobei bei dem Fahrzeug die Räder entlang einer Längsachse des Fahrzeugs ausgerichtet sind, wobei ein Motor zwischen den Rädern angeordnet ist und die Kammer (14) unterhalb des Motors positioniert ist.
7. Fahrzeug nach einem der vorangehenden Ansprüche, bei dem die Kammer (14) eine flache Form aufweist, wobei ihre senkrechten Ausmaße bedeutend kleiner als ihre waagerechten Ausmaße sind.
8. Fahrzeug nach einem der vorangehenden Ansprüche, bei dem die Kammer (14) aus einem Metallblech mit besagtem vorbestimmten Volumen hergestellt ist.
9. Fahrzeug nach einem der vorangehenden Ansprüche, bei dem die Kammer (14) rechteckförmig ist mit einer oberen Hälfte und einer unteren Hälfte, wobei die beiden Hälften miteinander verbunden sind, um besagtes vorbestimmtes Volumen zu bilden.
10. Fahrzeug nach einem der vorangehenden Ansprüche, bei dem die Kammer (14) eine Bodenfläche (26) hat, die nach unten zum Verbindungsrohr (13) hin abgeschrägt ist, um die angesammelte Feuchtigkeit von der Kammer (14) zurück in das Verbindungsrohr (13) abzulassen.
11. Fahrzeug nach einem der vorangehenden Ansprüche

che, bei dem die Kammer (14) horizontal unterhalb des Motors positioniert ist und den Bodenabstand aufrechterhält und sich nicht jenseits der Fahrzeugbreite erstreckt.

12. Fahrzeug nach einem der vorangehenden Ansprüche, bei dem das Verbindungsrohr (13) einen Nippel aufweist, um die Messung der Abgasemissionswerte zu gestatten.
13. Fahrzeug nach Anspruch 2, bei dem das Verbindungsrohr (16) einen Nippel aufweist, um die Messung der Abgasemissionswerte zu gestatten.
14. Fahrzeug nach Anspruch 2, bei dem ein Verstärkungsbügel (18) zwischen besagter Kammer (14) und dem rückwärtigen Verteilerrohr (17) vorgesehen ist.
15. Fahrzeug nach einem der vorangehenden Ansprüche, bei dem besagte Kammer (14) über ein Verbindungsrohr (13) mit dem Verteilerrohr (1) verbunden ist und die Verbesserung der Drehmomentkennlinie von der Länge des Verbindungsrohrs (13) abhängt.
16. Fahrzeug nach Anspruch 15, bei dem besagte Kammer (14) über ein Verbindungsrohr (13) mit dem Verteilerrohr (1) verbunden ist und die Verbesserung der Drehmomentkennlinien von der Länge, dem Durchmesser und dem Volumen des Verbindungsrohrs (13) abhängt.

Revendications

1. Véhicule comprenant un système d'échappement pour améliorer les caractéristiques de couple d'un moteur, le système d'échappement comprenant un collecteur d'échappement de longueur fixe ayant une première extrémité (12) connectée à un conduit d'échappement dudit moteur, une chambre (14) ayant un volume prédéterminé, un silencieux d'échappement (15) et un tube de tête (1) pour connecter ladite première extrémité (12) dudit collecteur d'échappement et ledit silencieux d'échappement (15) **caractérisé en ce que** ledit moteur est un moteur à un seul cylindre à quatre temps et **en ce que** ladite chambre (14) est une chambre pour l'amélioration du couple de moteur (14) afin d'améliorer le couple dans une gamme sélectionnée de vitesse de moteur inférieure et celle-ci est connectée au tube de tête (1) et est située à l'extérieur dudit tube de tête (1) entre ladite première extrémité (12) du collecteur d'échappement et ledit silencieux d'échappement (15) à un emplacement entre 40% et 60% de la longueur développée du tube de tête (1).
2. Véhicule selon la revendication 1, dans lequel ledit

tube de tête (1) comprend un tube de tête avant relié à ladite première extrémité (12) du collecteur d'échappement et un tube de tête arrière (17) relié audit silencieux d'échappement (15), ledit tube de tête avant (11) et ledit tube de tête arrière (17) étant reliés entre eux par un tube d'union (16) auquel vient se fixer ladite chambre (14) avec un tube de connexion (13) de volume prédéterminé.

3. Véhicule selon l'une quelconque des revendications précédentes dans lequel ladite chambre (14) améliore de manière opérationnelle le couple dans une gamme de vitesse de moteur de 3,000 t/min et 5,000 t/min.
4. Véhicule selon l'une quelconque des revendications précédentes dans lequel ladite amélioration du couple dans une gamme de vitesse de moteur inférieure est obtenue tout en maintenant le couple moteur à une gamme de vitesse de moteur supérieure.
5. Véhicule selon l'une quelconque des revendications précédentes dans lequel ledit système d'échappement est appliqué à un véhicules à deux ou trois roues.
6. Véhicule selon l'une quelconque des revendications précédentes, dans lequel ledit système d'échappement est appliqué à un véhicule à deux roues, ledit véhicule ayant les roues alignées le long d'un axe longitudinal du véhicule, un moteur étant disposé entre lesdites roues, et la chambre (14) étant située sous le moteur.
7. Véhicule selon l'une quelconque des revendications précédentes dans lequel ladite chambre (14) a une forme plate où ses dimensions verticales étant significativement plus petites que ses dimensions horizontales.
8. Véhicule selon l'une quelconque des revendications précédentes dans lequel ladite chambre (14) en tôle a ledit volume prédéterminé.
9. Véhicule selon l'une quelconque des revendications précédentes dans lequel ladite chambre (14) est de forme rectangulaire et comporte une moitié supérieure et une moitié inférieure, lesdites deux moitiés étant unies l'une à l'autre pour former ledit volume prédéterminé.
10. Véhicule selon l'une quelconque des revendications précédentes dans lequel ladite chambre (14) a une surface inférieure (26) inclinée vers le bas vers un tube de connexion (13) pour que l'humidité accumulée soit drainée depuis la chambre (14) de retour dans le tube de connexion (13).

11. Véhicule selon l'une quelconque des revendications précédentes dans lequel ladite chambre (14) est placée horizontalement sous le moteur en maintenant la garde au sol et ne s'étendant pas au-delà de la largeur du véhicule. 5
12. Véhicule selon l'une quelconque des revendications précédentes dans lequel ledit tube de connexion (13) est pourvu d'un mamelon afin de permettre la mesure des valeurs d'émission des gaz d'échappement. 10
13. Véhicule selon la revendication 2 dans lequel ledit tube de couplage (16) est pourvu d'un mamelon pour permettre la mesure des valeurs d'émission des gaz d'échappement. 15
14. Véhicule selon la revendication 2 dans lequel une bride de renforcement (18) est prévue entre ladite chambre (14) et ledit tube de tête arrière (17). 20
15. Véhicule selon l'une quelconque des revendications précédentes dans lequel ladite chambre (14) est reliée au tube de tête (1) par un tube de connexion (13) et l'amélioration des caractéristiques du couple moteur dépend de la longueur du tube de connexion (13). 25
16. Véhicule selon la revendication 15 dans lequel ladite chambre (14) est reliée au tube de tête (1) par un tube de connexion (13) et l'amélioration des caractéristiques du couple moteur dépend de la longueur, du diamètre et du volume du tube de connexion (13). 30

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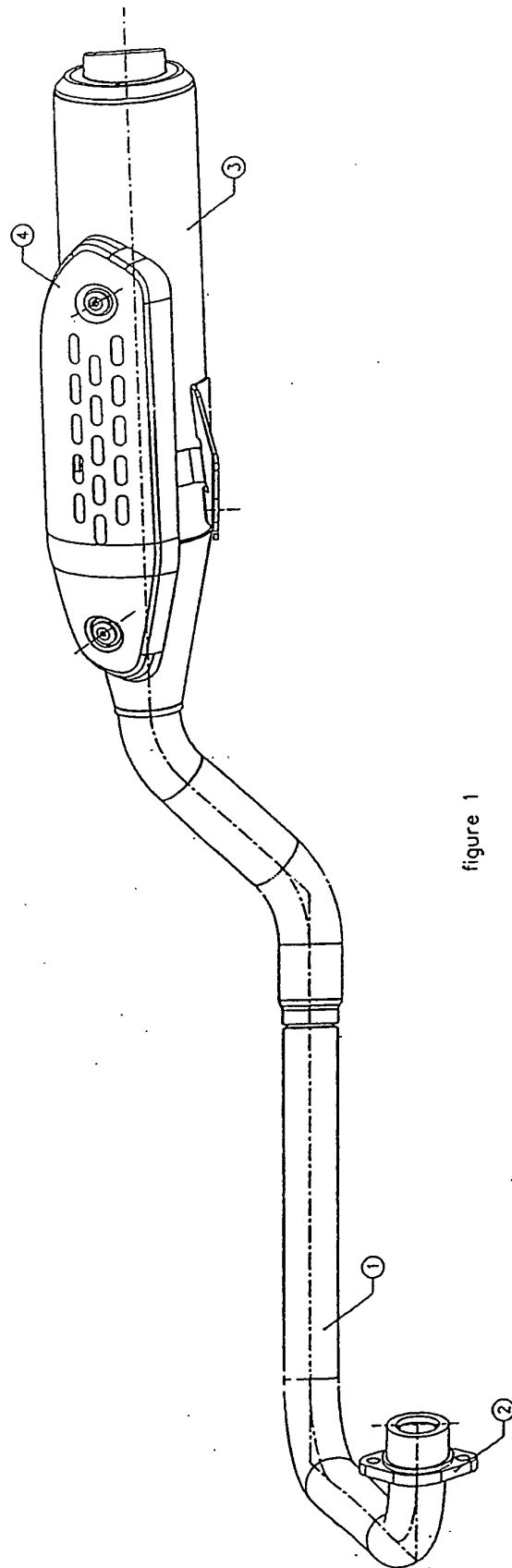


figure 1

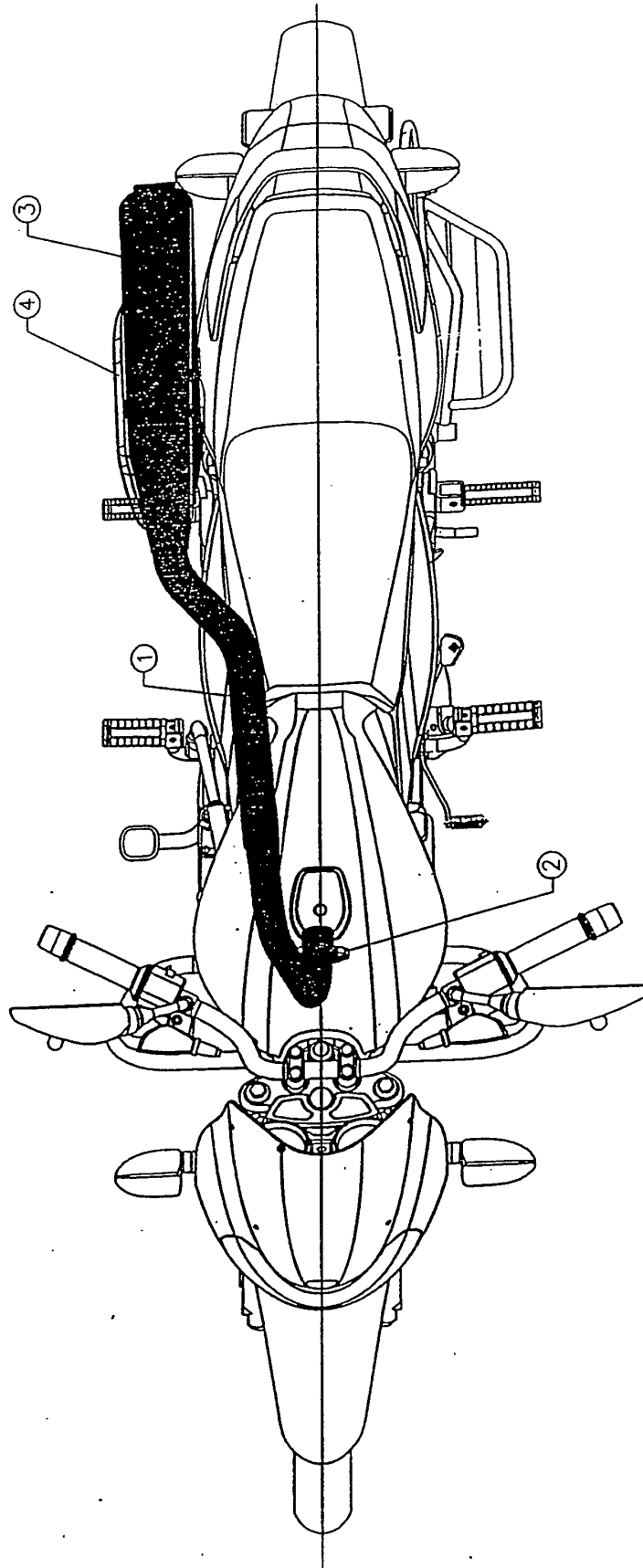


Fig : 1A

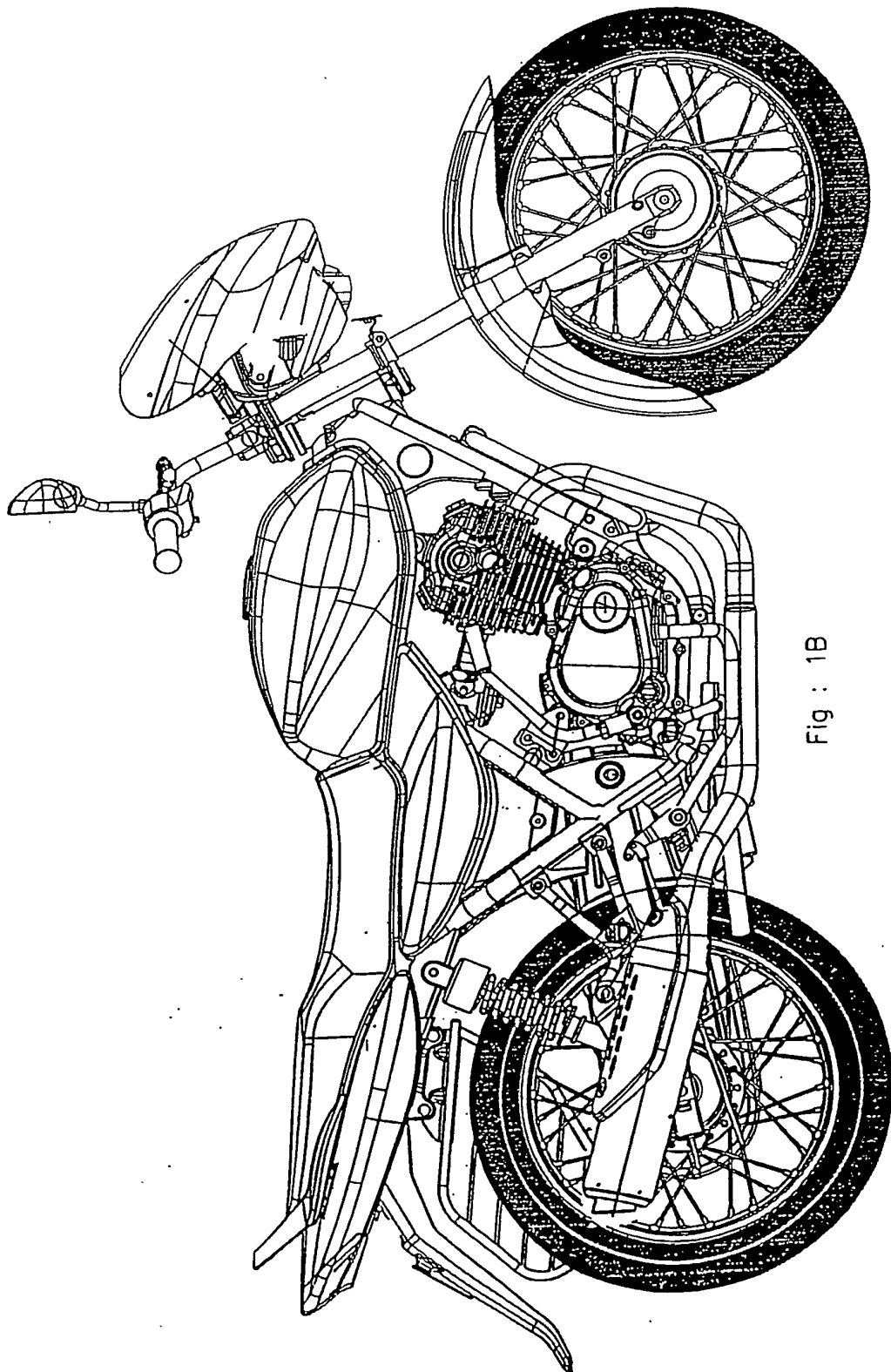


Fig : 1B

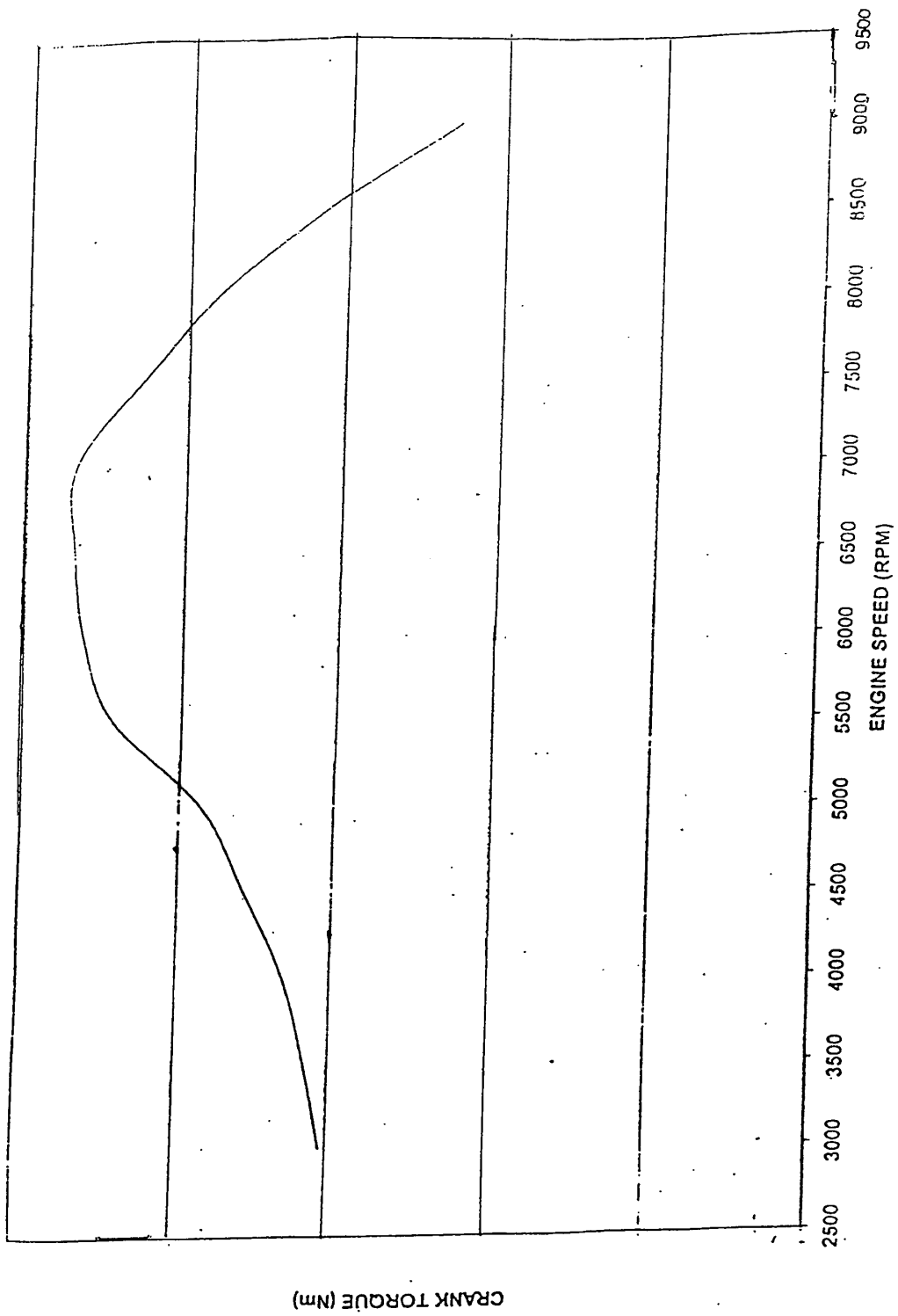


Figure 2

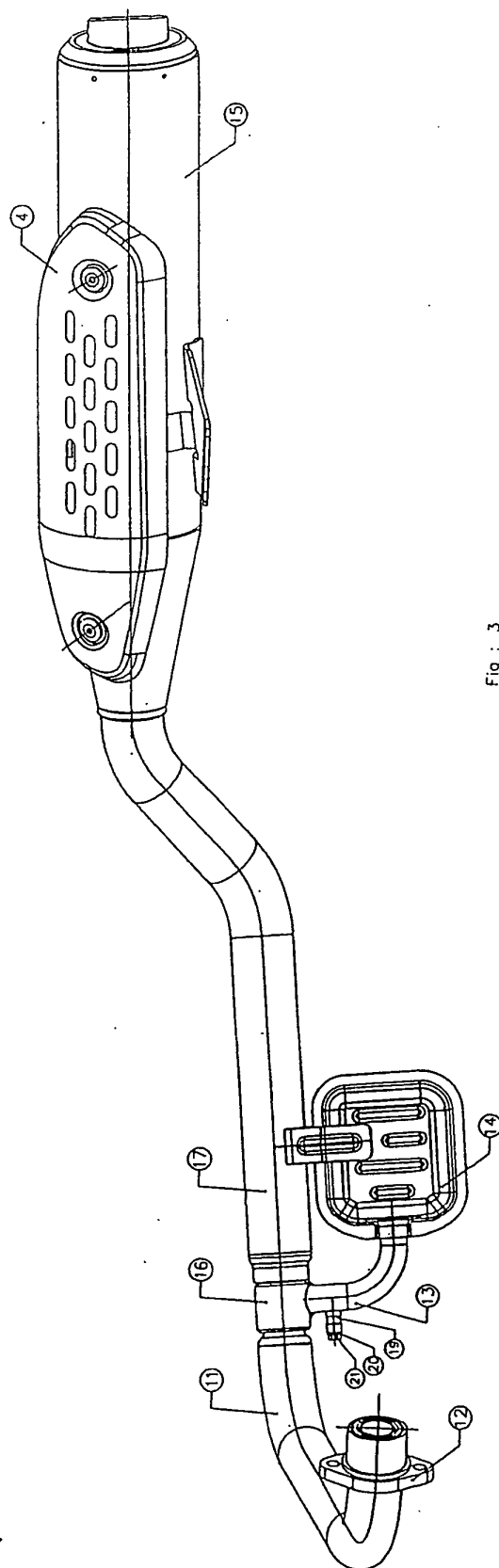


Fig : 3

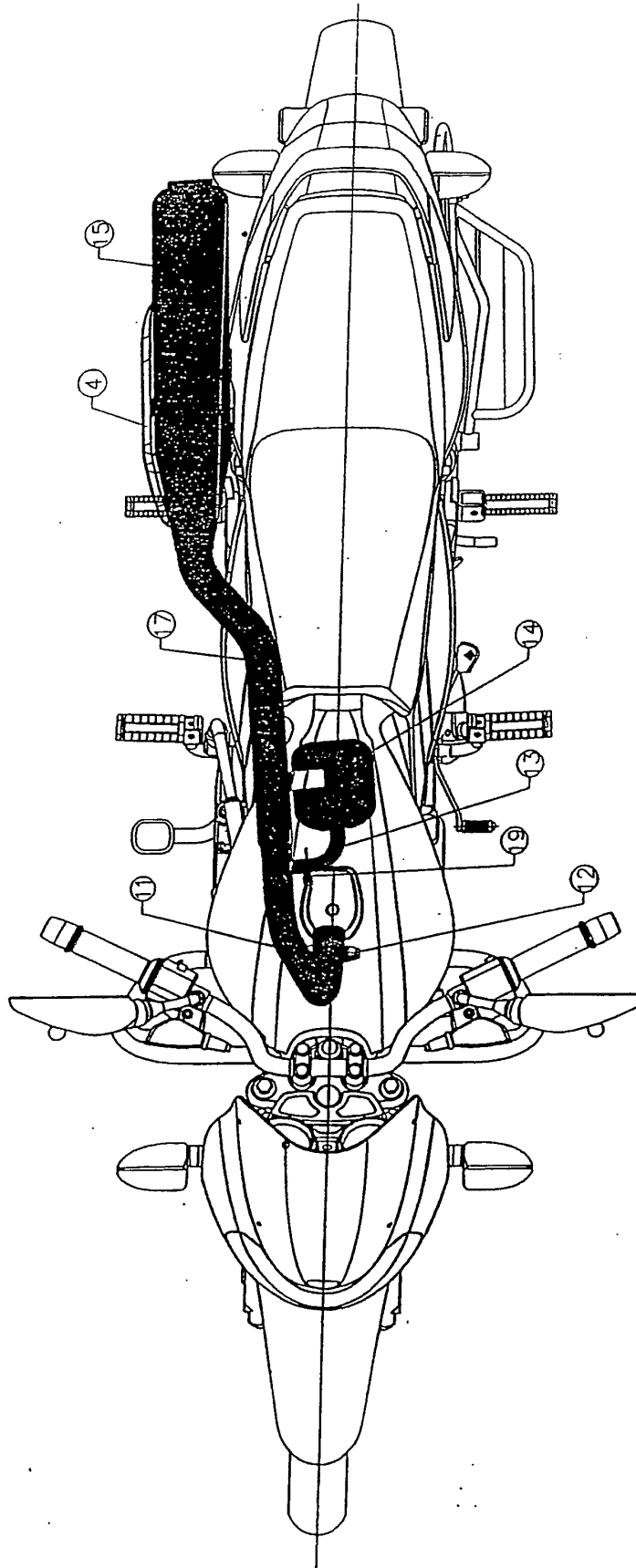


Fig : 3A

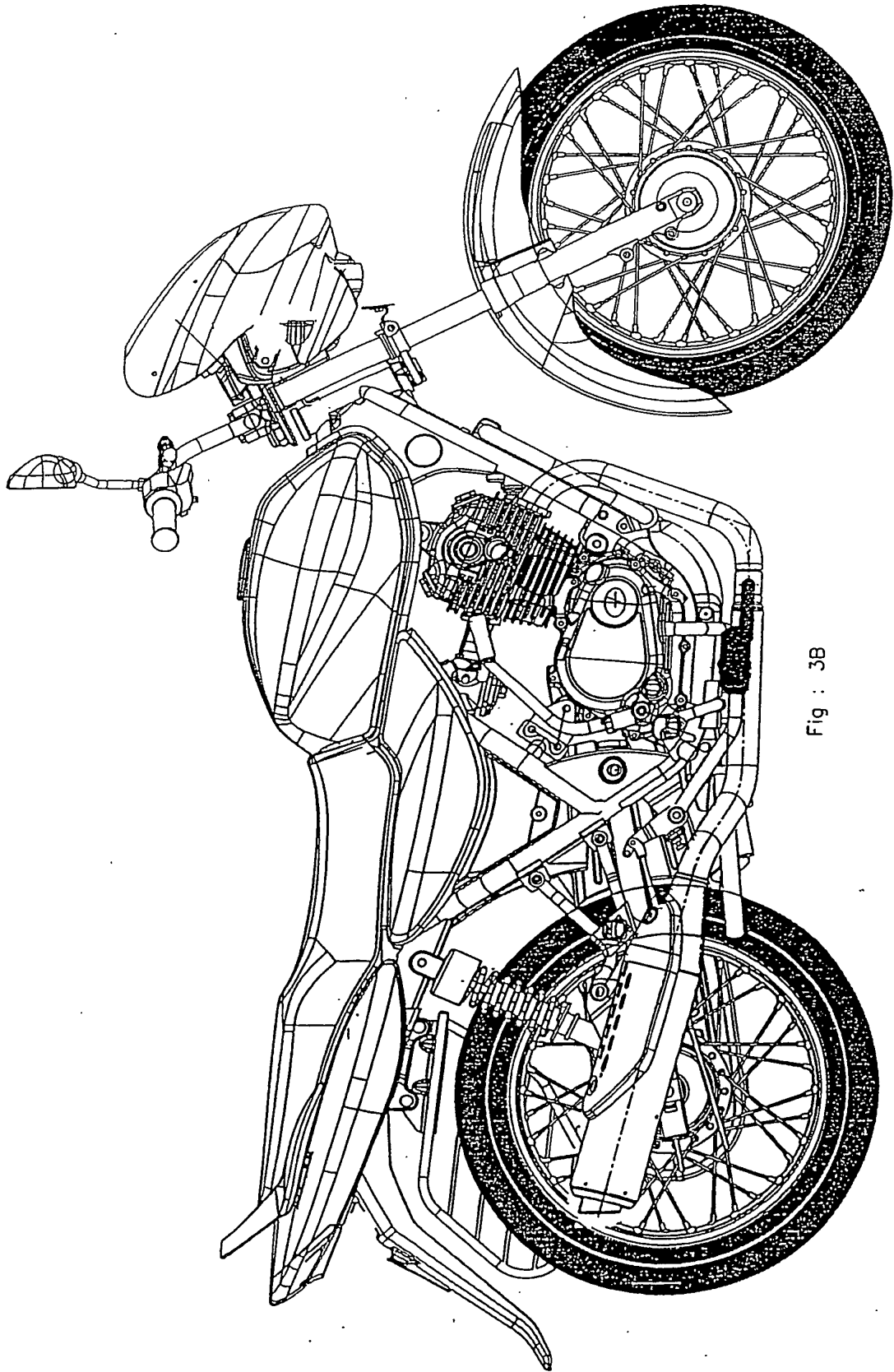


Fig : 3B

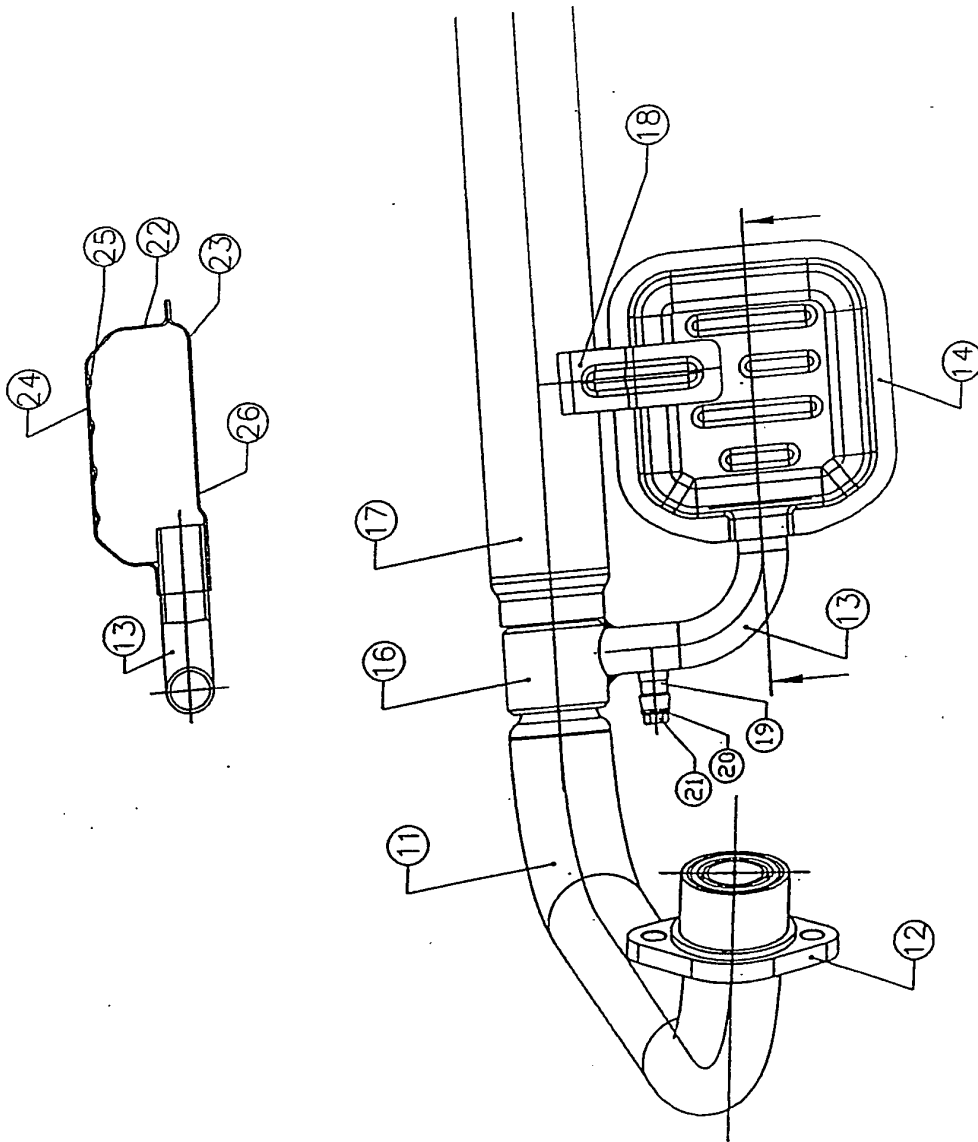


Fig. 4

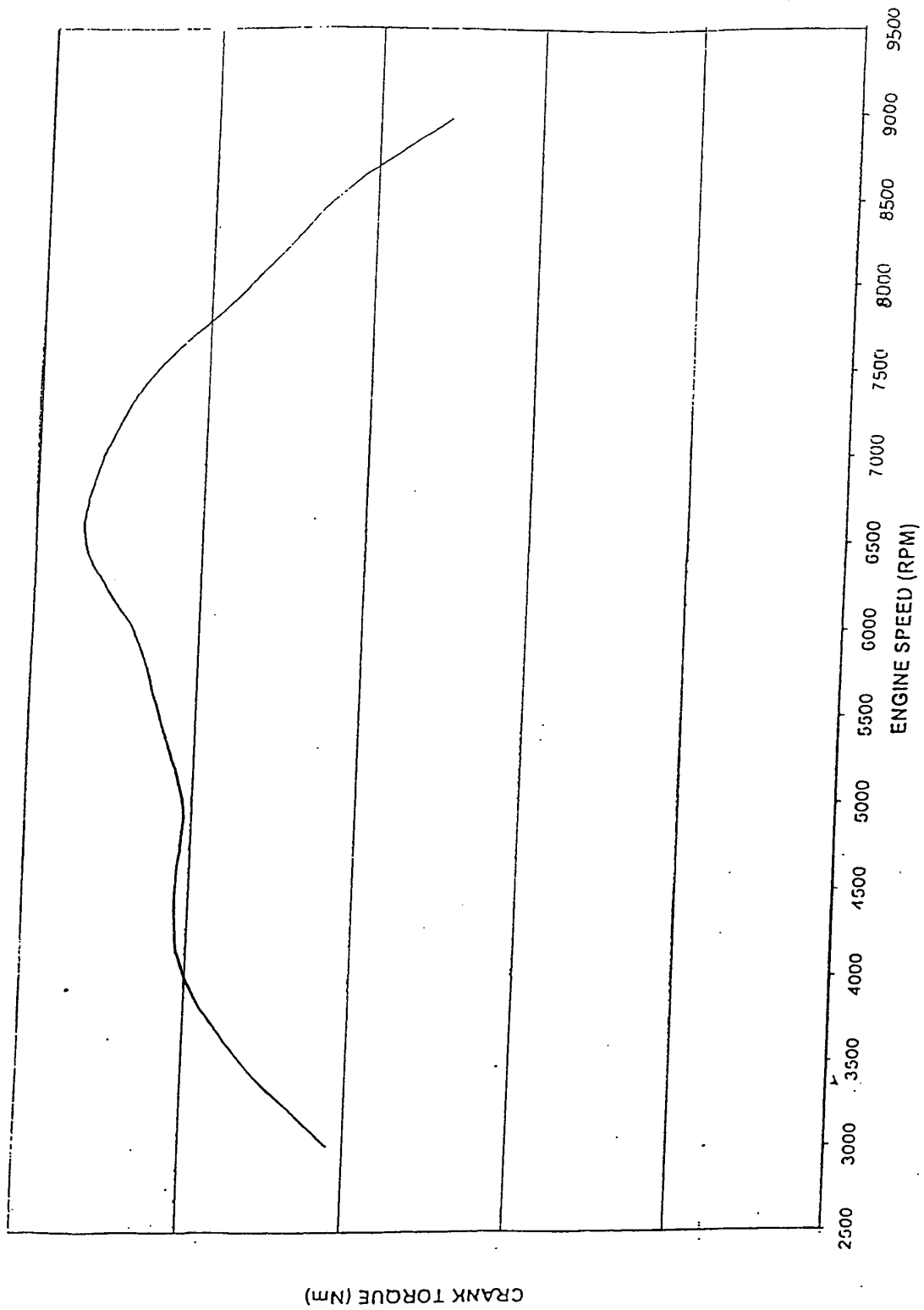


Figure-5

REFERENCES CITED IN THE DESCRIPTION

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