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(54) **Hydraulic tappet.**

(57) A hydraulic tappet of the type having a one-way check valve (74) for valve gear of an internal combustion engine is provided which is especially suited for use in smaller displacement, higher r.p.m. engines. Tappets having conventional check valves in some instances experience unsatisfactory operation at higher engine speeds due to excessive internal pressure in the tappet which results in over extension of the tappet. The hydraulic tappet of the invention eliminates this problem and includes a movable plunger assembly (62) received in the tappet body (54). The plunger assembly defines an internal fluid reservoir (72) and, in combination with the tappet body, a fluid cavity (70). The one-way check valve (74) is located within the fluid cavity and comprises a spherical valve member (78) biased by a conical spring (84) into engagement with a valve seat (76) adjacent a fluid passageway connecting the fluid reservoir and the cavity. A retaining cage (79) surrounds the valve member and spring and limits the movement of the valve member away from the valve seat. In the maximum open position the conical biasing spring is compressed to a minimum height substantially equivalent to its wire diameter, thereby permitting the ball to move away from the valve seat without obstruction from the spring. An opening (88) in the retaining cage allows the valve member to extend partially therethrough to further increase the travel of the ball.

**EP 0 028 736 A1**

BACKGROUND OF THE INVENTION

This invention relates to an improved hydraulic tappet for use in internal combustion engine valve gear and particularly in those engines having  
5 lower displacements and higher operating speeds.

DESCRIPTION OF THE PRIOR ART

An operating condition known as "pump-up" sometimes occurs in hydraulic tappets during conditions in which engine speeds generally exceed 4000 r.p.m.  
10 When pump-up occurs an excessive amount of hydraulic fluid enters a cavity within the lifter located between the lifter body and the lower end of the plunger which results in extension of the force transmitting length of the lifter. The excessive length prevents the intake or  
15 exhaust valve from completely closing. Failure of the valves to properly seat results in loss of engine power, back firing into the exhaust or intake manifold chamber, and valve burning. In some instances where ball type check valves are employed pump-up problems can be  
20 eliminated by increasing the distance that the ball valve member of the tappet check valve travels. The longer ball travel allows the check valve to be open for a greater period of time, thereby permitting the tappet to "pump down" even after valve gear forces are  
25 again transferred through the lifter.

A problem associated with providing long ball travel in tappet check valves is that, in some engine applications, the space available for  
accommodating the increased length of the check valve  
30 assembly is not available due to dimensional constraints imposed by existing valve gear components geometry.

SUMMARY OF THE INVENTION

In the present invention a hydraulic tappet is provided having a one-way check valve assembly which  
35 provides increased ball travel. The check valve

assembly includes an open ended cup-shaped spring retainer maintained in abutment with the lower surface of the lifter plunger by a compression biasing spring. A ball valve member is maintained in seating engagement  
5 with a valve seat formed around a fluid passageway which connects a fluid reservoir in the plunger with a cavity beneath the plunger. The cavity is defined by the lower end of the plunger and a blind bore formed in the lower end of the lifter body. A conical biasing spring has  
10 its major diameter end seated against the bottom end of the cup shaped retainer and its minor diameter end reacting against the ball valve member. The wire diameter, number of coils, and configuration of the conical biasing spring are established by known  
15 techniques to permit the spring to compress to a height substantially equivalent to its wire diameter thereby permitting the ball valve member to realize maximum travel away from the valve seat. Slots formed through the side wall of the cup shaped retainer permit the free  
20 flow of oil from the reservoir into the cavity.

It is therefore an object of the invention to provide a hydraulic lifter having a one-way check valve assembly which provides increased ball travel in a minimum amount of space and without diminishing the  
25 volume of the fluid cavity in which the check valve assembly is mounted.

It is another object of the invention to provide a hydraulic tappet having a one-way check valve assembly which requires a minimum amount of space while  
30 at the same time providing relatively long ball travel.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a transverse cross-sectional view of the block of an engine having overhead valve gear employing cam in block and a hydraulic tappet of the  
35 present invention with pushrods intermediate cam and valve rockers;

Fig. 2 is a partial sectional view taken along section lines 2-2 of Fig. 1 showing details of the hydraulic tappet with the one-way check valve of the tappet in the closed position; and

5 Fig. 3 is a partial section view similar to Fig. 2 showing the one-way check valve in the open position.

DETAILED DESCRIPTION

Referring to Fig. 1 a hydraulic tappet, 10 indicated generally at 10, is shown in association with conventional pushrod type valve gear of an internal combustion engine. It should be noted that the principles of the invention are applicable also to other valve gear systems such as stationary lash adjusters for 15 cam-over-rocker type valve gear.

The valve gear includes a valve 12 having a stem 14 thereof received in a valve guide 16 formed in a cylinder head 18 of the engine. A valve closing means as, for example, spring 20 is received over the valve 20 stem with a keeper 22 attached thereon to retain the spring, thus causing spring 20 to bias valve 12 to a closed position. A rocker shaft 24 is provided on engine head 18 and individual rocker arms 26 pivot thereabout so as to each have one end thereof contacting 25 the end of the valve stem. The opposite end 28 of each rocker arm is in pivotal contact with a pushrod 30 which extends downwardly through a passage 32 in cylinder head 18 in a manner such that pushrod 30 is free to reciprocate in the cylinder head. A tappet guide bore 30 34 is provided in an engine block 36 and guide bore 34 has a passage 38 communicating therewith, which passage also communicates with a gallery 40 in a pressurized engine oil pump circuit. Tappet 10 is received slidably in bore 34 and has an end face 42 thereof in contact 35 with a cam surface 44 of a rotating camshaft 46. Cam surface 44 of shaft 46 has a conventional base circle

portion 48 and a radially extending lobe portion 50 for causing longitudinal movement of hydraulic tappet 10 within bore 34 during each revolution of the camshaft.

Hydraulic tappet 10 has an oil receiving groove 52 provided around the periphery thereof for registering with oil passage 38 as the tappet moves in bore 34 for receiving a supply of pressurized oil from the engine pump circuit to operate the hydraulic lash adjusting means within the tappet.

Referring now to Fig. 2, hydraulic tappet 10 is shown in enlarged cross-section as having a body 54. A blind bore 56 is formed in body 54 with the blind end of the bore terminating adjacent cam face 42 of the tappet. Inlet port means are provided in the form of a hole 58 in the wall of the body 54. Oil receiving groove 52 communicates with bore 56 through hole 58 for transmitting metered engine lubricant to the hydraulic lash adjusting means contained therein.

The tappet bore 56 has a plunger means 62 slidably received therein. Plunger means 62 is formed of an upper portion 64 and a lower portion 66 which portions are in abutting contact along their respective adjacent transverse faces. At least one, and preferably a plurality, of radial grooves 68 and 70 are formed in the bottom surface of upper plunger portion 64. Plunger means 62 forms, in cooperation with the end of blind bore 56, a cavity 70 for retaining oil therein. A fluid reservoir 72 is defined by plunger means 62. An internal groove 69 formed into bore 56 and a reduced upper diameter portion 71 on lower plunger portion 66 facilitate the flow of oil from oil receiving groove and hole 58 through grooves 68 and 70 and then into fluid reservoir 72. A one-way valve means, indicated generally at 74, communicates reservoir 72 with cavity 70 and is in abutment with the lower end of lower plunger portion 66.

Valve means 74 has a valve seat 76 formed at the juncture of a passage 77 which fluidly communicates reservoir 72 with cavity 70. A ball valve member 78 is movable from a closed position contacting valve seat 76 to an open position spaced from valve seat 76. A retaining cage 79 is received over ball valve member 78 and serves to retain the ball therein. A conical biasing spring 80 is provided within retaining cage 79 and has a major diameter end 82 in abutment with cage 79 and a minor diameter end 84 in abutment with ball valve member 79.

Cage 79 has a plurality of longitudinally extending slots 86 through the side wall thereof, one of which is shown partially in Fig. 3, for permitting the free flow of fluid past cage 78 into cavity 70. Cage 78 has an opening 88 through the lower end thereof for achieving maximum travel of ball valve member 78 away from seat 76 by allowing the lower portion of the ball to extend therein as shown by Fig. 3. Conical spring 80 urges ball valve member 78 to a closed position in contact with valve seat 76.

In the embodiment shown by Figs. 1 - 3, the maximum ball travel necessary to avoid pump-up for a ball having a diameter of 0.2187 inch (5.556 mm) is approximately 0.075 inch (1.905 mm). Pump-up was found to occur when ball travel with a conventional one-way valve assembly was approximately 0.030 inch (0.076 mm).

A plunger bias spring 90 is provided in cavity 70 and registers against the lower end of lower plunger portion 66 to urge plunger means 62 in a direction away from the blind end of bore 56.

An annular plunger retainer 92 is provided over the upper end of upper plunger portion 64. When no load is present on the plunger means 62 from the associated engine valve gear components, retainer 92 serves to retain the plunger means in body 54 against the bias force of spring 90.

In operation, as the camshaft 46 of Fig. 1 rotates, the lobe of the cam surface causes the tappet to move upwardly within bore 34 so as to exert a force on the pushrod 30. The upward movement of pushrod 30 rotates rocker 26 in a clockwise manner about the shaft 24 to press down upon stem 14 of valve 12 and thus opens the valve. When lobe portion 50 of the cam surface begins to raise the tappet 10, the one-way valve means 74 closes and traps oil in cavity 70 which prevents the plunger means 62 from further collapsing within bore 56. When the lobed surface portion of the cam surfaces passes the tappet, the tappet face 91 rests on the base circle portion of the cam and the valve closes. When the valve is closed and the tappet face contacts base circle portion 48 of the cam, the force on pushrod 30 then decreases to a level as determined by the plunger bias spring 90 provided in cavity 70 of the tappet body 54. The plunger bias spring 90 moves the plunger upwardly within the tappet body, thereby causing the plunger to take up any lash in the pushrod-rocker-valve train; and, simultaneously oil is admitted into the cavity 70 through the one-way valve means 74 by the suction formed in cavity 70 due to the outward motion of the plunger means therefrom. As the cam surface 44 continues rotation for a subsequent valve event, and the lobe portion 50 pushes the hydraulic tappet 10 upward, the pushrod exerts a force on the plunger means 62 and causes one-way valve means 74 to close, retaining the plunger in its adjusted position by trapping therein the fluid which entered into cavity 70 during the time when the valve means 74 was open. However, during high engine r.p.m. operating conditions, (approximately 4000 r.p.m. and above) an amount of oil can sometimes flow into the cavity which is in excess of that needed to take up lash in the valve gear. The excess oil volume in cavity 70 causes the force transmitting length to increase which in turn prevents the valve from closing.

This excessive oil flow can occur at various stages of camshaft rotation whenever a condition of dynamic unloading occurs on the hydraulic tappet 10. In the invention as embodied in Figs. 1 - 3, the long ball  
5 travel allows the excessive volume of fluid in cavity 70 to "pump down" or flow back into reservoir 72 prior to closing of ball valve member 78 against seat 76.

Further modifications and variations will be apparent to those having ordinary skill in the art and  
10 the invention is limited only by the following claims.

## WHAT IS CLAIMED IS:

Claim 1. A hydraulic tappet (10) for a valve gear of an internal combustion engine, the tappet being of the type adapted to receive and transmit periodically applied forces comprising:

- 5 (a) body means (54) having a blind bore (56) formed therein, said body means including a contact surface (42) adapted to contact associated engine valve gear components for receiving said forces;
- (b) plunger means (62) slidably received in  
10 said body bore and defining, in cooperation with the blind end of said bore, a cavity, said plunger means including,  
(i) means defining a reaction surface (64) adapted to contact associated engine valve gear components and transmit said forces,  
15 (ii) means defining a fluid reservoir (72),  
(c) said body means and said plunger means including means for receiving fluid under pressure from said engine and directing said fluid to said reservoir (52, 58, 71, 68);
- (d) means biasing said plunger means  
20 outwardly of said cavity (90); and  
(e) one-way valve means (74) for permitting fluid flow from said reservoir to said cavity, said one-way valve means including  
(i) a spherical valve member (78),  
(ii) retaining means (79) received over said  
25 valve member, said retaining means including a member having a portion in abutment with said plunger means, said retaining means including passageway means (86) for permitting fluid flow  
30 therethrough,  
(iii) a conical biasing spring (80) having one end engaging said valve member and the other end thereof in abutment with said retaining

35 means, said spring urging said valve member  
to a closed position for preventing fluid flow  
from said reservoir to said cavity,  
(iv) said retaining means member further  
defining a central opening (88) formed through  
40 said closed end portion for permitting a portion  
of said valve member to extend therethrough  
while said valve member is in said second  
position.

Claim 2. A hydraulic tappet (10) for a valve  
gear of an internal combustion engine, comprising:

- (a) body means (54) having a blind bore (56)  
formed therein, said body means including a contact surface  
(42) adapted to contact associated engine valve gear  
5 components for receiving periodically applied forces;
- (b) plunger means (62) slidably received in said  
bore and defining, in cooperation with the blind end of said  
bore, a cavity, said plunger means including,
  - 10 (i) means defining a reaction surface (64)  
adapted to contact associated engine valve  
gear components and transmit said periodically  
applied forces,
  - (ii) means defining a fluid reservoir (72), and
- 15 (c) said body means and said plunger means  
including means for receiving fluid under pressure from  
said engine and directing said fluid to said reservoir  
(52, 58, 71, 68),
- (d) means biasing said plunger means  
outwardly of said cavity (90); and
- 20 (e) one-way valve means (74) for permitting  
fluid flow from said reservoir to said cavity, said one-way  
valve means including,
  - (i) means defining a fluid passageway (77)  
communicating said reservoir with said cavity  
25 and a valve seat (76) adjacent one end of said  
fluid passageway,

(ii) a spherical valve member (78) movable between a closed position in sealing engagement with said valve seat and an open position spaced from said valve seat,  
30 (iii) retainer means (79) for limiting movement of said spherical valve member and for establishing said open position of said valve member, said retainer means including a cup-shaped member (79) having passageway means (86)  
35 for permitting fluid flow therethrough, said cup-shaped member having an opening (88) through the bottom end thereof,  
(iv) biasing means (80) for urging said valve  
40 member to said closed position, said biasing means including a conical spring (80) having a minor diameter end portion (84) in contact with said valve member and a major diameter end portion (82) in contact with said retainer means,  
45 said conical spring compressible to a substantially flat position for permitting a portion of said spherical valve member to extend into said opening in said cup-shaped member.

Claim 3. A hydraulic tappet (10) for a valve gear of an internal combustion engine, the tappet being of the type adapted to receive and transmit periodically applied forces comprising:

5 (a) body means (54) including structure defining a contact surface (42) adapted to contact associated engine valve gear components for receiving said forces;  
(b) lash adjusting means (62, 74) associated with said body means and movable with respect thereto, said lash  
10 adjusting means including structure defining a reaction surface (64) adapted to contact associated engine valve gear components and transmit said forces, said lash adjusting

means cooperating with said body means to define a fluid pressure chamber (72) for retaining fluid to alter the position of said reaction surface with respect to said contact surface, said lash adjusting means including one-way valve means (74) for permitting fluid flow to said fluid pressure chamber, said one-way valve means including:

- (i) a spherical valve member (78)
- (ii) retaining means (79) received over said valve member, said retaining means including a member having a portion in abutment with said plunger means, said retaining means including passageway means (86) for permitting fluid flow therethrough,
- (iii) a conical biasing spring (80) having one end engaging said valve member and the other end thereof in abutment with said retaining means, said spring urging said valve member to a closed position for preventing fluid flow from said reservoir to said cavity,
- (iv) said retaining means member further defining a central opening (88) formed through said closed end portion for permitting a portion of said valve member to extend therethrough while said valve member is in said second position;
- (c) said body means and said lash adjusting means cooperating to define a passage (52, 58, 71, 68, 72) for directing fluid to said one-way valve means upon said body means being applied with fluid from the engine; and,
- (d) means biasing said lash adjusting means (90) in a direction to increase the distance between said contact surface and said reaction surface.

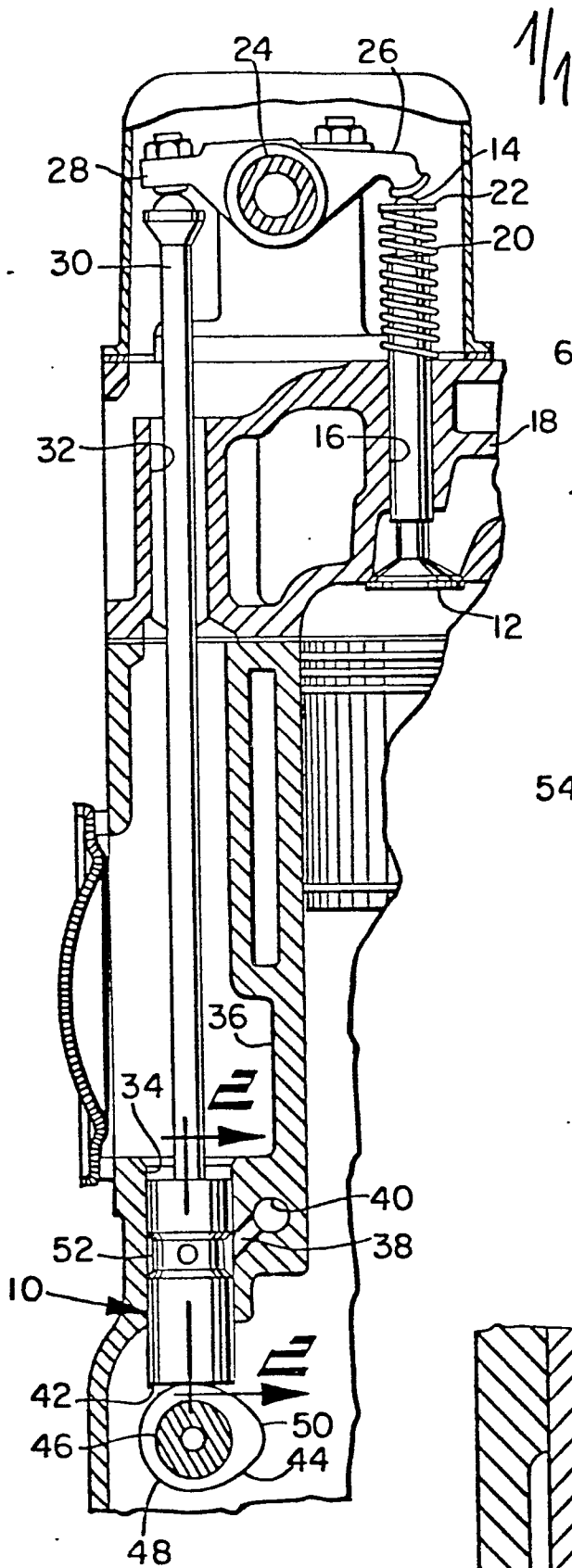


FIG. 1

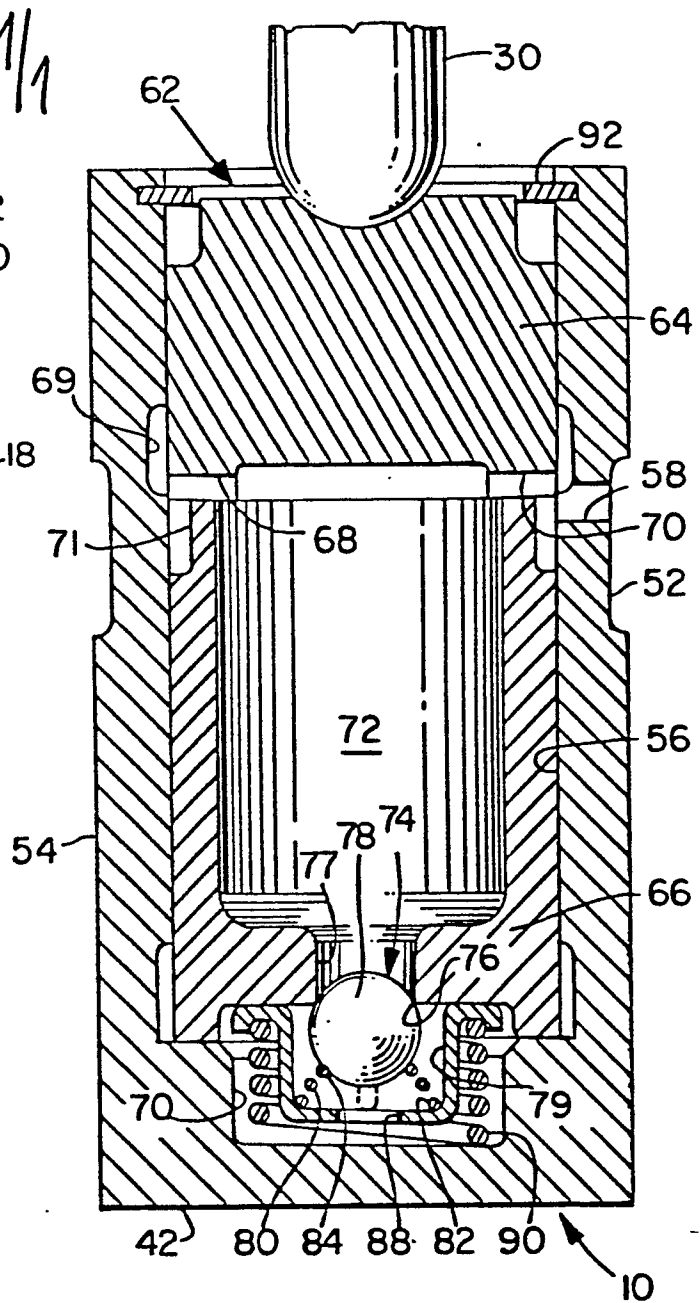


FIG. 2

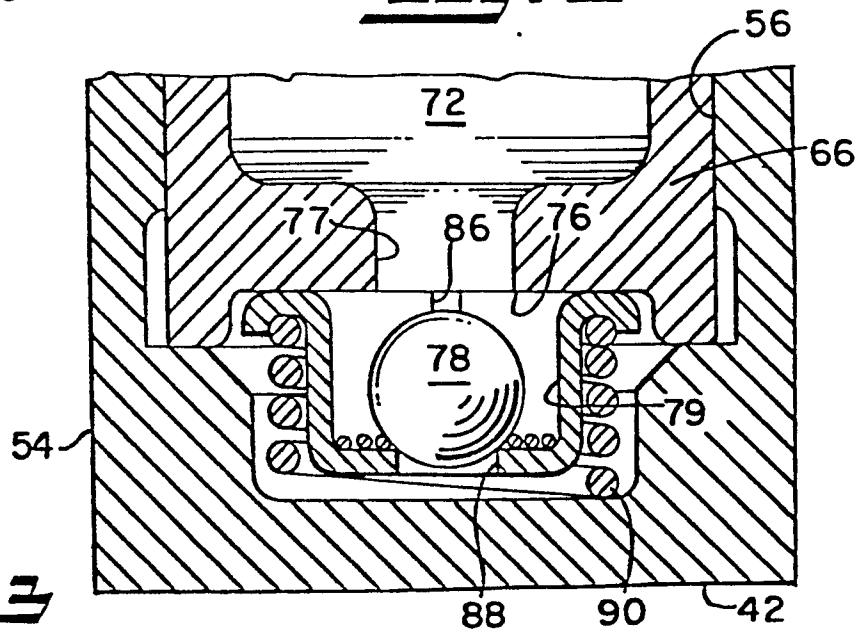


FIG. 3



| DOCUMENTS CONSIDERED TO BE RELEVANT |                                                                                                          |                                                | CLASSIFICATION OF THE APPLICATION (Int. Cl. <sup>3</sup> )                                                                                                                                                                                                                 |
|-------------------------------------|----------------------------------------------------------------------------------------------------------|------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Category                            | Citation of document with indication, where appropriate, of relevant passages                            | Relevant to claim                              |                                                                                                                                                                                                                                                                            |
| X                                   | <u>US - A - 3 605 707</u> (EATON YALE)<br>* Column 1, line 1 - column 2, line 70; column 8, lines 3-47 * | 1,2,3                                          | F 01 L 1/24                                                                                                                                                                                                                                                                |
|                                     | --                                                                                                       |                                                |                                                                                                                                                                                                                                                                            |
|                                     | <u>US - A - 4 083 334</u> (RONCON)<br>* Column 7, lines 1-62 *                                           | 1,2,3                                          |                                                                                                                                                                                                                                                                            |
|                                     | --                                                                                                       |                                                |                                                                                                                                                                                                                                                                            |
|                                     | <u>US - A - 3 450 228</u> (GENERAL MOTORS)<br>* Figure 2; column 2, line 54 to column 3, line 74 *       | 1,2,3                                          | TECHNICAL FIELDS SEARCHED (Int. Cl. <sup>3</sup> )<br><br>F 01 L                                                                                                                                                                                                           |
|                                     | --                                                                                                       |                                                |                                                                                                                                                                                                                                                                            |
|                                     | <u>US - A - 3 967 602</u> (BROWN)<br>* Column 6, lines 10-17 *                                           | 1,2,3                                          |                                                                                                                                                                                                                                                                            |
|                                     | --                                                                                                       |                                                |                                                                                                                                                                                                                                                                            |
| A                                   | <u>US - A - 4 164 917</u> (CUMMINS)<br>* Column 1, lines 5-35 *                                          | 1                                              |                                                                                                                                                                                                                                                                            |
|                                     | ----                                                                                                     |                                                |                                                                                                                                                                                                                                                                            |
|                                     |                                                                                                          |                                                | CATEGORY OF CITED DOCUMENTS                                                                                                                                                                                                                                                |
|                                     |                                                                                                          |                                                | X: particularly relevant<br>A: technological background<br>O: non-written disclosure<br>P: intermediate document<br>T: theory or principle underlying the invention<br>E: conflicting application<br>D: document cited in the application<br>L: citation for other reasons |
|                                     |                                                                                                          |                                                | &: member of the same patent family, corresponding document                                                                                                                                                                                                                |
| X                                   | The present search report has been drawn up for all claims                                               |                                                |                                                                                                                                                                                                                                                                            |
| Place of search<br>The Hague        |                                                                                                          | Date of completion of the search<br>11-02-1981 | Examiner<br>WASSENAAR                                                                                                                                                                                                                                                      |