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(54) **Power blade for throttle assembly**

(57) A method and apparatus is provided for driving a throttle blade (14) about an axis of rotation (24) between maximum and minimum airflow positions. The throttle assembly includes a throttle body (12) with an airflow passage (18) and a bore (22) intersecting the airflow passage for supporting a throttle shaft (16). The throttle blade is mounted on the throttle shaft for rotation with respect to the shaft between the maximum and minimum airflow positions. The throttle blade has a disc-shaped body (32) with a central bore (34) extending therethrough for receiving a drive mechanism (26). The drive mechanism includes a motor (28) operably connected to a gear drive (30) to move the throttle blade between the maximum and minimum airflow positions. A position sensor (42) is also mounted within the bore to monitor the position of the blade relative to the shaft.

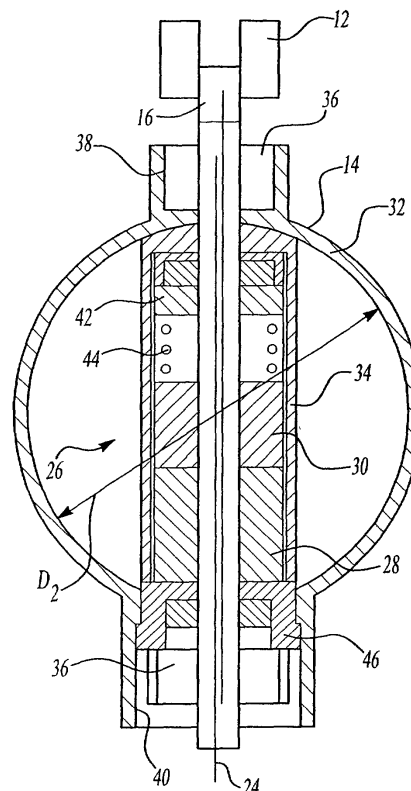


Fig-3

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention.

[0001] This invention relates to a method and apparatus for rotating a throttle blade on a throttle shaft between maximum and minimum airflow positions. Specifically, a drive assembly is mounted within the throttle blade to move the blade between various airflow positions.

2. Related Art.

[0002] Throttle valves typically include a throttle blade or disc attached to a throttle shaft, which extends across a bore formed in a throttle body. The throttle blade rotates within the bore to control air flow from an intake manifold to a vehicle engine. A pair of bearings is supported within the bore to facilitate rotation of the throttle shaft.

[0003] A motor and geardrive are typically mounted to one side of the throttle body to provide the power necessary to rotate the throttle blade within the throttle body. A position sensor is also mounted to the throttle body to monitor the position of the shaft within the bore. Multiple assembly operations are required to assemble the various components. The bearings are installed within the throttle body, the blade is mounted to the shaft, the shaft is assembled into the throttle body, the motor and geardrive are mounted to the body, and the position sensor is mounted to the body. This assembly process is labor intensive and time consuming.

[0004] Another disadvantage with this assembly process is that the mounting of the position sensor, motor, and geardrive to the throttle body takes up valuable packaging space. Thus, it is desirable to provide and improved drive mechanism and position sensor in a more modular form that is easy to install, and which overcomes the above referenced deficiencies with prior art systems.

SUMMARY OF THE INVENTION

[0005] The subject invention provides a drive assembly that is mounted within a throttle blade for controlling the rotational movement of the blade within a throttle body. A position sensor is also mounted within the blade to monitor the position of the blade relative to a blade supporting throttle shaft. The mounting of the drive assembly and the position sensor within the blade eliminates the need to provide separate exterior mounting of such components on the throttle body. This provides a more modular design that decreases assembly time and cost.

[0006] In a disclosed embodiment of this invention, a throttle assembly includes a throttle body with an airflow

passage defining a longitudinal axis and having a bore intersecting the airflow passage. The bore defines an axis of rotation that is transverse to the longitudinal axis. A throttle shaft is supported within the bore and a throttle blade is mounted on the throttle shaft for rotation about the axis of rotation. The blade rotates within the airflow passage between a maximum airflow position and a minimum airflow position. A drive mechanism is secured to the throttle blade to move the blade between the maximum and minimum airflow positions.

[0007] In a preferred embodiment, the blade is comprised of a disc-shaped body having a central bore extending therethrough. The drive mechanism is housed within the bore to control rotation of the blade. Preferably, the blade is mounted on the shaft with at least one bearing so that the shaft remains stationary while the blade rotates on the shaft. A position sensor can optionally be mounted within the bore to monitor the position of the blade relative to the shaft and for generating a signal representing the blade position that can be utilized by an electronic throttle control system.

[0008] The method for driving the throttle blade between maximum and minimum airflow positions includes the following steps. The throttle body is provided with an airflow passage defining a longitudinal axis and a bore intersecting the airflow passage. A throttle shaft is mounted within the bore and a throttle blade is mounted on the shaft for rotation about the axis of rotation. A drive mechanism is secured to the throttle blade and the blade is driven between the maximum and minimum airflow positions by the drive mechanism. Additional steps include forming a central bore within the blade and installing the drive mechanism within the bore and mounting a position sensor within the bore to monitor the position of the blade relative to the shaft.

[0009] These and other features of the present invention can be best understood from the following specification and drawings, the following of which is a brief description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

Figure 1 is side schematic view of a throttle assembly with a throttle blade incorporating the subject invention in the maximum airflow position.

Figure 2 is a view similar to Figure 1 but showing the throttle blade in the minimum airflow position.

Figure 3 is a cross-sectional view of the throttle blade shown in Figures 2 and 3.

Figure 4 is an enlarged view of Figure 3.

Figure 5 is a schematic view of one embodiment of a drive mechanism.

DETAILED DESCRIPTION OF AN EXEMPLARY EMBODIMENT

[0011] A throttle assembly 10, shown in Figure 1, includes a throttle body 12, a throttle disc or blade 14, and a throttle shaft 16. Throttle body 12 has an airflow passage 18 that defines a longitudinal axis 20. The throttle blade 14 rotates within the passage 18 to control air flow from an intake manifold to a vehicle engine (not shown).

[0012] The body 12 also includes a transversely extending bore 22 that intersects the airflow passage 18. The bore 22 defines an axis of rotation 24 that is transverse to the longitudinal axis 20.

[0013] The throttle shaft 16 is supported within the bore 22 such that the shaft 16 remains stationary, i.e., there is no relative motion between the shaft 16 and the blade 14 as the blade rotates within the passage 18. The throttle blade 14 is mounted on the throttle shaft 16 for rotation about the axis of rotation 24 and within the airflow passage 18. The blade 14 rotates between a maximum airflow position, shown in Figure 1 where a maximum amount of air is permitted to flow through passage 18, and a minimum airflow position, shown in Figure 2 where a minimum amount of air is permitted to flow through passage 18.

[0014] A drive mechanism 26 is secured to the throttle blade 14 for moving the throttle blade 14 between the maximum and minimum airflow positions. The drive mechanism 26 is shown in greater detail in Figures 3 and 4. The drive mechanism 26 includes a motor 28 and a geardrive or gearbox 30. The motor 28 drives the gearbox 30 to rotate the blade 14 with respect to the shaft 16.

[0015] The throttle blade 14 includes a disc-shaped body 32 having a predetermined diameter D1 and a thickness "t". The body 32 has a central bore 34 having a predetermined diameter D2 that extends through the body 32 in a direction along the first diameter D1. The shaft 16 is received within the bore 34. Preferably at least one bearing assembly or bushing 36 is mounted within the bore 34 to rotatably support the blade 14 with respect to the shaft 16. In one embodiment, a first bearing assembly 36 is mounted at one end 38 of the bore 34 and a second bearing assembly 26 is mounted at an opposite end 40 of the bore 34.

[0016] The drive mechanism 26 is also mounted within the bore 34 to provide a compact, modular assembly. Preferably the motor 28 and the gearbox 30 are concentrically mounted on the shaft 16 within the bore 34.

[0017] In the preferred embodiment, a position sensor 42 is mounted within the blade 14 for monitoring the position of the blade 14 relative to the shaft 16 and/or bearings 36. A spring assembly 44 having a predetermined load is mounted between the position sensor 42 and the gearbox 30. The spring 44 ensures automatic closing of the blade 14 in the event of motor de-activation. The spring 44 preferably has an adjustable stop to operate in combination with a second spring to ensure that the blade 14 can be made to automatically stop at a slightly

open position if desired.

[0018] Any type of position sensor known in the art can be used to determine the blade position including a thick film potentiometer with current supplied via flex cables or slip rings or a sensor having current supplied via radio frequency (RF) or inductive circuitry. Thus, any contact or non-contact type sensor could be used.

[0019] The method for driving the throttle blade 14 between maximum and minimum airflow positions includes the following steps. The throttle shaft 16 is mounted within the throttle body bore 22. The blade 14 is mounted on the shaft 16 for rotation about the axis of rotation 24. The drive mechanism 26 is secured to the throttle blade 14 and the blade 14 is driven between the maximum and minimum airflow positions with the drive mechanism 26. Additional steps include forming a central bore 34 within the blade 14 and installing the drive mechanism 26 within the bore 34 and mounting the shaft 16 to the blade 14 with at least one bearing assembly 36 such that the blade 14 rotates with respect to the shaft 16.

[0020] The throttle blade 14 is preferably made from a plastic material and the body 32 includes an enlarged center section. Preferably, a plurality of ribs 54, shown in Figure 4, are formed along the exterior surface of the body 32 and are orientated transverse to the axis of rotation 24. The enlarged center section is a hollow section that defines the central bore 34. The drive mechanism 26 mounted within the bore 34 preferably includes a small electric motor 28 and gearbox 30 of the epicyclic type, shown in Figure 5. The motor 28 and gearbox 30 are arranged so that the application of a current to the motor terminal via an electrical connection 46 well known in the art, results in rotary motion of the blade 14 on the axis 24 which is parallel to motor's axis of rotation. The motor polarity is arranged so that current in one direction produces blade rotation in one direction and current in an opposite direction produces blade rotation in an opposite direction. The blade 14 and motor 28 include bearings so that the entire assembly can be rotatably mounted into the throttle body 12.

[0021] One embodiment of the motor 28 and gearbox 30 is shown in Figure 5. The motor 28 has an output shaft 48 that drives a plurality of gears 50. The output shaft 48 acts like a sun gear that drives the planet gears 50. The planet gears 50 are in driving engagement with a ring gear 52. The gearbox 30 and gears 50, 52 are arranged so that the motor shaft torque is amplified at the blade 14. The amplification ratio will be typically in the range of 10:1 to 30:1, however other amplification ratios could also be used depending on the application.

[0022] The diameter of the motor 28 is in the range of 10 mm to 25 mm and the enlarged section (defining the bore 34) preferably has a wall thickness of 1 mm to 3 mm. As discussed above, one end of the enlarged section houses the position sensor 42 to detect the position of the blade 14 relative to the bearing end mounts 36.

[0023] The air passage 18 is defined by a third diam-

eter D3. This air flow diameter D3 must be increased to accommodate the increased size of the enlarged section of the blade 14 so that an adequate amount of air is allowed to flow through the passage 18. For example, a current 52 mm bore diameter throttle body 12 will have a predetermined air flow area "A" that is partially obstructed by the blade 14 and the shaft 16. If the shaft is 10 mm in diameter, the air flow area A at the maximum airflow position is equal to the shaft diameter Ds times the third diameter subtracted from the quantity of pi times the third diameter squared divided by four ($A = (BD^3/4) - (D3 * Ds)$). To obtain an equivalent flow area with a blade 14 that has an enlarged center section (assuming the motor has an 18 mm diameter and the wall thickness is 1.5 mm around the motor 28) the third diameter will be approximately 61.5mm, with the blade 14 having an overall 21 mm diameter "shadow area" when in the maximum airflow position, i.e., wide open throttle. The difference between these two examples is 1603.8 square millimeters for the 52 mm air passage bore D3 and 1679.45 square millimeters for the enlarged section blade design. Thus, the performance characteristics would remain relatively the same for the enlarged section blade design with only a slight increase in air passage bore size. The time to fully open or close the blade 14 would be typically 60-120 milliseconds. The power supply would be nominally 12 volts and maximal torque on the blade at motor stall would be between .5 and 2.5 Newton meters. Durability of the assembly would last several million cycles of moving between open and closed positions.

[0024] The improved blade design is lower cost than existing spur gear and motor designs and allows smaller motors and gears to be used, which reduces the overall weight. The integration of the driving mechanism into the blade provides a modular design where one interior blade assembly can be made for several different air passage bore diameter sizes. When used in combination with a plastic throttle body, the air flow path can be adapted to suit an extremely wide range of air flow requirements all with the same blade assembly.

[0025] The subject invention provides a drive assembly that is mounted within a throttle blade for controlling the rotational movement of the blade within a throttle body. The compact drive mechanism 26 can be utilized in a gasoline powered vehicle with or without electronic throttle control or can be utilized in an electric vehicle, hybrid vehicle, or other alternatively powered vehicle. A position sensor is optionally mounted within the blade to monitor the position of the blade relative to a blade supporting throttle shaft. The mounting of the drive assembly and the position sensor within the blade eliminates the need to provide separate exterior mounting of such components on the throttle body. This provides a more modular design that decreases assembly time and cost.

[0026] Although a preferred embodiment of this invention has been disclosed, it should be understood that

a worker of ordinary skill in the art would recognize many modifications come within the scope of this invention. For that reason, the following claims should be studied to determine the true scope and content of this invention.

Claims

1. A throttle assembly comprising:

a throttle body having an airflow passage defining a longitudinal axis and a bore intersecting said airflow passage and defining an axis of rotation that is transverse to said longitudinal axis;
a throttle shaft supported within said bore;
a throttle blade mounted on said throttle shaft for rotation about said axis of rotation and within said airflow passage between a maximum airflow position and a minimum airflow position; and
a drive mechanism secured to said throttle blade for moving said throttle blade between said maximum and minimum airflow positions.

2. An assembly according to claim 1 wherein said throttle blade includes a disc-shaped body having a central bore extending therethrough for receiving said shaft, said drive mechanism being mounted within said bore.

3. An assembly according to claim 1 wherein said drive mechanism includes a motor and a gear drive mounted within said blade.

4. An assembly according to claim 1 including a position sensor mounted within said blade for monitoring the position of said blade relative to said shaft.

5. An assembly according to claim 1 including at least one bearing assembly for mounting said blade for rotation with respect to said shaft.

6. An assembly according to claim 5 wherein said shaft is fixedly mounted to said throttle body.

7. A method for driving a throttle blade between maximum and minimum airflow positions comprising the steps of:

- (a) providing a throttle body with an airflow passage defining a longitudinal axis and a bore intersecting the airflow passage and defining an axis of rotation that is transverse to the longitudinal axis;
- (b) mounting a throttle shaft within the bore;
- (c) mounting a throttle blade on the shaft for ro-

tation about the axis of rotation;
 (d) securing a drive mechanism to the throttle blade; and
 (e) driving the blade between the maximum and minimum airflow positions with the drive mechanism.

8. A method according to claim 7 including the step of mounting the shaft to the blade with at least one bearing assembly such that the blade rotates with respect to the shaft. 10

9. A method according to claim 8 including the step of sensing the position of the blade relative to the bearing assembly. 15

10. A method according to claim 8 including the step of forming a central bore within the blade and installing the drive mechanism within the bore. 20

11. A throttle assembly comprising:

a throttle body having an airflow passage defining a longitudinal axis and a bore intersecting said airflow passage and defining an axis of rotation that is transverse to said longitudinal axis; 25

a throttle shaft supported within said bore;
 a throttle blade mounted on said throttle shaft for rotation about said axis of rotation between a maximum airflow position and a minimum airflow position, said throttle blade having a disc-shaped body with a central bore extending therethrough; and 30

a drive mechanism mounted within said central bore for moving said throttle blade between said maximum and minimum airflow positions. 35

12. The assembly according to claim 11 wherein said drive mechanism includes a motor and a geardrive. 40

13. The assembly according to claim 12 wherein said motor and geardrive are concentrically mounted within said central bore. 45

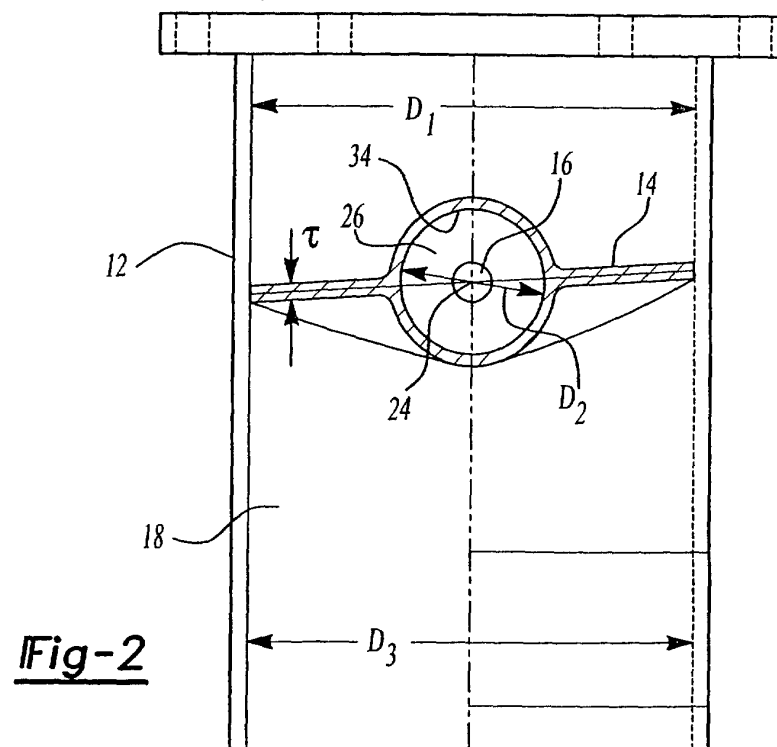
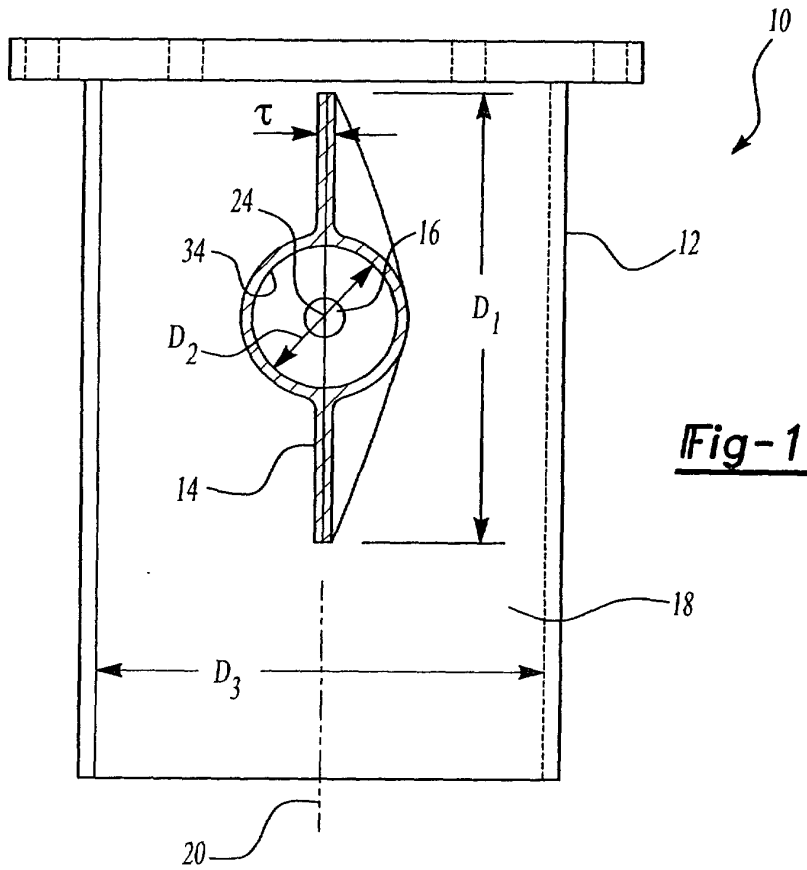
14. The assembly according to claim 12 including a first bearing mounted at one end of said central bore and a second bearing mounted at an opposite end of said central bore for rotatably supporting said blade with respect to said shaft. 50

15. An assembly according to claim 14 wherein said throttle shaft is secured to said throttle body such that there is no relative motion between said throttle shaft and said throttle body. 55

16. An assembly according to claim 15 wherein said disc-shaped body has a predetermined thickness

and said central bore defines a bore diameter that is greater than said thickness.

17. An assembly according to claim 12 including a position sensor mounted within said central bore to monitor the position of said blade relative to said shaft.



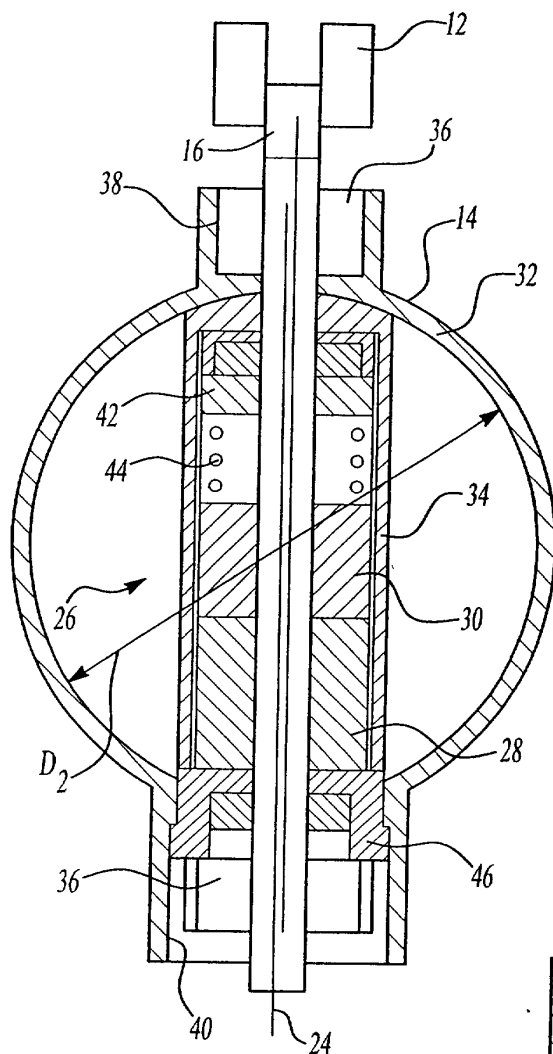


Fig-3

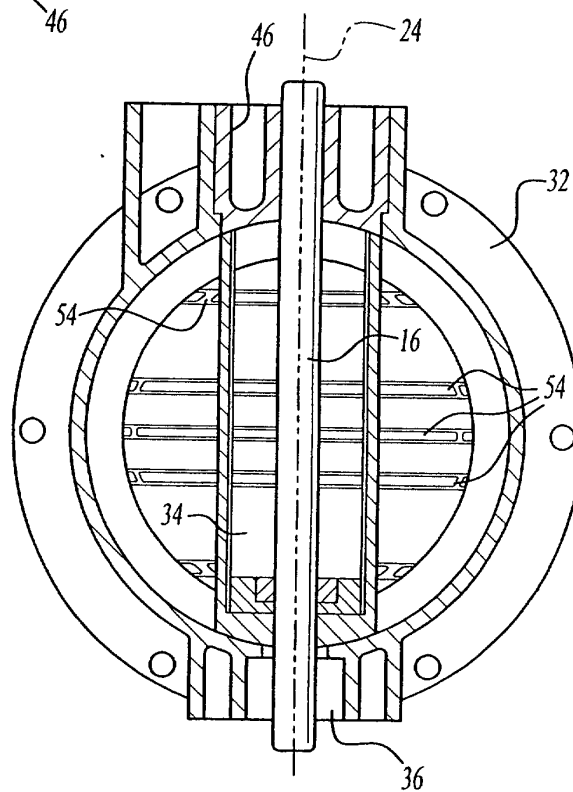


Fig-4

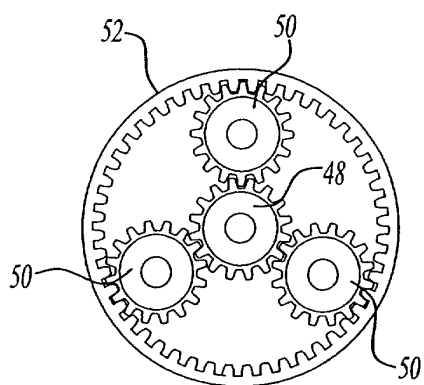


Fig-5



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 20 0270

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Place of search THE HAGUE		Date of completion of the search 25 June 2001	Examiner Joris, J
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

EPO FORM 1503 03/82 (F04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 01 20 0270

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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