United States Patent

Nakajima

[15] **3,675,632**

[45] **July 11, 1972**

[54] INTAKE MANIFOLD VACUUM CONTROL SYSTEM

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[73] Assignee: **Nissan Motor Company Limited,** Yokohama, Japan

[22] Filed: **April 2, 1971**

[21] Appl. No.: **130,835**

Related U.S. Application Data

[63] Continuation of Ser. No. 808,259, March 18, 1969, abandoned.

[52] **U.S. Cl.**.....**123/97 B,** 123/119 D, 123/124 R, 123/117 A, 261/44, 261/50 A, 261/DIG. 19

[51] **Int. Cl.**.....**Fo2m 7/12,** F02d 9/00

[58] **Field of Search**.....123/97 B, 124 R, 119 D, 117.1; 261/DIG. 19, 44, 50 A, 56

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Primary Examiner—Wendell E. Burns
Attorney—Robert E. Burns

[57] **ABSTRACT**

System for reducing the amount of hydrocarbons contained in the exhaust gases emitted from an automotive gasoline-powered engine having a carburetor of variable venturi type during the deceleration of the automobile. The hydrocarbon content of the engine exhaust gases is reduced during the deceleration by lowering the vacuum at the intake manifold of the engine through introduction of a proper amount of air-fuel mixture into the intake manifold by way of an additional bypass passage and under the control of a specially constructed valve.

3 Claims, 6 Drawing Figures

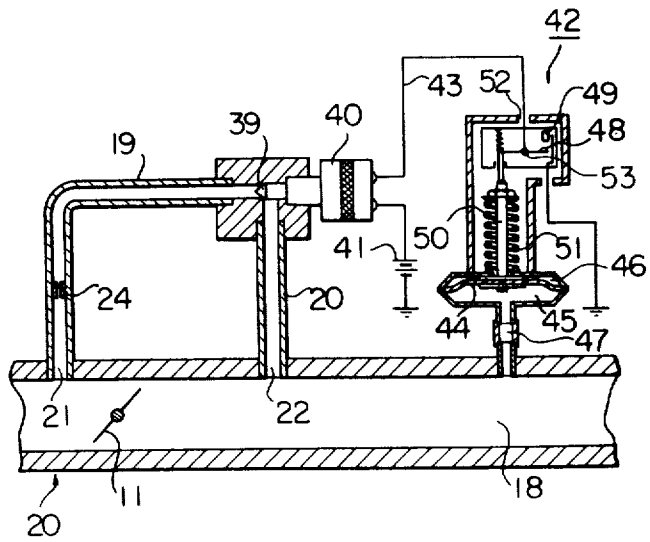


Fig. 1

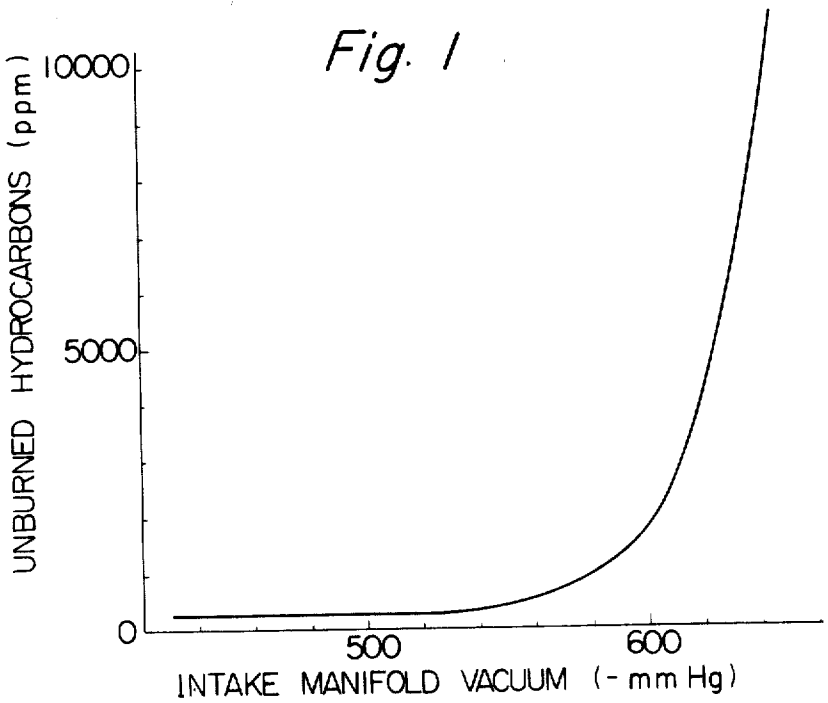

UNBURNED HYDROCARBONS (ppm)
10000
5000
0
500
600
INTAKE MANIFOLD VACUUM (- mm Hg)

Fig. 2

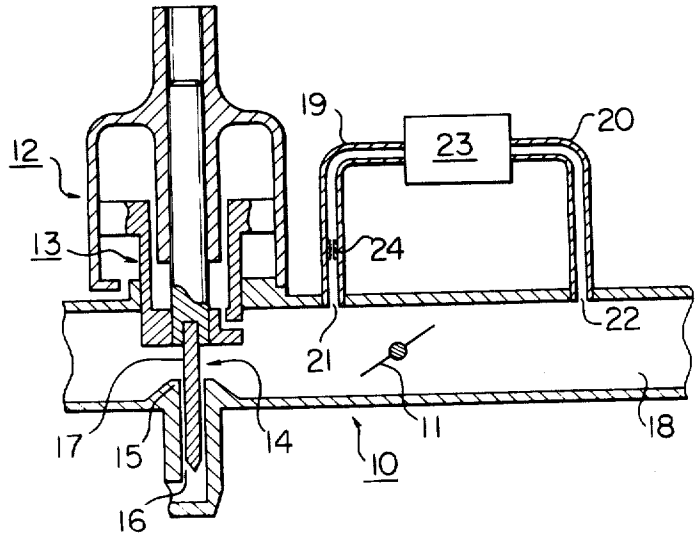

12
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Fig. 3

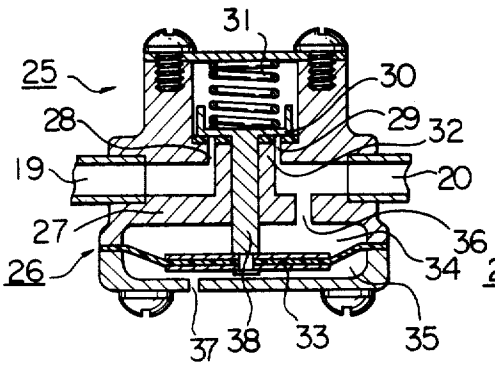


Fig. 4

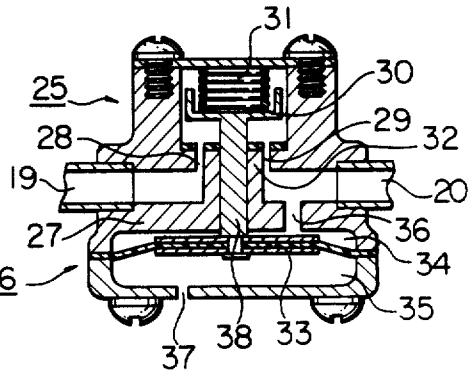


Fig. 5

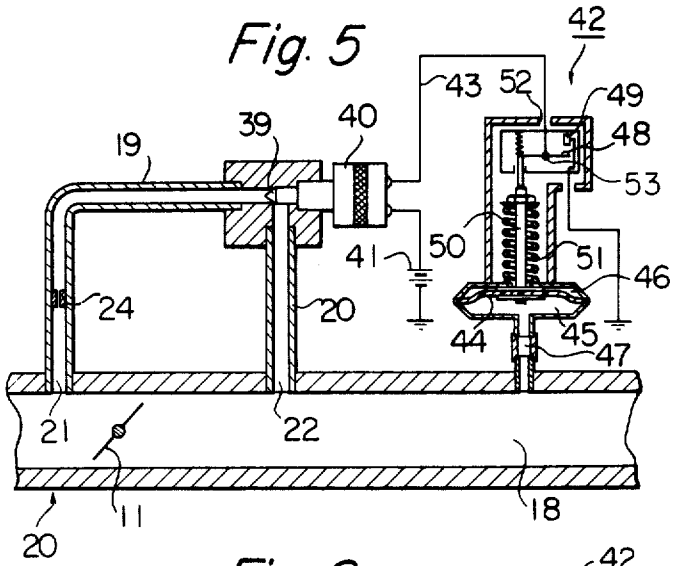
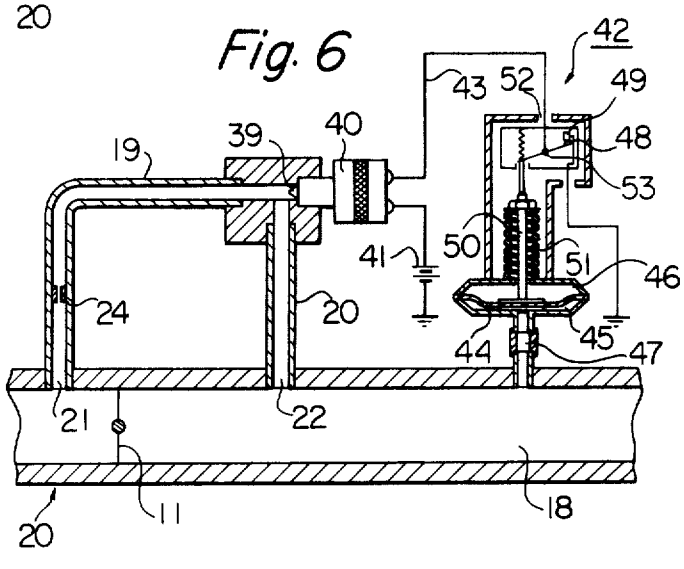


Fig. 6



INTAKE MANIFOLD VACUUM CONTROL SYSTEM

This application is a continuation of application Ser. No. 808,259 filed Mar. 18, 1969 now abandoned.

The present invention relates to system for reducing the amount of hydrocarbons contained in the exhaust gases that are emitted from the gasoline-powered internal combustion engine having a carburetor of variable venturi type and, more particularly, to a system which is adapted to introduce an appropriate amount of air-fuel mixture into the intake manifold of the engine during the deceleration of the automobile whereby the vacuum at the intake manifold is lowered to such a level that is optimum for reducing the hydrocarbon content of the exhaust gases to a minimum.

As is will known, the vacuum at the intake manifold of an engine increases abruptly during the deceleration of the automobile when the throttle valve of the carburetor is kept substantially fully closed. Experiments have revealed that the vacuum at the intake manifold often exceeds the level of about 650mm of Hg when in the deceleration, while it remains less than 500mm of Hg during the idle operation. This is entirely due to the fact that the throttle valve of the carburetor is substantially closed during the deceleration so as to shut off the flow of an air-fuel mixture to the intake manifold although the engine continues to operate at a relatively high speed which is proportioned to the running speed of the automobile. The intake manifold vacuum that has increased to such a high level results in unsatisfactory combustion and misfire of the air-fuel mixture in the combustion chamber of the engine, giving rise to the hydrocarbon content of the engine exhaust gases emitted unburned or partially burned during the deceleration.

This will import that the hydrocarbon content of the engine exhaust gases could be lessened if the vacuum at the intake manifold is lowered to a certain level. Attempts have therefore been made to control the vacuum at the intake manifold with a view to reducing the amount of the unburned compounds of the engine exhaust gases. These attempts include two major systems, one to let the throttle valve of the carburetor slightly open to permit the air-fuel mixture to flow through the throttle valve in a predetermined volume even during the deceleration and the other to supply a predetermined amount of atmospheric air to the intake manifold in response to the decrease in the automobile speed.

In order to let the throttle valve of the carburetor slightly open during the deceleration, it is essential that the valve and the associated parts be designed and machined with utmost preciseness. When, moreover, the engine has been put on prolonged use, meticulous readjustment of the carburetor settings will be required to suit the alterations in the idle adjustment. The system of the former type is thus considered as lacking in practicability.

Introduction of atmospheric air into the intake manifold during the deceleration as put into practice in the system of the later type, on the other hand, will cause the air-fuel mixture to become too lean to assure satisfactory combustion of the mixture in the combustion chamber of the engine, sometimes resulting in further increase in the amount of unburned hydrocarbons in the exhaust gases.

A primary object of the present invention is therefore to provide a system which is adapted for effectively reducing the amount of hydrocarbons in the engine exhaust gases emitted during the deceleration of the automobile.

Another primary object of the invention is to provide a system which is adapted to lower the vacuum at the intake manifold of the engine for reducing the hydrocarbon content of the exhaust gases during the deceleration.

A further primary object of the invention is to provide a system for introducing an air-fuel mixture which is appropriate in volume and mixture ration into the intake manifold of the engine in close response to the rapid rise in the vacuum at the intake manifold for thereby lowering the said vacuum to such a level that is appropriate for suppressing the emission of unconsumed fuel from the combustion chamber of the engine.

These and other objects and features of the present invention will become apparent from the following description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a graphical representation of a typical example of the relationship between the intake manifold vacuum and the amount of unburned hydrocarbons;

FIG. 2 is a view showing, largely in a vertical section, the general construction of the system according to the invention;

FIG. 3 is a view showing, in a vertical section, a preferred embodiment of the flow control assembly used in the system according to the invention, the valve arrangement being shown to be under the full or part throttle operation of the automobile;

FIG. 4 is a view similar to FIG. 3 but showing the flow control assembly under the decelerating operation;

FIG. 5 is a view showing, largely in a vertical section, the overall construction of a modified form of the system of the invention under the part-throttle operation; and

FIG. 6 is a view similar to FIG. 5 but showing the same system under the deceleration.

Now, FIG. 1 is presented to explain how sharply the amount of hydrocarbons contained in the exhaust gases increases if the intake manifold vacuum rises in excess of 600mm of Hg or more while it remains substantially negligible as long as the intake manifold vacuum is kept lower than about 550 mm of Hg. To reduce the unburned hydrocarbon content of the engine exhaust gases to a minimum, therefore, it would be the best approach to have the intake manifold vacuum lowered down to 550 mm of Hg from the purely theoretical point of view. It is, however, empirically known that reduction in the intake manifold vacuum to such a low level is detrimental to the driveability of the automobile, especially the braking performance of the engine and, hence, the reasonable level to which the intake manifold vacuum should be lowered with satisfactory results is considered to lie in the neighborhood of 600 mm of Hg for all practical reasons.

Referring now to FIG. 2, the system according to the present invention is intended for installation in a carburetor of variable venturi type consisting largely of a carburetor body 10, a throttle valve 11 mounted within the carburetor body, a flow control assembly 12 having a suction piston 13, a venturi 14 defined by the bottom wall of the suction piston 13 and a venturi bridge 15, a fuel jet 16 opening at the bridge 15 into the carburetor body, and a jet needle 17 secured to the bottom wall of said suction piston 13 and movably inserted into the fuel jet 16. The sectional area of the venturi 14 is changed with the mechanical displacement of the piston 13 which moves up and down with the fluctuation in the gas pressure in the carburetor upstream of the throttle valve 11 so as to regulate the flow of the air and fuel into the engine combustion chamber (not shown). Discussion of further detailed construction and function of the carburetor to which the system of the present invention is directed is herein omitted for the shake of simplicity of description, because the carburetor of the type per se is well known to those skilled in the art.

During the deceleration of the automobile, as already mentioned, the throttle valve 11 is kept substantially fully closed to shut off the flow of an air-fuel mixture to the engine combustion chamber (not shown) with the result that the vacuum at the intake manifold 18 increases sharply to an extremely high level, say, up to about 650 mm of Hg. The engine still operating at a relatively high speed proportioned to the running speed of the automobile, such a high vacuum built up at the intake manifold causes an unsatisfactory combustion and misfire in the engine combustion chamber.

To avoid such difficulties, there is provided on the carburetor an additional bypass passages which is adapted to draw a predetermined amount of air-fuel mixture to the engine combustion chamber even during the deceleration, according to the present invention.

The bypass passages, as indicated at 19 and 20 in FIG. 2, have their inlet 21 located downstream of the venturi 14 and

upstream of the throttle valve 11 and their outlet 22 located downstream of the throttle valve 111 or at the intake manifold 18 of the engine. For regulating the flow of the air-fuel mixture through the passages 19 and 20 depending upon the modes of the automobile operation, a bypass flow control assembly 23 is interposed between the inlet 21 and outlet 22 of the passages. Designated at 24 is an orifice for metering the mixture immediately past the inlet 21.

The detailed construction arrangements of an example of the bypass flow control assembly 23 are illustrated in FIGS. 3 and 4. As shown, the assembly 23 comprises a valve compartment 25 and a diaphragm compartment 26, which are isolated from each other by a wall member 27.

The valve compartment 25 communicates upstream with the passage 19 by way of the auxiliary passage 28 and downstream with the passage 20 by way of the auxiliary passage 29, and has accommodated therein a valve member 30 and a coil spring 31. The valve member 30 is normally forced by the action of the coil spring 31 against the tubular projection 32 of the wall member 27, which projection thus serves as a valve seat.

The diaphragm compartment 26, on the other hand, is divided by a diaphragm member 33 into two different chambers 34 and 35. The chamber or suction chamber 34 communicates with the passage 20 through a suction vent 36, while the chamber or air chamber 35 is opened to the air through an air vent 37. The diaphragm member 33 is connected with the valve member 30 through a rod 38 which is slidably yet airtightly inserted into the tubular projection 32.

Under the full or part throttle operation, as best illustrated in FIG. 3, the vacuum at the intake manifold of the engine is kept at a relatively low level so that the diaphragm member 33 is forced toward the air chamber 35 by the action of the coil spring 31 to cause the valve member 30 to abut closely against the valve seator projection 32, whereupon the flow of the air-fuel mixture is shut off at and by the control assembly 23.

During the deceleration of the automobile when the vacuum at the intake manifold increases to an extremely high level, as aforementioned, the diaphragm member 33 is pulled over toward the suction chamber 34 so that the valve member 30 is released from the valve seat or projection 32 against the action of the coil spring 31 thereby to permit the passage 28 to communicate with the passage 29, allowing the mixture to flow into the engine intake manifold by way of the bypass passages 19 and 20, as best seen from FIG. 4.

It is important in this instance that the tension of the coil spring 31 be so determined as to overcome the force of the vacuum exercised on the diaphragm member 33 during the full and part throttle operations but to yield to the force of the higher vacuum that develops during the deceleration.

A modification of the flow control assembly as used in the system according to the present invention is illustrated in FIG. 5.

As shown, there is provided intermediate the passages 19 and 20 a needle valve member 39 which is operatively connected with a solenoid device 40. The solenoid valve device 40 may be of known construction and is arranged to function in such a manner as to keep the passages 19 and 20 closed while the device 40 remains de-energized and opened while the device 40 remains excited.

The solenoid device 40 is grounded at one terminal thereof through a power source 41 and connected at the other with a diaphragm switch assembly 42 through a wire circuit 43. The diaphragm switch assembly 42 is divided by a diaphragm member 44 into two different chambers 45 and 46. The chamber or suction chamber 45 communicates with the intake manifold 18 of the engine through a suction conduit 47. The chamber or air chamber 46 communicates with the atmosphere through the air vent 52 and has accommodated therein a moving contact 48 connected with the wire circuit 43, a stationary contact 49 which is grounded, a rod 50 mechanically connecting the moving contact 48 with the diaphragm member 44, and a coil spring 51 acting to normally hold the moving contact 48 in a position to be released from the stationary contact 49.

During the full and part throttle operations of the automobile when the vacuum at the throttle manifold 46 is maintained at a relatively low level, as shown in FIG. 5, the tension of the coil spring 51 overcomes the force of the vacuum exercised on the diaphragm member 44 so that the moving contact 48 connected with the diaphragm member through the rod 50 remains released from the stationary contact 49, thus keeping the solenoid device 40 de-energized. The result is that the needle valve member 39 intrudes into the bypass passages 19 and 20, which are consequently kept closed while in the non-decelerating operation of the automobile.

During the deceleration when the intake manifold vacuum increases abruptly to an extremely high level as illustrated in FIG. 6, the diaphragm member 44 is pulled toward the intake manifold or toward the suction chamber 45 with the result that the rod 50 which is secured to the diaphragm member 44 is moved accordingly against the action of the coil spring 51. This causes the moving contact 48 to turn around the fulcrum 53, thereby being brought into contact with the stationary contact 49. The solenoid device 40 thus becomes energized. With the solenoid device 40 thus excited, the valve member 39 is actuated to withdraw from the passages 19 and 20 so as to permit the air-fuel mixture to flow through the passages 19 and 20 down into the intake manifold of the engine.

The amount of the mixture to be delivered to the intake manifold of the engine may be determined through calibration of the orifice 24 so that the vacuum at the intake manifold 18 may be lowered to approximately 600 mm of Hg during the deceleration.

Now, it will be understood from the foregoing description that, according to the present invention, the engine can operate invariably under sound conditions and with the least emission of hydrocarbons since the vacuum at the intake manifold is maintained under a predetermined level throughout the varying driving conditions of the engine and since the engine is supplied with an air-fuel mixture which is appropriate not only in volume but in mixture ratio for satisfactory combustion in the combustion chamber of the engine even during the deceleration of the automobile.

It may also be mentioned that the reduction in the intake manifold vacuum down to 600 mm of Hg leads to increased stability of the engine driveability so that the dispersion of the concentrations of the hydrocarbon content of the engine exhaust emission can be restricted within an extremely narrow range, let alone the remarkable decrease in the amount of the hydrocarbons.

I claim:

1. In a system for supplying an appropriate amount of fuel-air mixture to an intake manifold of an automotive internal combustion engine, which system comprises a carburetor of variable venturi type with a throttle valve downstream of a variable venturi, means connecting an outlet of the carburetor to said intake manifold and a bypass passage having an inlet located downstream of said venturi and upstream of said throttle valve and an outlet located downstream of said throttle valve;

the improvement for controlling flow of a fuel-air mixture through said bypass passage comprising means including in series a flow-metering orifice and valve means for opening and closing said bypass passage, and valve actuating means responsive to a pressure difference between a vacuum in said intake manifold and an ambient atmospheric pressure for holding said valve means closed to close off flow of said fuel-air mixture when said pressure difference is less than about 550 mm of mercury and for opening said valve means to allow flow of said fuel-air mixture when said pressure difference is greater than about 550 mm of mercury, said valve means being per se essentially neutral to said intake manifold vacuum and controlled solely by said actuating means.

2. A system according to claim 1, in which said valve means and actuating means comprise a hollow valve body having a partition dividing an interior of said body into a diaphragm chamber and a valve chamber, a valve seat in said valve chamber, inlet and outlet passages opening into said valve seat, a valve member movable in said valve chamber between a closed position to close said passages and an open position to open said passages, calibrated spring means normally holding said valve member in said closed position, said valve member having a stem extending through said partition into said diaphragm chamber, a diaphragm having its periphery secured to said body and a central portion connected to said valve stem, said diaphragm dividing said diaphragm chamber into a suction chamber connected with said intake manifold and an air chamber open to the ambient atmosphere, said suction chamber and air chamber being so disposed that said diaphragm is subjected on its one side to said intake manifold vacuum and on its other side to said ambient atmospheric pressure and that said pressure difference tends to move said valve member to said open position against the action of said spring means, said spring means applying a force to hold said valve member in said closed position when said pressure difference acting on said diaphragm is less than about 550 mm of mercury.

3. A system according to claim 1, in which said valve means comprises a hollow valve body, inlet and outlet passages opening into said valve body and a valve member movable between an open position in which said passages are in communication with each other and a closed position in which said passages are closed, and in which said valve actuating means comprises solenoid means connected with said valve member and holding said valve member in said closed position when said solenoid means is deenergized and in said open position when said solenoid means is energized and electric circuit means for selectively energizing said solenoid means comprising switch means and suction responsive means for operating said switch means comprising a diaphragm chamber, a diaphragm having its periphery secured to said chamber and dividing said chamber into a suction chamber connected with said intake manifold and an air chamber open to the ambient atmosphere, calibrated spring means biasing said diaphragm toward said air chamber and means connecting said diaphragm with said switch means for closing said switch means when said pressure difference is sufficient to overcome the biasing force of said spring means, said spring means applying a force for holding said switch means in an open position and thereby said valve member in said closed position when said pressure difference acting on said diaphragm is less than about 550 mm of mercury.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,675,632 Dated July 11, 1972

Inventor(s) YASUO NAKAJIMA

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the heading insert after item "[63]" the following:

--[30] Foreign application priority data
March 23, 1968 Japan 43-18540 --

Signed and sealed this 24th day of April 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.