

- [54] DECONTAMINATION OF INTERNAL
COMBUSTION ENGINE EXHAUST GASES
AND DEVICES FOR THE
IMPLEMENTATION OF THE PROCEDURES**

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- [22] Filed: **June 30, 1970**

- [21] Appl. No.: 51,163

- [30] Foreign Application Priority Data

July 3, 1969	Austria	6390/69
Aug. 6, 1969	Austria	7589/69
Nov. 10, 1969	Austria	10547/69

- [52] U.S. Cl..... **261/41 D**, 261/65, 261/47,
48/180 A, 48/180 B

- [51] **Int. Cl.**..... **F02m 23/02**

- [58] **Field of Search**..... 261/41 D, 65

- [56]
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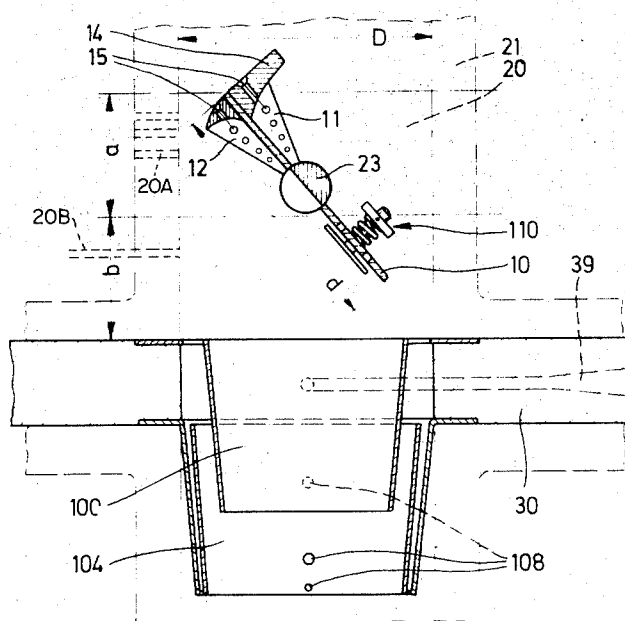
Primary Examiner—Tim R. Miles

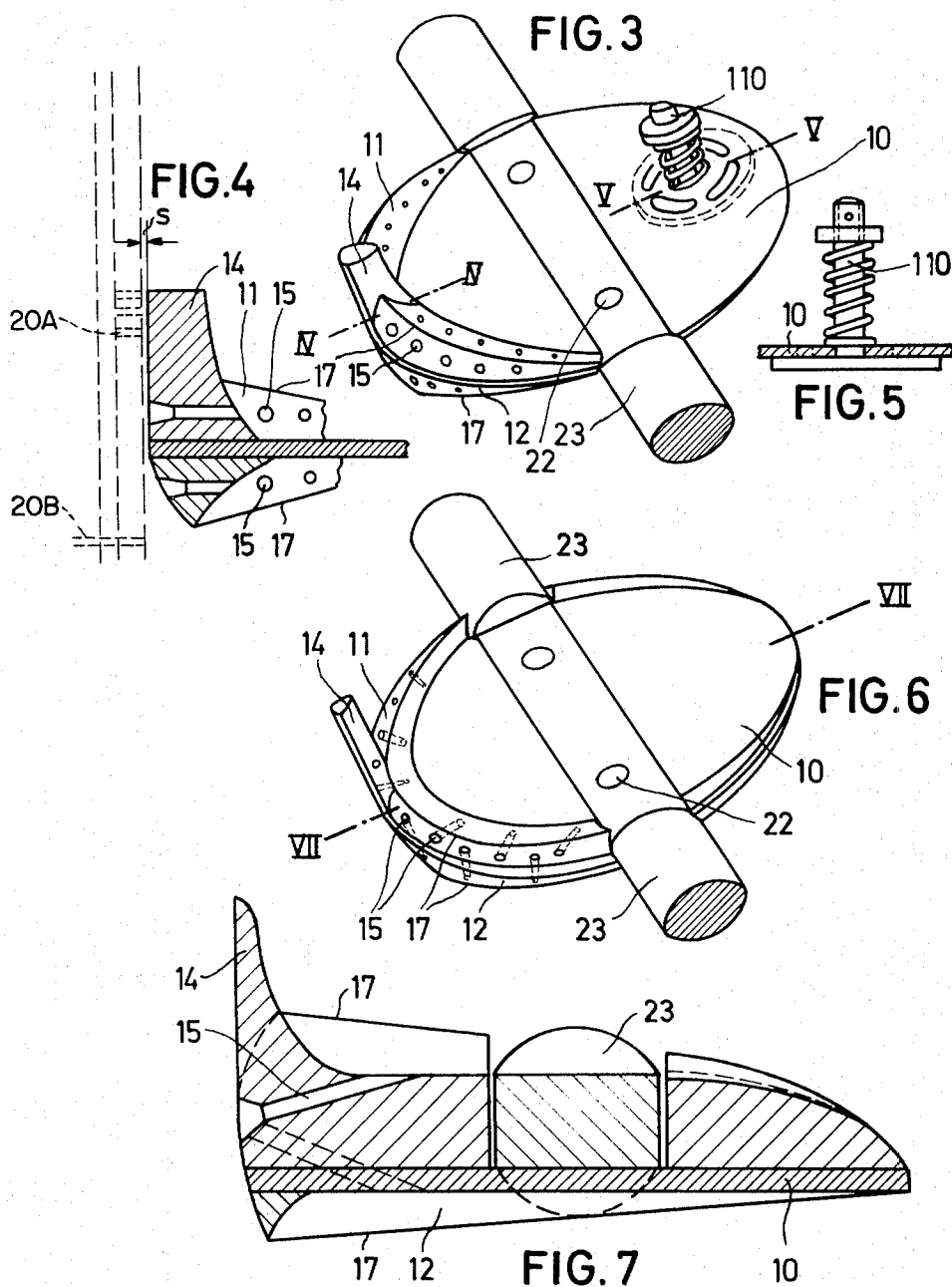
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- [57]
- ABSTRACT**

Apparatus for decontamination of internal combustion engine exhaust gases by the preparation of a flammable and ignitable air-fuel mixture with a variable air ratio figure λ by means of a throttle flap adjustment for regulating the fuel jet flow resistance, and which is adjustable such that fuel atomization is performed. This is accomplished by the fact that the airstream flowing from the air filter to the carburetor, particularly in the lower engine r.p.m. range i.e. if the throttle flap swivel range is small, is accelerated in the crescent-shaped gap between throttle flap (10) and carburetor duct wall (20), on the whole throttle flap semi-circumference facing the fuel jets, to nearly sonic or supersonic speed. Furthermore, at the throttle flap swivel range in the medium engine operating range at subsonic speed, the air stream flowing from the air filter to the carburetor is additionally accelerated by further jet effect, whereas the airstream from the air filter to the carburetor in the operating range up to full engine load is homogenized by very intensive elimination of the turbulence.

24 Claims, 21 Drawing Figures





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FIG. 8

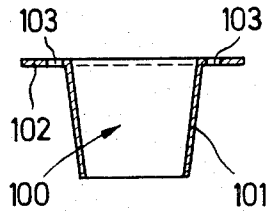


FIG. 10

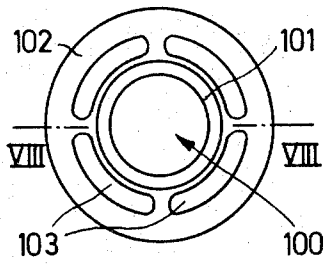
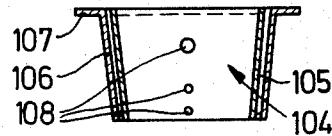


FIG. 9

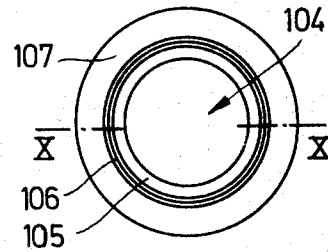


FIG. 11

FIG. 12

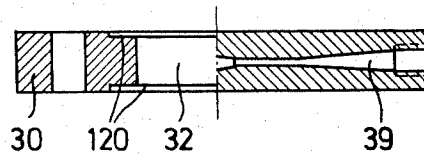
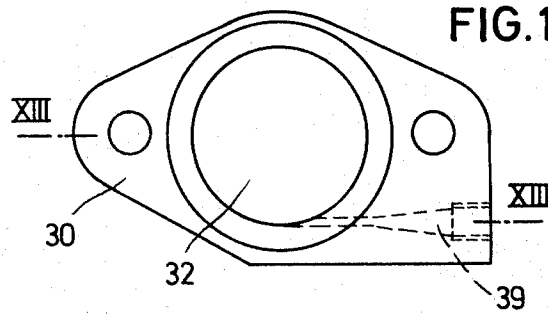


FIG. 13

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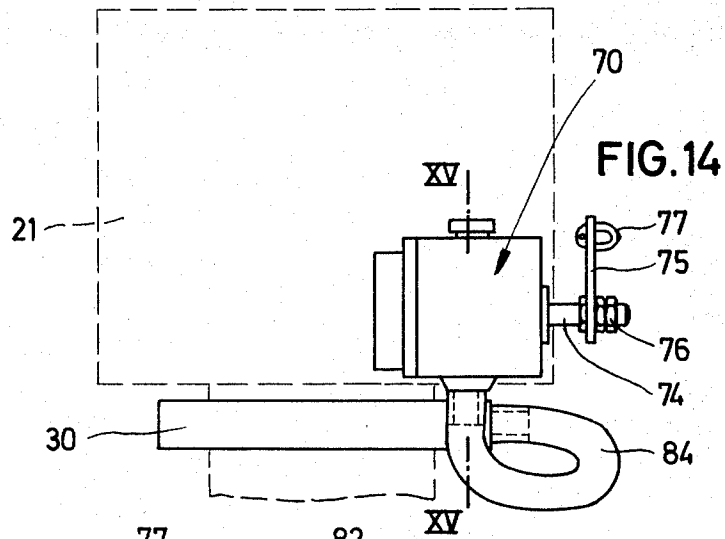


FIG. 14

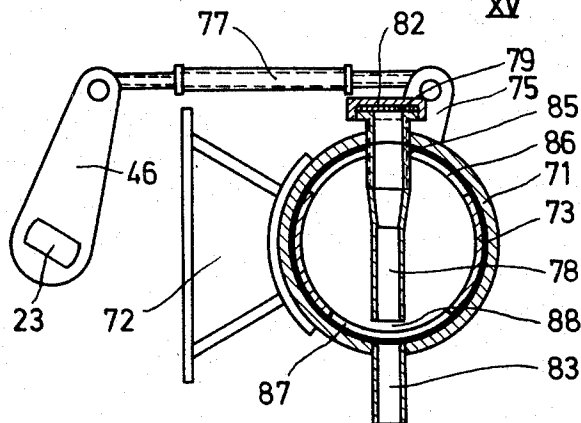


FIG. 15

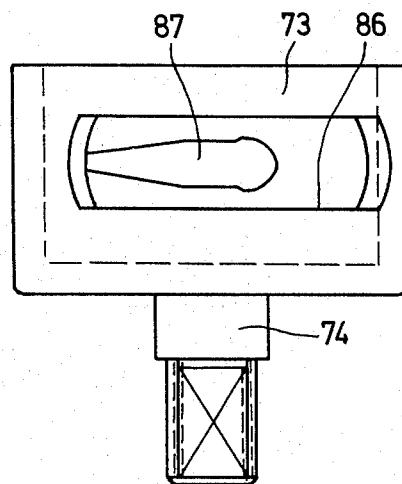


FIG. 16

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FIG. 17

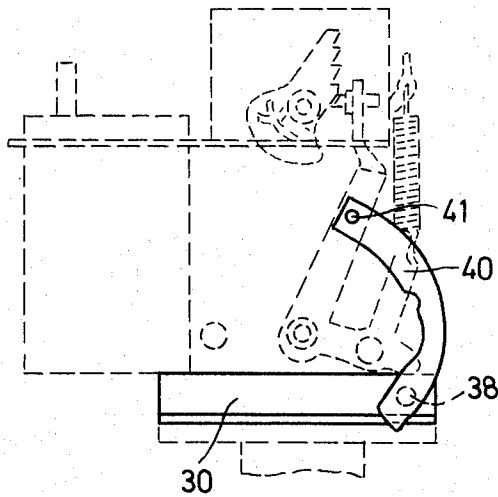


FIG. 18

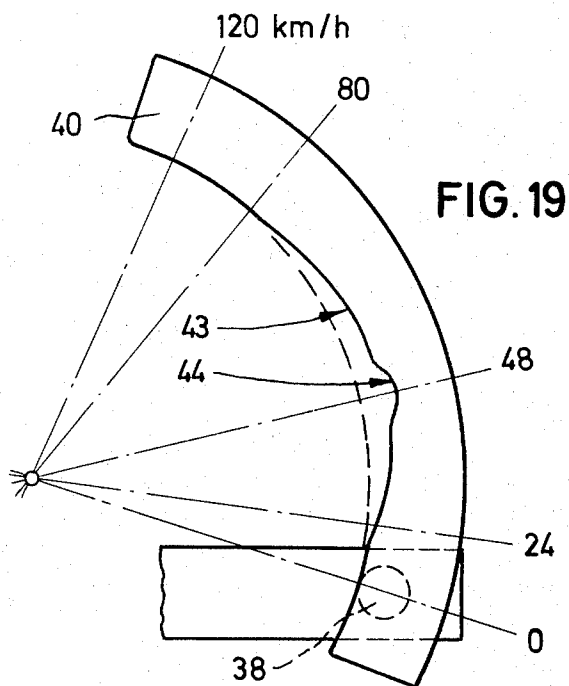
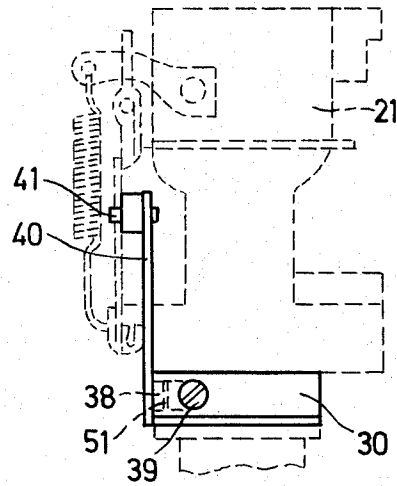


FIG. 19

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FIG. 20

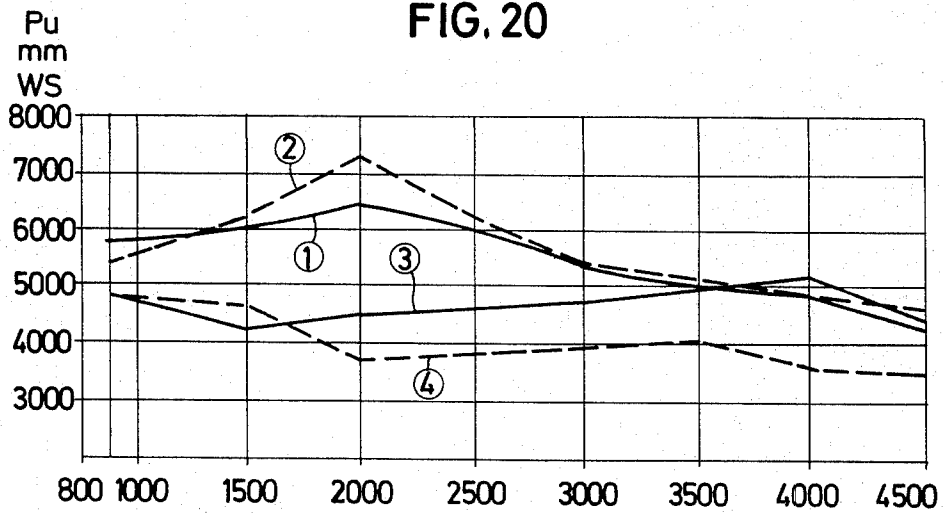
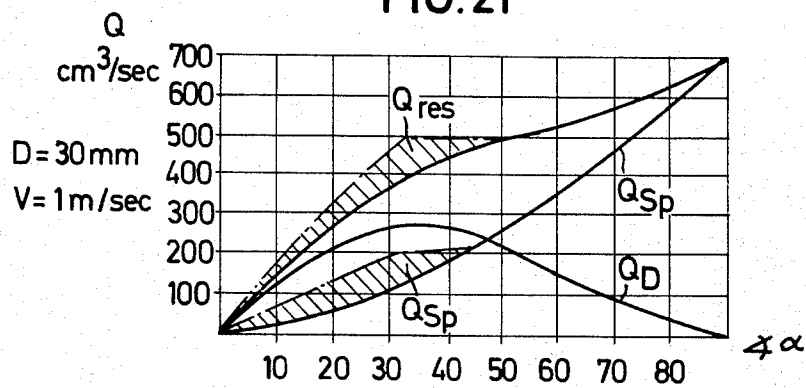


FIG. 21



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DECONTAMINATION OF INTERNAL COMBUSTION ENGINE EXHAUST GASES AND DEVICES FOR THE IMPLEMENTATION OF THE PROCEDURES

This invention relates to both procedures for decontamination of internal combustion engine exhaust gases by preparation of a flammable and ignitable air-fuel mixture, with a variable air ratio figure λ adjustable by a throttle flap regulating the hydraulic resistance in the fuel jets which is adjustable in such a way that fuel atomization is performed and to devices for the implementation of such procedures.

As is generally known internal combustion engine carburetors have a starter flap, throttle flap, idling fuel jet, main fuel jet, and a supplementary jet for reaching maximum performance during full-speed operation.

The air-fuel ratio in the air-fuel mixture is expressed by λ which, e.g. in FIG. 1 is used as abscissa for plotting the composition of the CO-CH and NO_x portions, and with respect to the path of the effective medium pressure (psi) $\lambda=1$ being the stoichiometric air: fuel ratio = 14.8 : 1.

The starter flap and throttle flap control the carburetor hydraulic resistance against the fresh air stream to the engine and/or internal combustion engine. The starter flap provides for reducing of the air portion in the air-fuel mixture during starting, and thus leads to a rich mixture.

The task of the throttle flap is to regulate the mixture flown through by influencing the functioning of the various fuel jets.

Upon closing the throttle flap, a high vacuum of about 5 - 6,000 mm WS results in the inlet manifold and causes the idle jet to operate. In order to void stalling of the engine, a relatively rich mixture of e.g. $\lambda = 0.95$ is provided. If the throttle flap is further opened, the main fuel jet equipped with a venturi-arrangement starts operating and supplies a mixture with a mainly constant and relatively high air-fuel ratio of $\lambda = 1.0$.

During full speed operation the pressure drop on the fully opened throttle flap is reduced to about 3,500 - 4,500 mm WS. Thereby the supplementary fuel jet is operating and supplies the engine with a much enriched air-fuel mixture.

In case of a multi-cylinder engine, smooth running can only be reached if all cylinders operate properly and without combustion interruptions, as e.g. can be caused by a partial air rarefaction.

In case of a reduction of the total mixture, as required by the exhaust gas decontamination requirements and regulations, that cylinder which receives the poorest mixture, due to non-uniform mixture distribution, will first start to operate irregularly. The more non-uniform the mixture distribution of an engine, the less is the possibility of a reduction of the total air-fuel mixture. In the main, therefore, it is important that for getting a steady flame front formation and flame front propagation speed in each cylinder of an internal combustion engine, a widely homogenized and flammable air-fuel mixture is supplied.

It is known that e.g. warming up of the suction tube wall following the carburetor, has an influence on the air-fuel mixture just like the carburetor and suction tube forms. Even in case of small heated areas, heating-up e.g. by means of exhaust gases leads to an evapora-

tion of the most part of the liquid fuel flowing along the walls.

In particular, the invention relates to the procedures of a homogenized mixture production and distribution in the carburetor, and in particular in the area of the throttle flap and its forms, taking into consideration the flow developments in the carburetor with the effects on the hydraulic resistance for the fuel flow on the various jets.

The task of the invention is to largely decontaminate internal combustion engine exhaust gases and to form carburetors and supplementary devices for carburetors in such a way as to guarantee a widest possible decontamination of internal combustion engine exhaust gases.

As is generally known, the gas flow speeds in the cross sections of the fresh air supply from the air filter to the carburetor and behind the carburetor for the air-fuel mixture in the suction tube to the cylinder reach a speed of as much as 0.15 and 0.2 Mach, at Reynolds numbers of up to 1.0×10^5 and/or 1.5×10^5 i.e. in the range of aerodynamics, so that flow processes can be handled according to the basic equations for incompressible flows.

The situation is completely different in the throttle flap area. If the throttle flap is nearly closed, speeds in the sonic range occur in the narrowest areas of the crescent-shaped gaps between throttle flap and carburetor tube bore as a result of the great differences in pressure. In that flow range of the throttle flap the equations for compressible flows, both for the Bernoulli's and for the continuity equation have to be applied.

The task of the invention is solved by the fact that, for the decontamination of internal combustion engine exhaust gases by preparation of a flammable and ignitable air-fuel mixture with a variable air ratio figure λ by means of a throttle flap adjustment regulating the hydraulic resistance in the fuel jets, and which is adjustable such that fuel atomization is performed, a procedure is applied in which the airstream-speed flowing from the air filter to the carburetor, particularly in the lower engine r.p.m. range, i.e. if the throttle flap swivel range is small, is accelerated in the crescent-shaped gap between throttle flap and carburetor duct wall on the whole throttle flap semi-circumference facing the fuel jets, to nearly sonic or supersonic speed, and that furthermore, at the throttle flap swivel range in the medium engine operating range, at subsonic speeds, the air stream flowing from the air filter to the carburetor, is additionally accelerated by jet effect in the throttle flap area, whereas the air stream from the filter to the carburetor in the operating range up to full engine load, is homogenized by very intensive elimination of the turbulence.

To effect this, appropriate additional air is supplied to the air-fuel mixture, streaming off from the throttle flap area, in a variable λ variation for the purpose of reduction in accordance with the operating stage intervals of an exhaust gas decontamination law, whereas the fuel film depositing on the carburetor tube wall, no matter whether in the form of a condensate or as slowly evaporating fuel composites from the thrust strokes is subjected to a time-delayed post-carburetion.

Moreover, the air-fuel mixture flow, flowing off from the throttle flap area is divided into an internal — and a wall channel flow, the time-controlled supplied addi-

tional air being superimposed on the wall channel in the form of a revolving flow, so that the more dense and slowly evaporating fuel composites being still liquid will remain in the fuel film streaming off.

The procedures and devices for implementation of the procedures, according to this invention, are closer outlined by examples and show:

FIG. 1 illustrates a diagram of the air-fuel ratio.

FIG. 2 Part-sectioned drawing of a throttle-flap and air-regulating plate and/or static tube.

FIG. 3 Perspective view of a throttle flap.

FIG. 4 Part-sectioned drawing along line IV—IV of FIG. 3.

FIG. 5 Part-sectioned drawing along line V—V of FIG. 3.

FIG. 6 Perspective view of a throttle flap of another type.

FIG. 7 Part-sectioned drawing along the line VII—VII of FIG. 6.

FIG. 8 Part-sectioned drawing along the line VIII—VIII through a static tube upper section of FIG. 9.

FIG. 9 Static tube upper section top view.

FIG. 10 Part-sectioned drawing along the line X—X of FIG. 11.

FIG. 11 Static tube lower section — top view.

FIG. 12 Air regulating plate — top view.

FIG. 13 Part-sectioned drawing along line XIII—XIII of FIG. 12.

FIG. 14 View of a fresh air supply unit with drain tube.

FIG. 15 Part-sectioned drawing along line XV—XV of FIG. 14.

FIG. 16 View of the roller guide of a fresh-air supply unit — enlarged scale.

FIG. 17 Side view of a fresh-air supply unit in the form of a segment lever.

FIG. 18 Front view according to FIG. 17.

FIG. 19 Segment lever — enlarged scale.

FIG. 20 Diagram showing the relation between pressure and engine r.p.m.

FIG. 21 Diagram showing the portion of flow stream in relation to the air ratio figure λ , at a D-30 mm throttle flap diameter and a mixture flow speed $V = 1$ m/s.

FIG. 1 clearly shows the functional requirements of an exhaust gas decontamination system. For reasons of smooth engine running conditions during idling, of good starting quality and of a good performance in the other engine r.p.m. ranges the idling adjustment is such that the air ratio figure λ is between 0.9 and 1.0, preferably at 0.95. In order to reach an exhaust gas decontamination within the limits of an exhaust gas decontamination regulation, a reduction of the fuel portion in the air-fuel mixture to $\lambda = 1.1$ to 1.15 must be performed. With most four-stroke engines of the state-of-the-art stutter-free running is still possible with a reduction to that degree. In order to comply with the requirements of an exhaust gas decontamination law, with regard to a reduction of the NO_x composites, the then necessary air-fuel ratio adjustment would require a reduction of the fuel portion in the air-fuel mixture to $\lambda = 1.25$ and 1.3. No state-of-the-art four-stroke engine permits a reduction to such a degree. To effect this, a costly and time-consuming new engine development would be required. Moreover, this also required addition of a catalytic operating afterburner i.e. partial de-

contamination actions must take place as a result of measures before and after the cylinder.

Of decisive influence in all these measures is that a carburetor or additional devices to a carburetor of the state-of-the-art, can no more be adjusted after installation in those parts, serving such measures i.e. which effect a reduction of the mixture in the r.p.m. range demanded in the exhaust gas decontamination law.

This is an important requirement for the executive orders of an exhaust gas decontamination law.

These requirements are also met by the invention procedures and devices for implementation of these procedures for exhaust gas decontamination.

FIG. 2 shows an additional device for a state-of-the-art carburetor, in the form of a throttle flap 10. It has ring-shaped rims 11 and 12, which are of protruding form at 14 and at least partially blocks the bypass jets 20A and thereby cover the effective operating range of the bypass jets 20A in the carburetor duct 20. A snuffle valve 110 can also be arranged at that side of throttle flap 10 which is free of rims.

Moreover, an air regulating plate 30 will be arranged below a standard state-of-the-art carburetor, having inserts 100 and 104 for the purpose of forming a ram jet with post carburetor effect. This air regulation plate 30 possesses a lateral, preferably jet-formed bore 39 for the supply of fresh air regulated by a fresh air transmitter.

The distances in carburetor duct 20 which can preferably be used flow-technically for the mixture formation at little swivel angles, are identified as a and b , with the possibility of producing both good surface finish and fit or distance a , between carburetor duct 20 and throttle flap 10, whereas distance b has a greater surface roughness, which can, if required, later on be roughened up to knurled-roughness in order to produce a wave form with Mach-angle $\sin \alpha = 1/M$ characteristics particularly if a transsonic flow occurs, or in the supersonic case $M \geq 1$.

Throttle flap 10 has a smaller dia. d than the inner dia. D of carburetor duct 20, whereby an annular clearances as shown on FIG. 4 is formed and guaranteed, which results from the determination of the idling r.p.m. and the idling jet bore 20B selected.

To guarantee the functioning of a standard carburetor for formation of an optimum mixture with respect to a large exhaust gas decontamination, the fit quality of this clearance s is determined according to the ISA system-of-fits. Due to this tolerance an additional air adjustment screw, as provided in many cases, is no more required.

As can be seen from FIG. 3, the ring-shaped rims 11 and 12 are only arranged around half of the circumference of throttle flap 10, namely in the idle-jet bore 20B area and bypass-jet bore 20A area.

According to FIGS. 6 and 7, the ring-shaped rims 11 and 12 can also extend over half of the throttle flap circumference. This version can be of importance to multiple stage carburetors in the bore of the second stage which becomes effective only at a speed which is higher than that of the idling r.p.m. In such a case the ring-shaped rims 11 and 12 can e.g. be of such a form that the height of the rim is determined by the swivel angle position by arranging the maximum elevation at that side pointing upwards, whereas the elevation goes down to about zero at that side pointing downwards.

For supporting throttle flap 10 bearing shaft 23 is recessed in the throttle flap area.

In case of a throttle flap having rims extending all around the circumference, an insert-type shaft bearing can be provided. The attachment of the throttle flap with shaft 23 is performed by self-locking screws 22 with plastic inserts.

The form of the rims 11 and 12 depends on their function in the various swivel angle ranges of throttle flap 10.

For small swivel angles of 0° to about 15° , that is to say in the lower engine performance range, the gap between the spherical-shaped rim surfaces and the carburetor duct bore 20 is not to increase beyond that existing at the idling r.p.m. adjustment for the 0° swivel angle.

In the medium performance range of the engine for swivel angles of about 15° to 45° or 55° , depending upon the marginal values of an exhaust gas decontamination test, the spherically formed rim backs have still a strong jet effect at the side of the bypass-bores 20A. Therefore speeds into the transsonic range will occur at that half circumference of throttle flap 10 with a crescent-formed gap, down to the fit tolerance of idling r.p.m. $\alpha = 0^\circ$, so that the fuel film preferably consisting of reluctantly evaporating fuel portions is exposed to influences of the boundary layer of the flow. The inner friction during these high speeds is due to the low pressure present in that throttle flap range. They are also an asset for the preparation of the fuel film. A further addition is the displacement effect of the high speed.

If, as proposed, a smooth-surface wall is produced along distance a of the carburetor duct (FIG. 2) for reasons of fit, gradually passing into a rough surface, along distance b , so the fuel film on distance a will be rapidly forced away and will be decelerated on distance b . On this rough surface of distance b a wave form occurs in this boundary layer area, with the Mach angle $\sin \alpha = 1/M$ which is relevant at these high speeds. The spreading is all over the carburetor duct, with reflections on the respective opposite wall. An intensive homogenized mixture is formed. Since fuel atomization primarily depends on the gas-fluid relative speed a super-atomization occurs in this area of swivel range of throttle flap 10, which is of importance for further transport to the cylinder.

The inner surface form of rim 12 on throttle flap 10 has a particular function in this swivel angle range. It is to change the ram pressure area on the upper surface of throttle flap 10 both in size and form. The inner rim area can get a gradual transition to the plate thickness of throttle flap 10. It is preferable to provide a steep gradient on rim 12 at the inner side, at best with an angle of $50^\circ - 60^\circ$. Thereby a local flow deflection occurs in the area of this abruptly sloping-down back of rim 12, which, due to its thrust effect, over the downward-pointing side of throttle flap 10 permits flowing off of an increased portion of the impact flow via the crescent-formed gap. The effect of this increased portion of flow is shown on FIG. 21 diagram.

This swivel angle range of flap 10 is within the motor vehicle speed range for which an exhaust gas decontamination is required. The aerodynamic design of throttle flap 10 contributes a portion of a reduction of the air-fuel mixture in the sense of a λ variation.

The rims 11 and 12 possess fine, jet-like bores 15. Their effect in the throttle flap swivel angle range de-

scribed is such that they contribute to reducing the ram pressure field over the throttle flap, because there is a low pressure field over the outside of the rim back, due to the jet effect. This suction effect also brings about a removal of a portion of the congested flow on the upward-pointing half of throttle flap 10.

The rims 11 and 12 cause a different effect in the load range up to full load of the engine. In the case of swivel angles up to $= 90^\circ$ the first flow path around the outside of the throttle flap breaks off at the sharp corners of the rim backs to define a vortex generator. The spherical form of the 2 rim backs, which become effective in this swivel angle range, have the advantage over a disc-shaped throttle-flap of the state-of-the-art, that a ram point can form, which determines the flowing off.

As has already been mentioned, the rims 11 and 12 have fine jet-like bores 15. These fine bores define a second streamlined path for the air and produce thin flow lines of high-speed air which remove quickly the vortex trains which leave the sharp edges 17 of the rims 11 and 12.

This strong turbulence has a homogenizing effect on the mixture formation in this swivel angle range of throttle flap 10.

In the evaluation of the various operating stages of an exhaust gas decontamination test the delayed thrust requiring only a short operating time has a great influence on the total result of an exhaust gas decontamination measure. This influence is minimized by keeping the high fuel thrust low. The fuel flow from the bypass jets can be reduced by quick build-up of a hydraulic resistance.

In the area of the bypass bores 20A the upper rim 11 of throttle flap 10 will be provided with a protuberance-like, locally limited elevation 14, having, at a swivel angle $= 0^\circ$, the fit of throttle flap 10 to the carburetor duct. Rapid swivelling back of throttle flap 10 causes just as rapid build-up of a hydraulic resistance for the bypass jets, which considerably reduces the fuel flow.

The flow in the throttle flap area permits, particularly for the delayed thrust, a generally known measure. A snuffle valve 110 can be provided at the rim-free side of throttle flap 10, over which a ram pressure is always effective in the medium swivel ranges of throttle flap 10.

During rapid swivelling back of throttle flap 10 in the delayed thrust the snuffle valve opens and thus further contributes to increased flowing-off of the flow in the throttle flap area.

The changes due to aerodynamics, as described before, in the flowing-off of the air-fuel mixture in the area of the throttle flap, are not sufficient to fulfill the requirements of an exhaust gas decontamination test. Their importance is particularly in the production of a strongly homogenized mixture-format. The effect of an aerodynamic-formed throttle flap 10 was investigated by low-pressure measurements, whereby the pressures on bore 38 in FIG. 18 were measured with and without additional air over segment lever 40 in FIG. 19. The measurement result is presented in FIG. 20. Explanation of FIG. 20:

Curve 1: Standard throttle flap (disc form) without additional air over segment lever 40.

Curve 2: Standard throttle flap (disc form) with additional air over segment lever 40.

Curve 3: Throttle flap provided with the invention characteristics, without additional air over segment lever 40.

Curve 4: Throttle flap provided with the invention characteristics with additional air over segment lever 40.

These measurements show that due to special influences of the throttle flap 10 characteristics in various throttle flap swivel ranges, a flow speed increase has occurred, which is an explanation for the low pressure difference. This small low pressure potential has a resistance-balancing effect in the turbulent air-fuel mixture flow in the carburetor duct. In that case the experimental engine is running remarkably smoother.

Small amounts of additional air must be introduced during the operating stages of an exhaust gas decontamination test run in the upper motor vehicle speed limits e.g. in the U. S.- California test up to 80 km/h and Europe test up to 50 km/h, in these engine r.p.m. ranges. This introduction must take place according to the requirements of the synchro-operational stages and the thrust intervals with their respective operating times. The time influence is synchronized with the throttle flap 10 movement by coupling the control linkage of the fresh air regulating arrangement with the shaft of throttle flap 10. The amount of air required according to the time intervals is introduced by a flat guide which can be formed as a roll guide 73 (FIG. 14-16) or segment guide and/or an envelope curve 43 and 44 (FIG. 17-19).

First of all, an air regulating plate 30 will be arranged under the carburetor. Its inner dia. D is that of the carburetor duct. Moreover, air regulating plate 30 is the carrier of a ram jet consisting of parts 100 and 104 (FIG. 2, 8-11).

The upper part 100 of the ram jet has a preferably conical inner wall 101, connected with a ring bearing. This arrangement can, depending on the case, also be one integral component. The ring bearing 102 possesses the cutouts 103, letting through the wall duct stream.

The lower part 104 also has a preferably conical inner wall 105, whereby the conicalness of the cone shell can either be the same as the upper part 100, or of tapered form towards the outlet. This cone shell 105 is connected with an intermediate cone shell 106 the tapered form of which is in the same direction, with a small space remaining in between. This intermediate shell 106 has a ring bearing 107. A ram jet is formed with parts 100 and 104, representing a basic measure for carburetors by dividing the air-fuel mixture flow from the throttle flap 10 area in an inner and in a wall flow.

As is generally known, the fuel film on the wall of the carburetor duct and on the following suction tube wall has a disturbing effect on the mixture preparation. This fuel film can deposit as condensate on the wall, or can form particularly in the delayed thrust interval. It mainly consists of the reluctantly evaporating portions of the total fuel. Part of the fuel film evaporates due to the influence of the low pressure field in the throttle flap 10 area, so that the wall stream is richer than the internal stream in the mixture flow. This discovery leads to two measures for exhaust gas decontamination: the reluctantly evaporating portions of the total fuel with larger density are, due to the displacement effect in the flow boundary layer, particularly at high flow

speeds, forced away into the narrow space between the cone shells 105 and 106 of the jet lower part 104, which thus becomes the collecting pocket for the liquid portions of the fuel.

Bores 108 are arranged in the cone shells 105 and 106 of the jet lower part 104, which both by their size and position to the bottom of the collecting pocket will be aligned such that this accumulating liquid fuel portion will be subjected to post-atomization. This effects a time shift in the preparation of the fuel film during the operating stage. In order to fulfill the requirements of an exhaust gas decontamination law this time shift of the preparation of the liquid reluctantly evaporating portions of the total fuel can be used for unloading of the operating stage, which is of great significance in the test.

The second measure concerns introduction of the additional air through a lateral bore 39 in the air regulating plate 30 which preferably will be formed jet-like. This bore 39 enters tangentially inner bore 32 of air regulating plate 30. The additional air is only blown into the gap between the jet upper part 100 and lower part 104. This additional air primarily exercises an effect on the wall channel stream which enters via cutout 103 of ring bearing 102 of the jet upper part 100.

The introduction of additional air according to the operating stages via a fresh air transmitter can be performed as follows. This procedure will be outlined by two examples.

FIGS. 14 to 16 show a fresh air transmitter 70. It consists of a housing 71 with a bearing or support bracket 72 for the purpose of attachment to the carburetor 21. Inside housing 71 there runs a preferably self-supporting roll guide 73, which is presented in FIG. 16 in enlarged scale. This roll guide 73 has a lug 74, by which it is supported in housing 71 and on which a lever 75 will be attached. A preferably adjustable linkage 77 is connected to this lever 75, being the connection to lever 46. Lever 46 is connected with the throttle flap shaft 23. This so-arranged operational linkage between fresh air transmitter and carburetor guarantees a synchronous adjustment of roll guide 73 with throttle flap shaft 23.

As can be seen from FIG. 15, a fresh air transmitter tube 78 is screwed into housing 71, which is closed at the air entry by a thin-mesh filter 79 and secured by the perforated cover 82. Opposite the fresh air transmitter tube 78 a tube 83 is attached in housing 71, through which the additional air to the air regulating plate 30 will be removed via the lateral bore 39. The distance between fresh air transmitter tube 78 and drain tube 83 can be adjusted by the thread 85 or the fresh air transmitter tube 78 to housing 71.

Roll guide 73 possesses two cutouts on the cylinder surface. A large cutout 86 for the swivel movement of roll guide 73 in housing 71 in the area of the fresh air transmitter tube 78 and a guide-type cutout 87, the size and form of which is determined by the amounts of fresh air required in the individual operating stages of an exhaust gas decontamination test.

As can be seen from FIG. 14, the fresh air transmitter 70 is connected to the air regulating plate 30 e.g. by a hose 84. A further fresh air transmitter is shown in FIGS. 17 to 19.

The air regulating plate 30 is closed at the end of bore 39 and has a bore 38 which is offset by 90°. A thin-meshed filter 51 is inserted in this bore 38. A segment

lever 40 is connected to the control linkage of carburetor 21 at 41 thus bringing about a synchronized motion of segment lever 40 with the throttle flap shaft 23 during passing over the lateral bore 38 located in the air regulating plate 30. Segment lever 40 can possess a guide for the additional air in the form of a segment lever cutout, a better solution, however, is an envelope curve 43, determining the amount of additional air for the individual operating stages of an exhaust gas decontamination test. The envelope curve 43 on segment lever 40, shown in FIG. 19 is adapted to the USA-California test. For constant operating stages e.g. for the constant operating stage at 48 km/h of the motor vehicle, a special stop 44 can be arranged, which is of no detrimental effect in the thrust operating stages during passing over envelope curve 43 above lateral bore 38.

The design of the fresh-air-transmitter to be adopted depends on the carburetor construction and on the space available in the engine carburetor area.

It is a known fact that the exhaust manifold of the motor vehicle can be followed by a catalytic-action afterburner, for the purpose of achieving in particular a reduction of the nitrogen oxide portions NO_x present in the exhaust gas of an i.c. engine. If the heterogeneous catalysis is applied for the nitrogen oxide portion NO_x reduction, the reduction takes place according to the equation $2 \text{CO} + 2 \text{NO} = 2 \text{CO}_2 + \text{N}_2$, but only then, if the free oxygen O_2 in the exhaust gas stream is low e.g. 0.5 to 1.5 vol. %.

This requirement for a reduction of the nitrogen oxide portions requires very precise rating, also of the additional air supply, in the range of the exhaust gas decontamination laws.

The design of a fresh air transmitter as a roll guide or segment lever with envelope curve or guide cutout enable the rating of the additional fresh air amount with such a precision that the reduction requirements for a post-catalytic reduction process of the nitrogen portion NO_x can be fulfilled.

The procedures and constructions of a carburetor described, or the additional devices to a carburetor of the state-of-the-art result in a λ -variation of the air-fuel mixture which can be adapted to the regulations of an exhaust gas decontamination law and which is effected purely flow-technically. The characteristic devices of the invention are inside a carburetor and cannot be seen and adjusted from the outside. Also the outside fresh-air transmitter is locked. The devices can be manufactured economically and can be mounted correctly without special knowledge and special tools. This exhaust gas decontamination system presents no problem to workshop and customer and thus facilitates the executive orders of exhaust gas decontamination laws.

I claim:

1. Apparatus for decontaminating the exhaust gases produced by an internal combustion engine by atomizing the fuel and varying the air-fuel ratio figure λ , comprising:

means defining a carburetor duct;

a throttle flap in said carburetor duct means for accelerating the air-fuel mixture flow past said throttle flap along a first path;

rim means on said throttle flap adjacent the periphery thereof for generating a vortex on the downstream side of said throttle flap along said first path;

means defining at least one bore in said rim means for accelerating said air-fuel mixture flow in a streamlined manner past said throttle flap in a second path intersecting said first path to effect an elimination of said vortex and thereby provide a homogeneous mixture of said air and said fuel;

air regulating plate means arranged downstream of said throttle flap means for carbureting the fuel which has condensed on the wall of said carburetor duct; and

fresh air supply means for supplying additional air downstream of said throttle flap means.

2. Apparatus according to claim 1, wherein said rim means varies in height along the length thereof.

3. Apparatus according to claim 1, wherein said rim means extends along said periphery on one side of the axis of rotation thereof.

4. Apparatus according to claim 1, wherein said fresh air supply means comprises an opening in said air regulating plate means.

5. Apparatus according to claim 1, wherein the plane of said throttle flap is perpendicular to the axis of said carburetor duct means when said internal combustion engine is at said idling speed.

6. Apparatus according to claim 1, wherein said rim means include means defining a plurality of nonradial openings therethrough so that the upper portion of said rim means shifts a large amount of air as compared to the flat portion of said throttle flap means due to an increased flow deflection of the air-fuel mixture ratio λ in the direction of $\lambda \geq 0$.

7. Apparatus according to claim 6, wherein said rim means includes means defining a sharp edge for producing a vortex in said air-fuel mixture downstream of said throttle flap means; and

wherein said bore means in said rim means produce streamlined jets downstream of said throttle plate means to eliminate said vortex and thereby cause a homogenization of the air-fuel mixture throughout the downstream cross section of said carburetor duct means.

8. Apparatus according to claim 1, including a conventional bypass bore in said duct means adjacent said throttle flap means and a protuberance on the upper side of said throttle flap means and adapted to at least partially block said conventional bypass bore for the purpose of reducing the fuel supply when said internal combustion engine is at idle speed.

9. Apparatus according to claim 8, including a snuffle valve on said throttle flap.

10. Apparatus according to claim 1, wherein said fresh air supply means comprises a segment lever which can be actuated synchronously by a connection with the operating linkage of the carburetor.

11. Apparatus according to claim 10, wherein said segment lever preferably has an envelope curve for the throttle flap swivel range which concerns the exhaust gas decontamination for the regulation of the amount of time-intervalled additional fresh air, whereby the idling position remains fully covered.

12. Apparatus according to claim 1, wherein said air regulating plate means includes a pair of conically shaped upper and lower conduit means.

13. Apparatus according to claim 12, wherein said conically shaped lower conduit means comprises a pair of concentric conically shaped conduits defining a gap therebetween; and

wherein the inner one of said conically shaped conduits has means defining openings in the wall thereof for atomizing the condensated fuel collected on said lower conduit means to thereby define a post carburetor for said condensated fuel.

14. Apparatus according to claim 12, wherein said upper conically shaped conduit means includes an annular flange extending radially outwardly therefrom.

15. Apparatus according to claim 4, wherein said annular flange has a plurality of openings therethrough.

16. Apparatus according to claim 14, wherein said air regulating plate means includes means defining an opening therethrough having annular recesses surrounding both the upper and lower ends of said opening;

wherein said conically shaped lower conduit means comprises a pair of concentric, conically shaped conduits defining a gap therebetween; and wherein the outer one of said lower conduit means has an annular flange thereon extending radially outwardly therefrom, said annular flanges on said upper and lower conduit means being received in said recesses in said air regulating plate means.

17. Apparatus according to claim 1, wherein said fresh air supply means is mounted directly on said means defining said carburetor duct.

18. Apparatus according to claim 17, wherein said fresh air supply means comprises a housing having bearing support means thereon and roll guide means in said housing, said roll guide means being secured to said bearing support means by nuts.

19. Apparatus according to claim 18, wherein an engaging lever is coupled, via a preferably adjustable link-

age means, to a connection lever attached to a throttle flap shaft, said engaging lever extending in parallel relationship to said connection lever.

20. Apparatus according to claim 18, wherein said roll guide means has two cutouts on its surface, one of which is, for the guide swivel movement, in the fresh air supply tube area, whereas the other is formed as a form guide, the form and size of which is determined by the amount of fresh air required in the individual operating stages of an exhaust gas decontamination test.

21. Apparatus according to claim 20, wherein said roll guide means in its form guide and/or segment lever in its envelope curve are formed in such a way that the amount of additional fresh air is precisely rated that a free oxygen content, or oxygen portion O_2 in the exhaust gas leaving the cylinder of the engine, is guaranteed to be within the limits of 0.5 to 2.0 vol. %.

22. Apparatus according to claim 18, including a fresh air supply tube threadedly connected to said housing, said fresh air supply tube being closed at the entrance by a thin-mesh filter and secured in place by a perforated screw cover.

23. Apparatus according to claim 22, including a drain tube on the housing connected to said downstream portion of said carburetor, said drain tube extending coaxially to the fresh-air supply tube, in order to transmit quantitatively regulated additional fresh air to said downstream portion of said carburetor duct means.

24. Apparatus according to claim 23, including a gap between said fresh air supply tube and said drain tube, said gap being adjustable by said threaded connection.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3 759 499 Dated September 18, 1973

Inventor(s) Ludwig G. Lang

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

Column 11, line 9; change "4" to---14---.

line 30; cancel "to" (second occurrence).

Signed and sealed this 16th day of April 1974.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents