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[54] **EXHAUST SILENCER FOR INTERNAL COMBUSTION ENGINES**

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[52] **U.S. Cl.** ..... **60/324,** 60/292, 123/97 B, 123/73

[51] **Int. Cl.** **F01n 1/18**

[58] **Field of Search** ..... 60/292, 324; 123/97 B, 107, 73; 181/38, 45, 64 A

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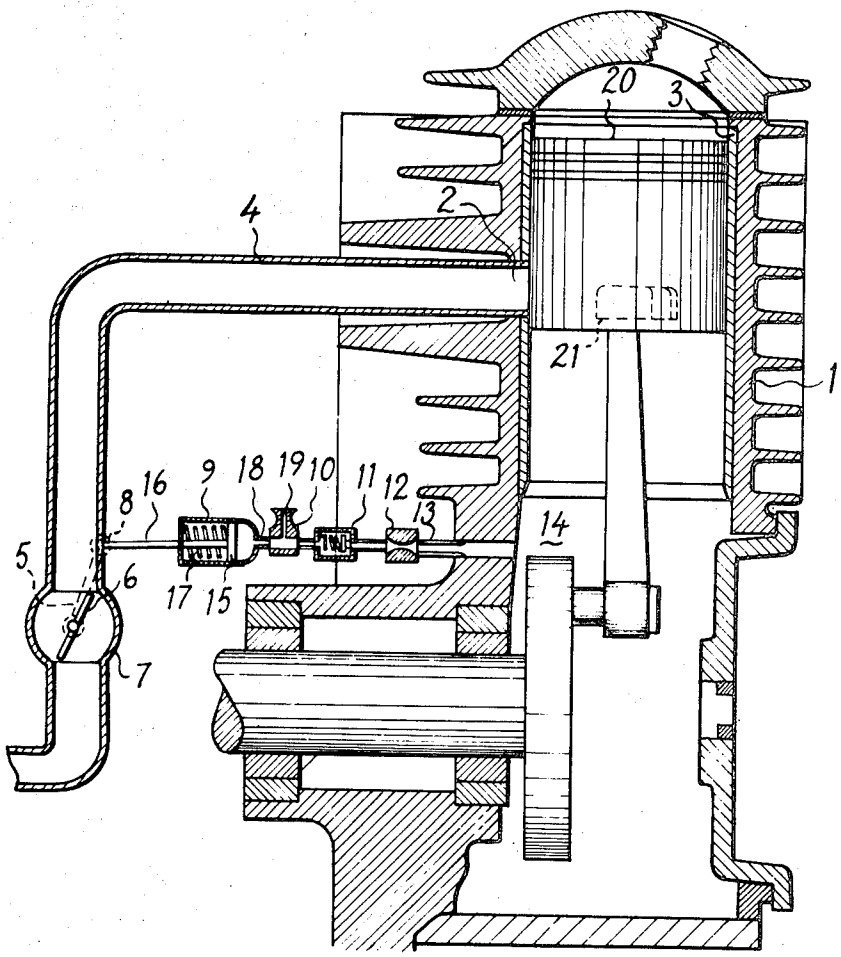
[57] **ABSTRACT**

A system for reducing the sound level of engine exhaust gases and arranged to be actuated in dependence of one of the physical magnitudes produced by the engine, such as gas pressure, engine temperature and like magnitudes. The system is provided with a baffle means located on the exhaust side of the engine and baffle actuating means disposed between the baffle means and the engine and adapted to adjust the setting of the baffle means in response to variations in said physical magnitude.

4 Claims, 3 Drawing Figures



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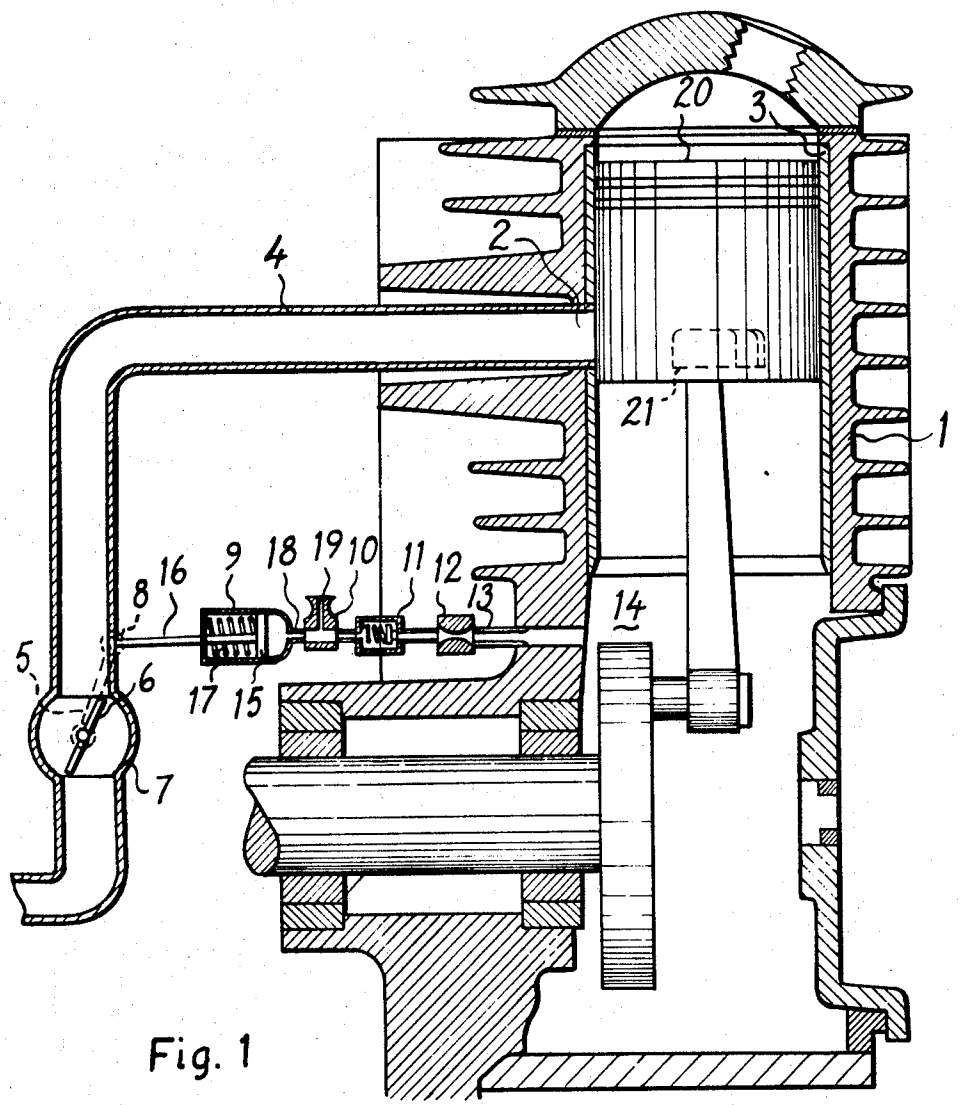

Fig. 1

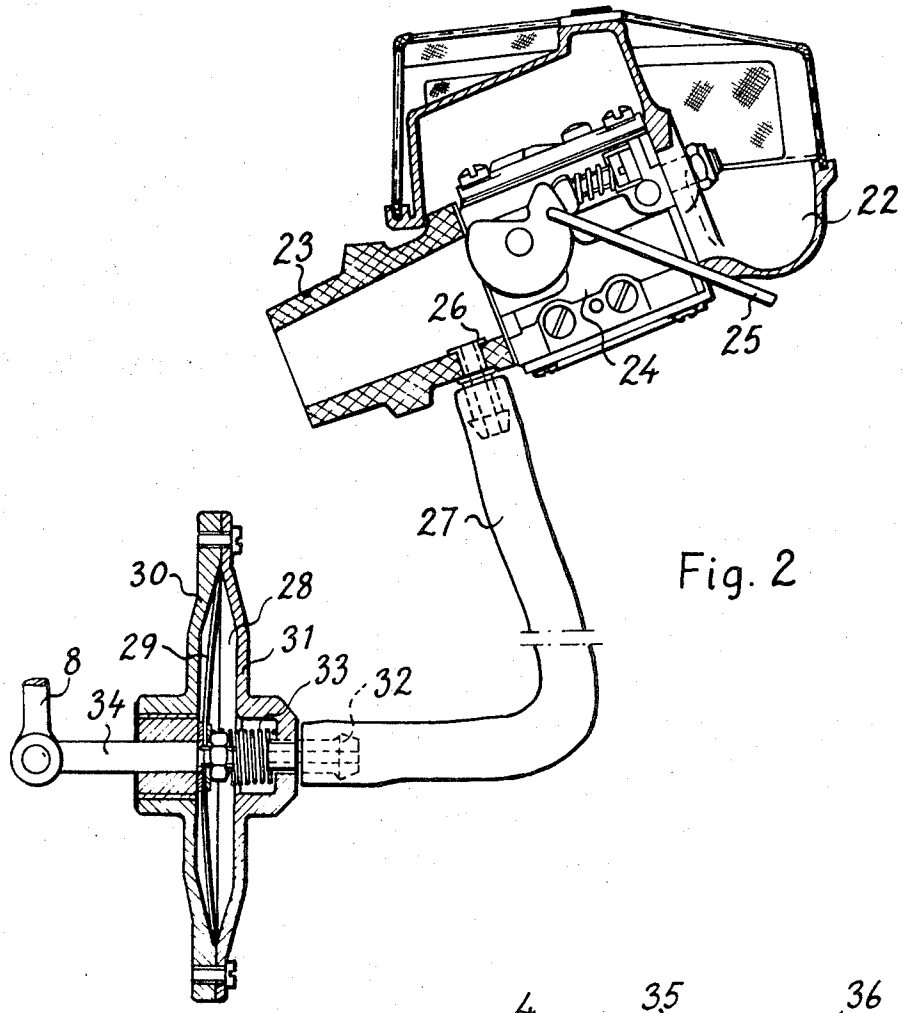

Fig. 2

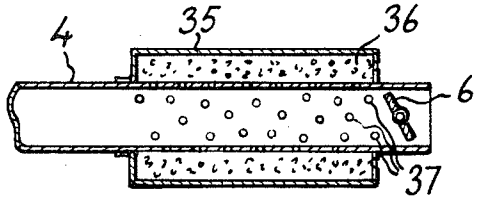

Fig. 3

EXHAUST SILENCER FOR INTERNAL COMBUSTION ENGINES

BACKGROUND OF THE INVENTION

The present invention relates to a system arranged in the exhaust passages of an internal combustion engine for the purpose of reducing the noise level of the engine exhaust gases. The system does not have a reducing effect on the maximum power output of the engine and is only operative at engine loads which are below maximum engine power. It is difficult to dampen effectively the sound of the exhaust from two-cycle internal engines without reducing the maximum power output of the engine.

During a run, an engine which operates under varying loads and which is provided with a speed regulator is only called upon to operate at full power for a fraction of the time taken to complete the run. If the engine operates at less than full power during the major portion of a run, the disadvantage of low sound reduction at full power is unimportant, provided that damping is effective at smaller engine loads. When using a conventional exhaust silencer, constructed according to the absorption or baffling technique, the noise level is reduced at all power outputs of the engine, but if for the aforementioned reasons the reduction of noise at full engine power is unimportant, the silencer can be constructed to provide an extra damping effect at engine loads which do not require maximum engine power. An automatic device which controls the extent to which the exhaust sound is reduced at different engine loads would therefore afford the important advantage whereby the level of engine exhaust sound is greatly reduced while still retaining the possibility of utilizing the full power of the engine. One method of eliminating the remaining disadvantage of high engine exhaust sound level at full engine power is to over-dimension the engine, so that the engine need not be run at a power output which results in a high level of exhaust sound in order for the engine to perform the work required thereby.

PRIOR ART

Devices for guiding the flow of gas through an engine are known to the art. Carburetor baffles and exhaust baffles which are adjusted manually by means of a handle or the like are examples of such devices. Moreover, it is known in the field of so-called small engines to arrange in parallel with the carburetor baffle on the suction side of the engine, a similar baffle on the exhaust side, with this latter baffle being opened and closed simultaneously with the carburetor baffle by means of a mechanical coupling disposed between the two baffles. When the load on the engine varies, however, the resistance in the exhaust passages must be adjusted according to the load, which creates a problem for the operator and requires a high degree of precision when adjusting the resistance in order for the engine to operate satisfactorily. Grounds are therefore to be found for arranging in the exhaust passages devices for automatic baffle adjusting means etc. so that from the point of view of sound reduction the means afford optimum resistance to the gas flow at all engine power outputs below maximum.

The problem on which the present invention is based resides in devising and utilizing means whose mode of operation is based on known magnitudes and which are

adapted to regulate the resistance presented to the exhaust gases in a manner whereby the reduction in sound is relative to the actual load on the engine. One possibility of obtaining regulating or control forces is known, for example, from the speed regulators of lawnmower engines which utilize a baffle pivotally arranged in the suction passage of the engine, with the baffle being caused to move by an amount which indicates the strength of the air flow in the passage. This force, however, is too small to control a throttle on the exhaust side of the engine. Consequently, in order to solve the problem it is necessary to use large physical magnitudes such as gas pressure and temperature. The solution provided by the present invention is mainly characterized in that the baffle member is capable of being adjusted to different degrees of throttling by means of a pressure detector arranged in the inlet system of the engine.

More particularly, in a two-cycle internal combustion engine having a crankcase, an exhaust line and an inlet means communicating with the crankcase, there is provided a silencer system including a baffle plate arranged in the exhaust line and being settable to different degrees of throttling, and a pressure-movement converter arranged in the inlet means detecting the peak pressure in the crankcase, with the baffle plate being actuated by the pressure-movement converter.

The invention will now be described with reference to a number of embodiments thereof illustrated in the accompanying drawing, of which

BRIEF DESCRIPTION OF THE INVENTION

FIG. 1 is a view partly in section and partly in elevation of a two-cycle engine provided with pressure detecting means which are connected to the crank case and which control a baffle means located in the engine exhaust pipe,

FIG. 2 is a diagrammatic view of a pressure detecting means with means for connecting the same to the suction passage of a carburetor for controlling a baffle means located in the engine exhaust pipe, and

FIG. 3 is a view in section of an absorption exhaust silencer provided with a baffle means.

DETAILED DESCRIPTION OF THE INVENTION

Shown in the drawing is a two-cycle engine **1**, the portion of engine applicable to the system of the invention being illustrated to the left of FIG. **1**. Extending from an exhaust outlet **2** on one side of a cylinder **3** to a baffle means **5** is an exhaust pipe **4**. The baffle means **5** is provided with an adjustable baffle plate **6** fixedly attached to a shaft which is rotatably mounted in the wall of a bead on a pipe **7** is provided with a lever arm **8**. By means of the baffle plate **6**, the passage through the pipe can be throttled or widened by setting the lever arm **8**, and thereby the plate **6**, to different positions. With the exemplary embodiment, when the engine is running, the lever arm **8** is set by a regulating means comprising a pressure movement converter **9**, a branch pipe **10**, a non-return valve **11**, a constriction **12** and a connecting pipe **13** passing to crankcase **14** of the engine. As will be seen from the drawing, the converter **9** includes a piston **15** arranged for movement in a cylindrical casing and having a piston rod **16** whose free end is connected to the lever arm **8**. A spring **17** located in the cylindrical casing urges the piston in a direction towards the inlet end, with which a pipe **18**

extending from the branch pipe **10** communicates. The non-return valve permits gas to flow from the crankcase to the cylindrical casing, but prohibits flow in the opposite direction. As will be seen, the restriction **12** located adjacent the crankcase will restrict the flow of gas through the components of the regulator. The system communicates with the surroundings via a pipe **19**, which has an extremely narrow bore.

The carburetor (not shown) of the engine is coupled to the crankcase in a conventional manner such that gas is drawn in during an interval when piston **20** is at its position of top dead center. The gas is compressed in the crankcase during the downward movement of the piston and flows out through a passage **21** to the cylinder **3**. Since the flow of gas through the engine is regulated by the carburetor throttle, the maximum pressure in the crankcase, while the gas therein is being compressed, will vary from a low value, when the carburetor throttle is set for idling speeds, to a high value, when the throttle is open and the engine is run at full power. The maximum gas pressure is between times a function of the extent to which the carburetor throttle is opened and the load on the engine.

In the regulator system **9-13**, there occurs, during the crankcase compression case, a flow of gas through the non-return valve **11** to the converter **9**, the gas actuating the piston **15** and flowing out successively through the pipe **19**. Subsequent to a number of crank case compression cycles, the pressure in the converter rises to the proximity of the maximum pressure obtained at each crankcase compression cycle (the peak pressure). Since the non-return valve **11** prevents backward flow of the gas to the crankcase, the gas pressure is maintained in the converter during the suction cycle. The diameter of the pipe **19** is so small that only a small portion of the gas in the converter is evacuated therethrough between two compression cycles. The piston **15** is therewith set in a position in which the force from the spring **17** and the pressure of the gas balance each other. When, as a result of the peak pressure in the crankcase compression cycle, a high pressure prevails in the converter, the piston and rod **16** are extended to the left as seen in FIG. **1**, and are retracted by the spring **17** as the peak pressure falls, causing part of the gas to be evacuated from the converter through the pipe **19**. Thus, the piston and rod move automatically with upward and downward variations in the peak pressure in the crankcase.

As previously mentioned, the control device **5** is intended to reduce the level of engine exhaust sound. Exhaust sound is greatest when the flow of gas through the engine is at a maximum, i.e. when the engine is running at full power. The sound decreases successively with decreasing power output. In order to obtain maximum power output, there should be no resistance to gas flow in the exhaust pipe, a condition corresponding to a fully open position of the plate **6**. The plate **6** is moved to the fully open position as a result of the gas pressure prevailing in the converter causing the piston **15**, the rod **16** and the lever arm **8** to move to a position in which the plate is parallel with the walls of the exhaust pipe. On the other hand, when the load on the engine requires an engine power output below maximum, the baffle plate is automatically set to an angle relative to the walls of the exhaust pipe, e.g. as shown in FIG. **1**, thereby providing for a sound dampening effect. Pulsating gas flows in the outlet **2** are then smoothed out in the pipe **4** and the flow past the baffle means is relatively smooth.

Another system for transmitting control movement to the exhaust baffle system is illustrated in FIG. **2**, and the system co-operates with an engine carburetor **22**. Extending between the carburetor and the engine is a suction pipe **23** and at the junction between the pipe **23** and the carburetor there is located in the carburetor housing **24** a baffle means which is actuated externally by a throttle control **25**. A varying subpressure, determined by the load on the engine and the engine speed, prevails in the suction pipe. This subpressure is due to the fact that at a certain engine speed, the load on the engine is corresponded by a definite flow of gas to the engine and the magnitude of the flow creates a specific subpressure in the suction pipe. If the load increases without an increase in engine speed, the flow of gas to the engine will also increase, owing to the fact that the density of the fuel in the cylinder becomes greater and the gas throttle is opened slightly wider, e.g. through the medium of a speed regulator. The increased gas flow on the suction side gives rise to more exhaust gases and therewith a greater exhaust sound. Thus, a change in exhaust noise stands in a certain relationship to the subpressure in the suction pipe and this factor is applied in the illustrated embodiment for controlling the exhaust baffle in a manner similar to that with the embodiment illustrated in FIG. **1**. In the embodiment of FIG. **2** a lead-through **26** is arranged in the suction pipe **23** and is connected to a hose **27** which passes to a vacuum box **28** in which a diaphragm **29** is secured at its outer edges between two flanged, circular cup-shaped members **30, 31**. The member **30** is attached to a member adjacent the engine and the other member **31** is provided with a nipple **32** arranged to be connected to the hose **27**. The subpressure is transmitted from the suction pipe to the interior of the cup-shaped member **31** and causes the center point of the diaphragm to be drawn over towards a spring **33** against the action thereof. A rod **34** attached to the center point of the diaphragm transmits the movement of the diaphragm to the arm **8** of the throttle device illustrated in FIG. **1** or to some similar linkage member. If movement of the diaphragm is too small to guide the baffle member efficiently, a lever arm mechanism or the like for amplifying the movement can be arranged between the rod **34** and the arm **8**. In the case of a single cylinder engine, a non-return valve should be arranged in the means connecting the vacuum box and the carburetor.

The exhaust baffle means acts to dam the axhaust gases between the engine outlet and the baffle, whereby pulsating gas flows are smoothed out during their passage to the baffle. Pulsating gas flow can be smoothed out more efficiently, however, by means of the specially constructed absorption damper illustrated in FIG. **3**. With this embodiment, the exhaust gas pipe **4** is provided with a baffle plate **6** which is controlled by the system of FIG. **1** or by the system of FIG. **2**. Located axially inwardly of the baffle plate **6** and in the immediate vicinity thereof is a damping means in the form of a metal cylinder **35** which surround the pipe and contains a porous, fibre material **36** between the inner wall of the cylinder and the pipe **4**. Disposed in the pipe **4** are a number of holes **37**, through which gas can pass out into the fibre material. The operation of the silencer is such that when the baffle is closed the gases are forced out into the fibre material and diffuse

out through an opening in the rear of the cylinder. Upon progressive opening of the baffle, more and more gas will flow out directly past the throttle.

The problem discussed in the introduction with respect to the provision of control means for throttling the engine exhaust pipe has been solved in the illustrated and described embodiments by utilizing the pressure occuring in the exhaust passages of the engine. The engine, however, has other physical magnitudes, such as the temperature of the exhaust gases for example, which in connection with suitable means can be utilized for controlling purposes. Naturally, the embodiment illustrated in FIG. 2 can be used for both two and four cycle engines. The invention is defined in its entirety in the following claims.

What is claimed is:

1. In a two-cycle internal combustion engine having a crankcase, an exhaust line and an inlet means communicating with the crankcase, a silencer system for the engine, said silencer system including a baffle means arranged in the exhaust line, said baffle means being settable in the exhaust line to different degrees of throttling, a pressure detector arranged in the inlet means, the pressure detector being defined by a pressure-movement converter detecting the peak pressure in the crankcase, and the baffle means being defined by a baffle plate arranged to be actuated by the converter.

2. The silencer system according to claim 1, characterized in that the converter is arranged to actuate the baffle plate in an opening direction when the crankcase peak pressure increases.

3. The silencer system according to claim 2, including an elastic means for actuating the converter and the baffle plate in a closing direction.

4. The silencer system according to claim 1, in which the pressure detector includes a line, a one-way valve arranged in the line between the converter and the crankcase, and means defining a narrow vent arranged between the valve and the converter, with the vent communicating with the atmosphere.

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