Feb. 12, 1924.

1,483,354

F. KOPPER, JR

GAS ENGINE MUFFLER

Filed Nov. 25, 1919

3 Sheets-Sheet 1

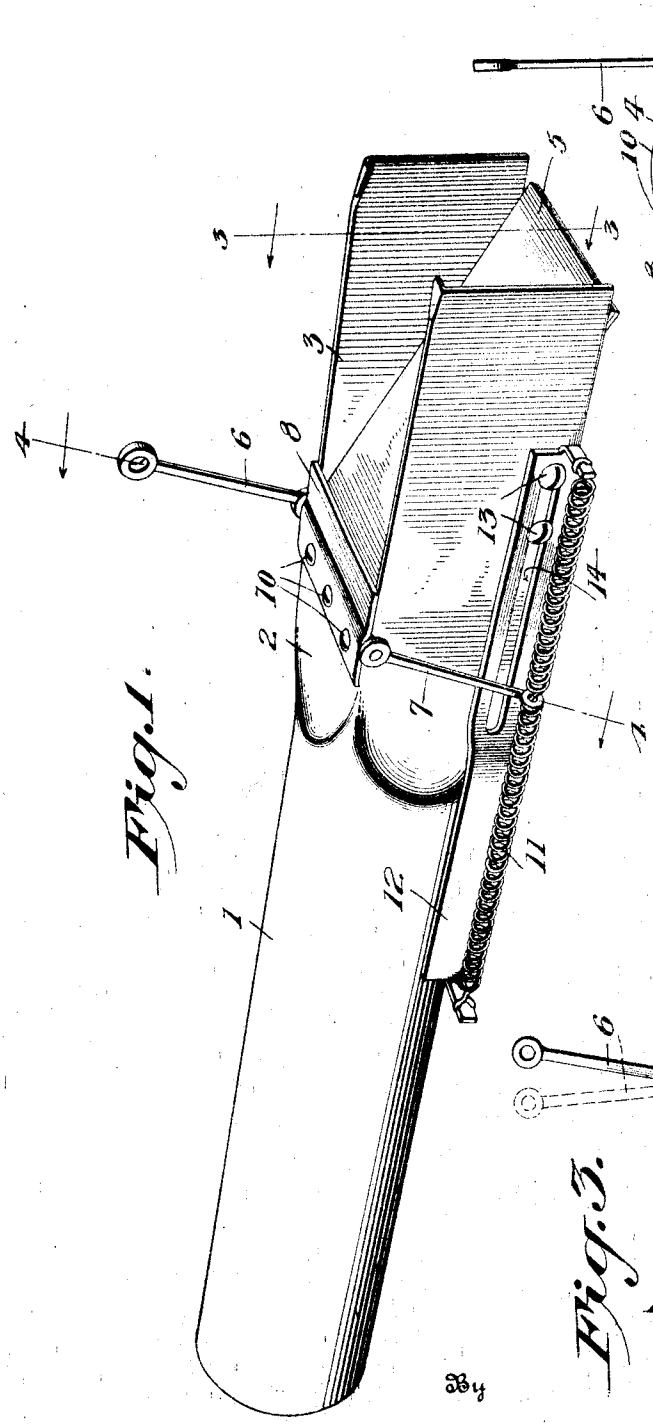

Fig. 1.

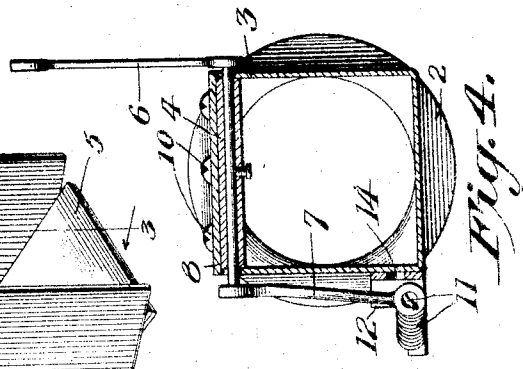

Fig. 4.

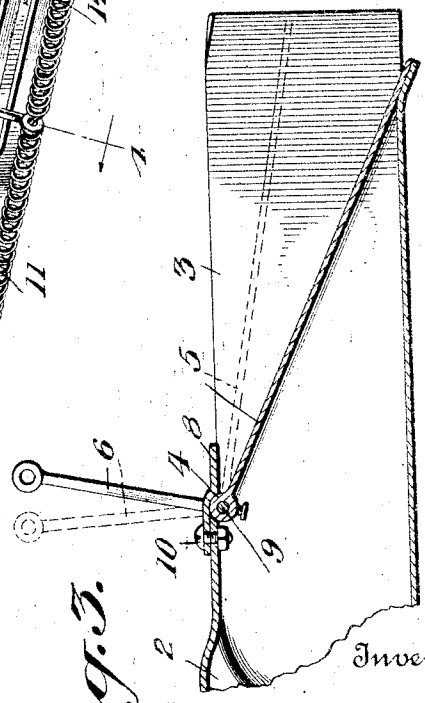

Fig. 3.

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GAS ENGINE MUFFLER

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Fig. 5.

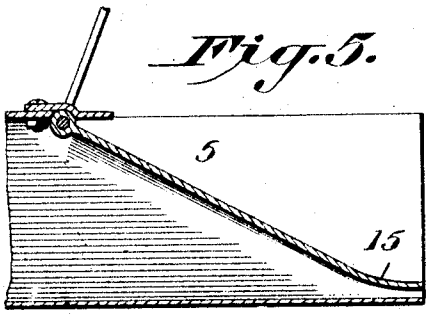
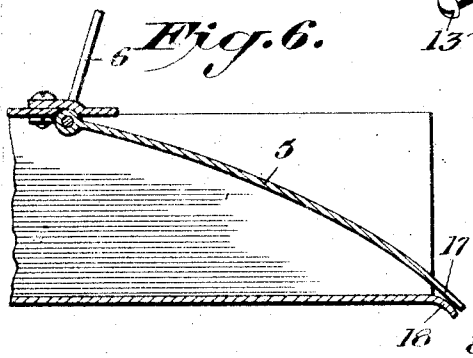


Fig. 2.

Fig. 6.



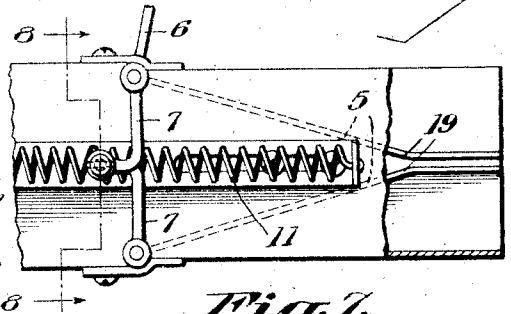


Fig. 7.

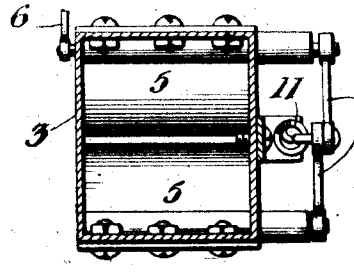


Fig. 8.

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GAS ENGINE MUFFLER

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Fig. 9.

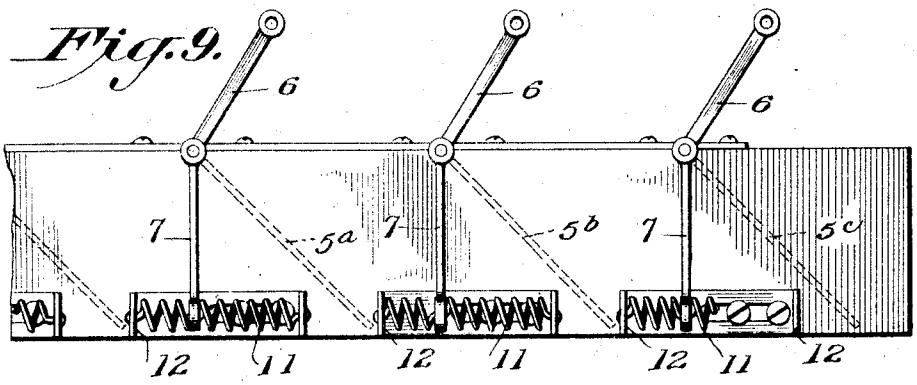


Fig. 10.

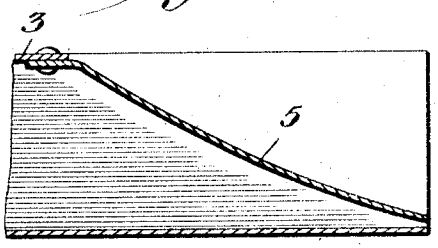
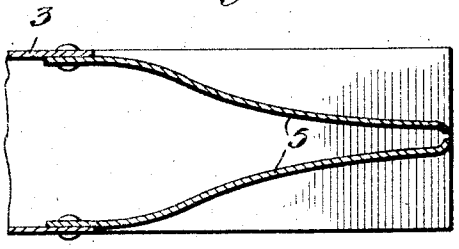


Fig. 11.



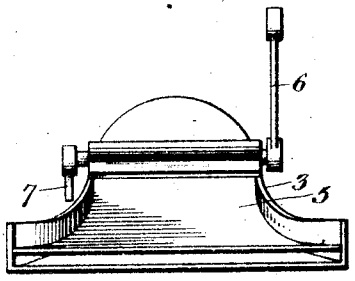


Fig. 13.

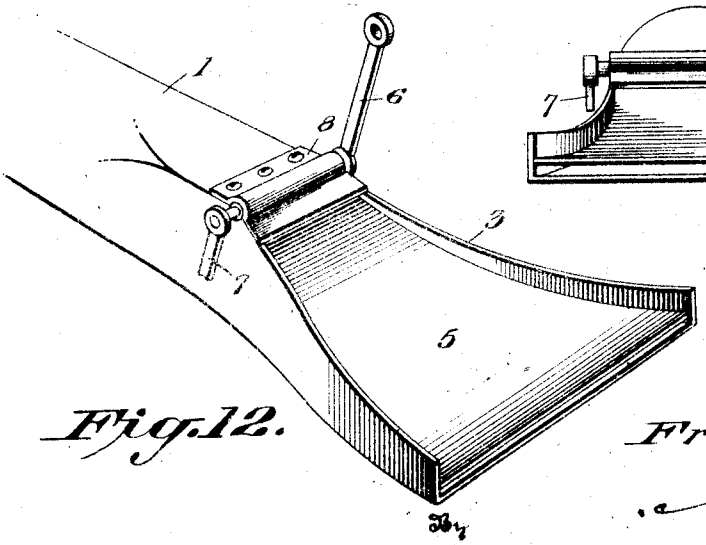


Fig. 12.

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Patented Feb. 12, 1924. 1,483,354

UNITED STATES PATENT OFFICE.

FREDERICK KOPPER, JR., OF WASHINGTON, DISTRICT OF COLUMBIA.

GAS-ENGINE MUFFLER.

Application filed November 25, 1919. Serial No. 340,562.

To all whom it may concern:

Be it known that I, FREDERICK KOPPER, Jr., a citizen of the United States of America, residing at Washington, in the District of Columbia, have invented certain new and useful Improvements in Gas-Engine Mufflers, of which the following is a specification.

This invention relates to improvements in gas-engine muffling devices and more particularly to a combined muffler and muffler cut-out.

One object of this invention is to provide a simple and efficient device by means of which the muffling of the noise of the explosion may be accomplished with the formation of a negligible back-pressure in the exhaust pipe.

A second object is to provide an efficient muffling device which may be adjusted to different types of motors, accomplishing its purpose equally well under the various changed conditions, and which may be adjusted for use with the same motor to provide a greater or less muffling effect.

Another object is to produce a muffler in which the formation of a partial vacuum or back-pressure in the exhaust pipe may be nearly completely eliminated, or, in any event, reduced to a point where the effect is of little consequence.

A further object of the invention is the provision of a muffler wherein the muffling effect is automatically varied by and in accordance with the speed of the motor to which it is operatively connected.

It will be understood that in the types of mufflers now most widely in use, there is provided an expansion chamber located at or near the end of the exhaust pipe of the motor. The interior of the chamber has a series of vanes or baffle plates of various kinds, the object in view being to receive the burnt gases passing from the exhaust under a relatively high pressure, to cause them to expand in the chamber and to slow up their discharge into the atmosphere by the system of vanes.

Such an arrangement as this is admitted to be of considerable efficiency in muffling the noise of the explosion, but since the gases are checked within it, there is produced a back-pressure which in turn lessens the efficiency of the motor, since it absorbs a part of the power of the engine. A further disadvantage in a muffler of this type is that it is in no sense adjustable nor can it be made so, save by variations in size of chamber, etc., which amounts to providing mufflers of a different type or size for each size of engine. Still further, such a muffler has points of disadvantage, in that it is "set" at the start, that is to say, the muffling effect is not variable nor can the muffler adjust itself to different engine speeds. The result is that the greater the engine speed, with its increased force of explosion, the greater is the back-pressure produced. Such mufflers, as a rule, are equipped with a device known as a cut-out to meet the condition, and this cut-out is simply a convenient means for by-passing the muffler—thus permitting the exhaust to pass directly into the atmosphere without the intervention of baffles or damping means. The use of the cut-out undoubtedly eliminates back-pressure and is of use to permit the operator to hear more distinctly the noise of the explosion, a matter of some convenience in locating trouble. However, the cut-out eliminates muffling altogether and is, consequently, not generally desirable.

The device which forms the subject matter of the present application gives a variable, adjustable and self-adjusting muffler and accomplishes this end with the nearly complete elimination of back-pressure. Further, it is so designed as to produce any desired degree of muffling, or it may be adjusted to give the effect of a cut-out.

Since the device has no elaborate system of baffles and no large expansion chamber, it is inexpensive to construct, and the simplicity in design in connection with its efficiency to muffle the exhaust noises makes it a distinct step forward in the art.

Briefly speaking, the device consists of an extension to be placed at the end of the exhaust pipe, provided with a spring-controlled closure interposed at an angle in the path of the gases. This closure or door may be provided with a hinge joint mounting, by which it is attached to the exhaust pipe, and it may be swung to close the exhaust opening completely or to give any sized opening desired. By reason of the spring mounting, more specifically to be described, the door moves in either direction on its hinge against a slight pressure caused by the spring.

It will be understood that the ordinary gas engine explosions leave the exhaust pipe opening, if unmuffled, in distinct puffs. These puffs or condensations are followed by corresponding rarefactions and the waves so formed produce the auditory effects. In the ordinary muffler, the slowing up of the gases in conjunction with the expansion chamber tends to eliminate the differences in pressure and to reduce the noise.

But in the present invention, the spring door accomplishes the same purpose. The door rides upon the waves of the explosions and is forced outwardly by successive condensations. The resistance offered by the spring to the movement of the door is sufficient to tend to cause an equalization of pressure; that is to say, the condensations are checked and merge with the rarefactions. This equalization in pressure damps the amplitude of the waves, resulting in a reduction in sound.

Since the successive rarefactions tend to produce a partial vacuum which is effective in setting up back-pressure, it will be obvious that the present invention, in eliminating this variation in pressure, not only muffles the sound, but also prevents back-pressure, which would absorb power from the engine.

It will be seen that the device as briefly described is simple and inexpensive in construction and without parts that wear out easily. Adjustments, as will be later described, are easily and readily made.

For a better understanding of the device, references is now made to the accompanying drawings showing the preferred, and various modified, forms of the device.

In the drawings:—

Figure 1 is a perspective view of the device.

Fig. 2 is a perspective view, showing the muffling elements disassembled.

Fig. 3 is a fragmentary sectional view, taken on line 3—3 of Fig. 1.

Fig. 4 is a view in transverse cross section on the line 4—4 in Fig. 1.

Figs. 5 and 6 are views similar to Fig. 3, but showing elements of a slightly modified form.

Fig. 7 is a view similar to Fig. 3 showing a pair of muffling elements in operative position.

Fig. 8 is a sectional view taken on line 8—8 of Fig. 7.

Figs. 9, 10, 11, 12 and 13 are views showing the invention in modified forms.

In the various views in which like reference characters refer to like parts, the exhaust pipe 1 of the motor is provided at its end with a chamber 2 of slightly increased diameter. It has been found that the provision at this point of a chamber of slightly increased diameter improves the muffling effect by permitting expansion of the gases. Leading from the chamber there is an extension 3, U-shaped in cross section, and providing the main body of the muffling device proper. Mounted by means of a hinge 4 on the open side of the U, there is a door or gate 5 provided with a pair of cranks 6 and 7. The hinge, as will be seen, is of usual form and has a portion 8 overlying the hinge pin 9, of which the cranks 6 and 7 form the end portions. The overlying member 8 is bolted to the body of the U-shaped portion of extension 3, as shown at 10. Any convenient way of mounting the gate 5 is permissible, provided it has freedom of movement within the trough of member 3.

The gate 5 conforms closely to the inside dimension of the U, but is allowed entire freedom of movement on its hinge, except as will be now explained. The crank 7 projects downwardly from the hinge pin and at its lower extremity engages a coiled spring 11, mounted longitudinally of the member 3 in a spring frame 12. The frame 12 is attached to the side of the U by means of a pair of bolts 13, the shanks of which project through a slot 14 in the frame 12. It will be seen that by this arrangement the frame may be moved to different positions along member 3.

The engagement of the crank 7 with the spring 11 results in the door being held yieldingly in any desired position with reference to the member 3. As will be seen, if the spring frame is moved to the left in Fig. 1, this draws the crank 7 with it, and the door 5 will move downwardly until it strikes the lower surface of the U. This, it will be understood, would completely close the orifice of the expansion chamber 2. Moving the spring frame 12 to the right makes it possible to place the door 5 at any desired angle to the path of the outcoming gases and to change the extent to which the exhaust orifice is closed, the door 5 being held yieldingly in any position in which it may be set. Should the exhaust gases increase in volume and strength, they would force the door farther open, crank 7 tending to compress that portion of the spring (Fig. 1) to the right of it and to extend the portion to the left. It will be understood that the force of the exhaust gases does not come regularly, but in explosive puffs. Consequently, some provision is necessary to prevent the door from having too great a freedom of movement in either direction, and the location of the point of engagement of the crank 7 with the spring, midway the ends thereof, attains this result. The door, as will be seen, can move inwardly only by compressing that portion of the spring which lies to the left of the point of engagement of the crank.

By the adjustable mounting of the spring, as shown, it is possible to control the degree of muffling. As previously explained, the extent to which the noises of the explosions of the motor are muffled depends upon the extent of the interposition of the door 5 in the path of the exhaust gases. By adjusting the door 5 to a position as shown in Fig. 1, a very complete muffling result is possible. But should less muffling be desired with less resistance to the passage of the exhaust gases into the atmosphere, this may be accomplished by setting the door in a position such that an orifice of increased size is presented. It will be understood that the position of the door is to be varied in accordance not only with the degree of muffling desired, but also with reference to the motor to which the device is attached. An 8 or 12 cylinder motor will, of course, produce a greater volume of exhaust gases than a 4 cylinder motor, and consequently, for a motor of a larger number of cylinders, door 5 must be set in a position to provide a less restricted outlet for the gases.

Should it be desired, for any reason, to cut out the muffler completely, this is provided for by having a crank 6 attached to the door, as shown. To the crank 6 there is to be attached a cord or chain to run to the driver's seat or to a suitable pedal, and the door 5 may be held wide open for such periods as may be desired. Under these conditions there is no muffling effect.

While the form shown in Figs. 1, 2 and 3 is the simplest and preferred type, it has been found that beneficial results are obtained by making slight changes in the form of the door 5. In Fig. 5 there is shown a door in which the outer extremity indicated at 15 has been bent slightly so that the door may have a larger surface of contact with the lower surface of the U. This prevents any possibility of chattering when the door is to be held nearly closed to produce an extreme muffling effect. In the modification shown in Fig. 6 the door 5 is bent in a curved form, and the lower surface of the U of member 3 is provided with a downwardly curved lip 18, with which the outer extremity 17 of the door, bent downwardly as shown, comes in contact. The effect of this combination of curved parts is to produce a greater muffling effect. This would necessarily be the case, since the path of the gases is slightly changed in leaving the muffler, and in making this change in direction, the gases come into closer contact with the door 5. In Fig. 7 there is provided, as shown, a pair of doors 5, 5, hinged at opposite on the member 3, and provided with pair of cranks 7, 7, engaging the spring 11. At their outer extremities 19, 19, the edges of the doors are bent, as shown, to provide a large contact surface. Such an arrangement as this, while slightly more complex than the simplest form, increases the muffling effect. It is necessary to provide only one of the doors 5 with the crank 6 for use as a cut-out. Fig. 8 shows a cross sectional view of the device in Fig. 7 and indicates how the pair of cranks 7, 7, engage the spring 11.

In Fig. 9 there is shown a series of muffling devices placed one after the other and working independently. Such an arrangement provides a satisfactory muffler for engines of extreme high power, as for instance, aircraft engines, and the muffling effect is cumulative. The doors 5^a, 5^b, 5^c and 5^d may be set to produce a cumulative muffling effect.

In the modification illustrated in Fig. 10, the door or closure 5, is formed of a piece of metal having an inherent resiliency. The door is secured at its upper end to the extension 3, and thence tapers or extends downwardly to a point closely adjacent the outer end of the floor of the member 3. Obviously the force of the outcoming gases will cause the lower end of the door 5 to move upwardly, against its inherent resiliency, and, obviously also, the size of the orifice is directly dependent upon the speed of the motor.

Fig. 11 shows a modification embodying two of the doors 5, both constructed of inherently resilient material. The outcoming gases cause the ends of the doors 5 to spread and increase the size of the orifice formed therebetween. Manifestly the size of this orifice is dependent upon the speed of the motor.

Figs. 12 and 13 illustrate still a further modification, wherein the member 3 is downwardly tapered, or flattened and outwardly flared. This construction is beneficial in that it permits of additional expansion of the gases, immediately prior to their exit.

It will be seen that the novel device provides a muffler which depends for its proper functioning upon the interposition of the door 5 at an angle in the path of the gases, and as previously explained, this serves the purpose of tending to equalize the condensations and rarefactions in the exhaust. By virtue of the fact that the door has relatively great strength, making an acute angle with the lower surface of the U member 3, the friction set up and the extent to which the gases are slowed up in their passage to the atmosphere is comparatively small. While it has been found by actual tests that this muffler will give practically the same muffling effect as the type at present in use, there is a lessening in back-pressure of between 60 and 75%.

It is to be understood that while the views in the drawings disclose the perferred forms of the invention, the novel device is obvious-

ly susceptible of further modifications within the meaning and scope of the appended claims.

What I claim and desire to protect by Letters Patent is:

1. A muffler provided with a member having an orifice, a closure pivotally mounted to restrict or enlarge said orifice, a flexible element in operative connection with said closure, and means for bodily moving said element to vary the normal position of said closure.

2. A muffler provided with a member having an orifice, a closure pivotally mounted to restrict or enlarge said orifice, a flexible element in alignment with said member and connected to said closure and adapted to yieldingly limit the swing thereof, and means for bodily moving said element to vary the normal position of said closure.

3. A muffler provided with a member having an orifice, a closure pivotally mounted to restrict or enlarge said orifice, a resilient element mounted in parallel with said member, and connected, between its ends, to said closure, whereby to hold said closure in a predetermined position with respect to said orifice, and means for bodily moving said element to a different position, to vary the normal position of said closure, substantially as described.

4. A muffler provided with a member having an orifice, a closure movably positioned to restrict the size of said orifice, resilient means connected to the closure and normally tending to hold it in a predetermined position, a support for said resilient means, and means for adjusting the position of said support whereby the closure may assume another position.

5. A muffler provided with a member having an orifice, a closure carried by said member and movably positioned to restrict the size of said orifice, a crank connected to the closure, a spring frame adjustably mounted on said member, and a spring held in said frame and in engagement with said crank to yieldingly retain the closure in position.

6. A muffler provided with a member having an orifice, a closure mounted on said member and adapted for movement into position to restrict or enlarge said orifice, resilient means in engagement with said closure and yieldingly resisting movement thereof in either direction, and means for adjusting the amount of resistance of said resilient means.

7. A muffler provided with a member having an orifice, a closure pivotally mounted to restrict or enlarge said orifice, in combination with a flexible element fixed at points longitudinally of its length, and means connecting said closure to said element, intermediate said points, whereby to normally hold said closure in a predetermined position.

8. A muffler provided with a member having an orifice, a closure pivotally mounted to restrict or enlarge said orifice, in combination with a flexible element fixed at points longitudinally of its length, means connecting said closure to said element, intermediate said points, whereby to normally hold said closure in a predetermined position and means permitting bodily moving said element with respect to said closure, whereby to normally hold said closure in another predetermined position.

9. A muffler provided with a member having an orifice, a closure mounted on said member and movable to restrict or enlarge said orifice, a spring mounted substantially parallel to said member and secured thereto at each end, said spring being connected, between its ends, to said closure and tending to return the latter to any predetermined position, when the closure is moved from that position, substantially as described.

10. A muffler provided with a member having an orifice, a closure mounted on said member and pivotally mounted to restrict or enlarge said orifice, a spring mounted adjacent said member and so connected to said closure as to tend to move said closure to a predetermined position when the closure is moved from that position and means whereby said spring may be bodily moved to thereby increase or diminish said tendency.

In testimony whereof I affix my signature.

FREDERICK KOPPER, Jr.