July 4, 1939. E. E. WILSON 2,164,365

COMPOUND RESONANCE UNIT

Original Filed Jan. 30, 1933 2 Sheets-Sheet 1

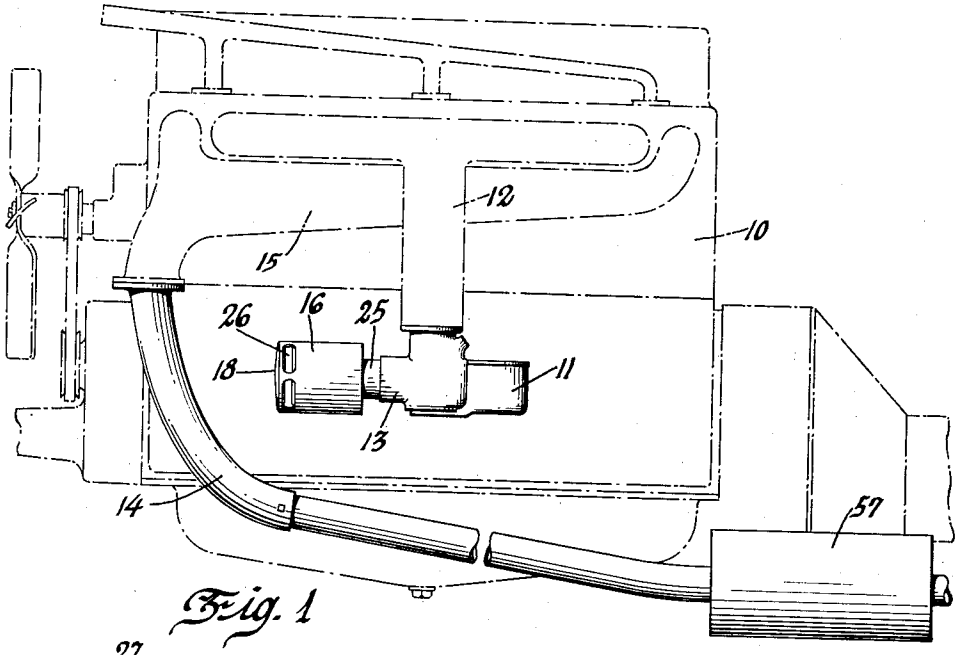


Fig. 1

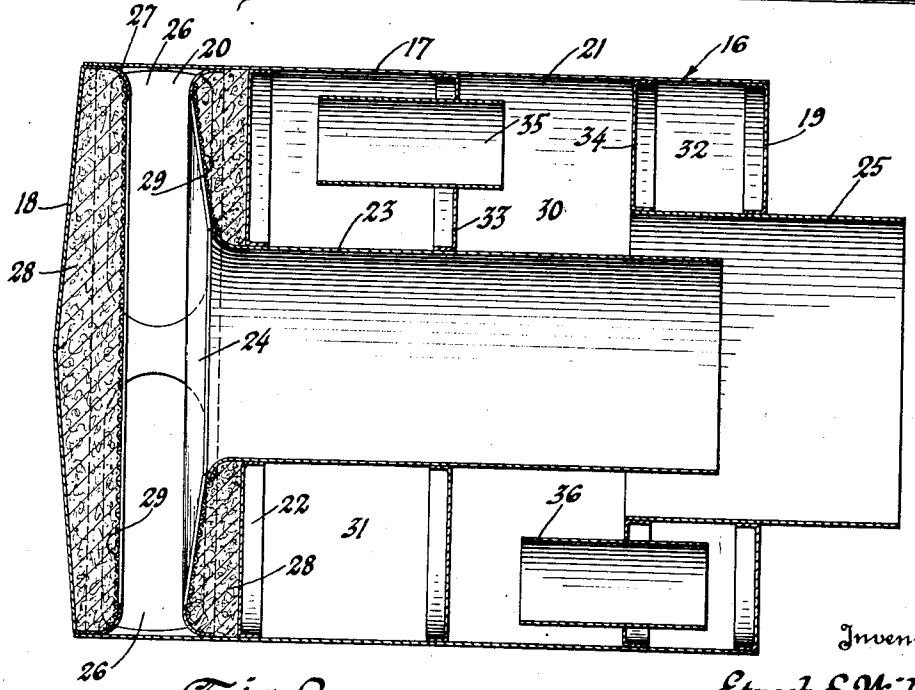


Fig. 2

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COMPOUND RESONANCE UNIT

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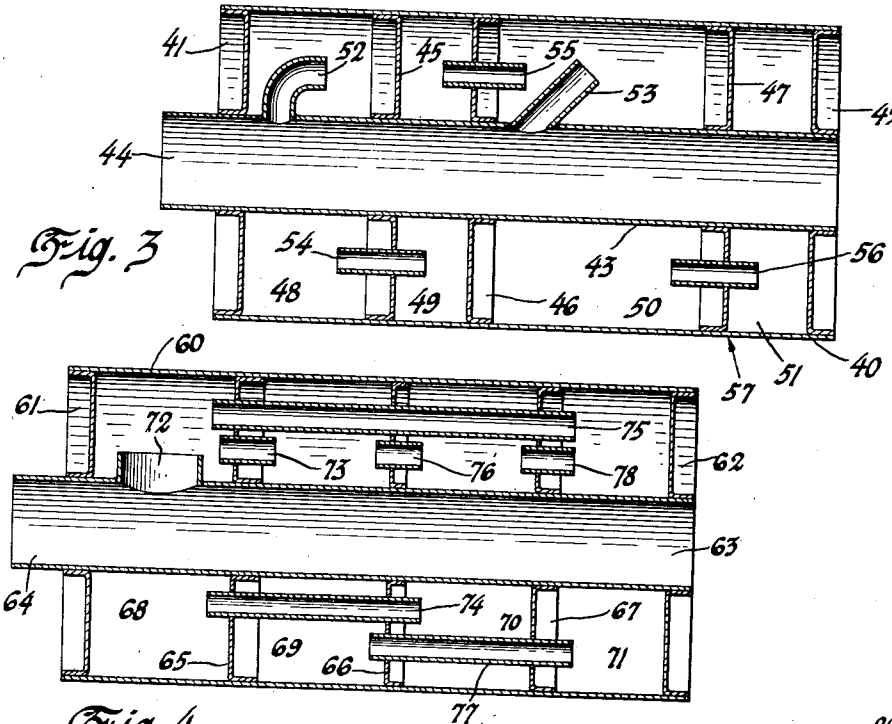


Fig. 3

Fig. 4

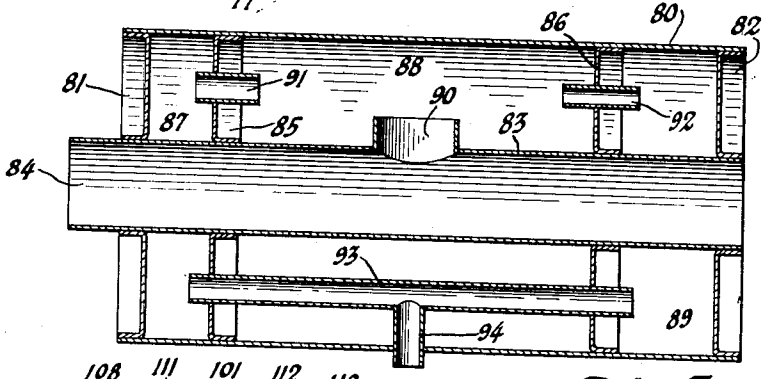


Fig. 5

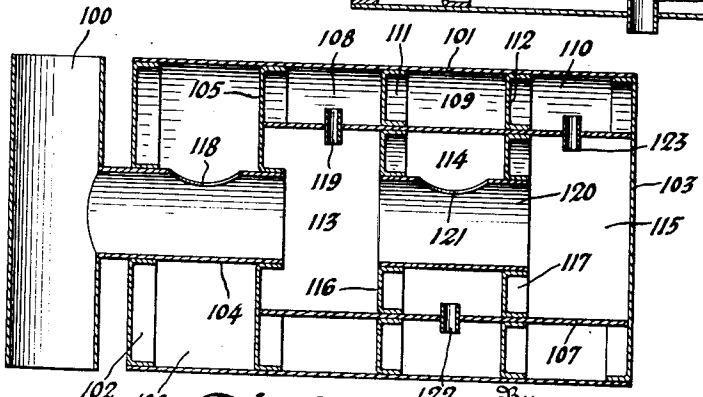


Fig. 6

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Patented July 4, 1939

2,164,365

UNITED STATES PATENT OFFICE

2,164,365

COMPOUND RESONANCE UNIT

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Application January 30, 1933, Serial No. 654,296
Renewed June 11, 1936

5 Claims. (Cl. 181—48)

This invention has to do with resonance units of the type disclosed in my copending application Serial No. 470,700, filed July 25, 1930 of which this application is, in part, a continuation. In the main this application is concerned with certain embodiments or features of the invention disclosed but not claimed in the above identified application or in my copending application Serial No. 633,265, filed September 15, 1932 which is also, in part, a continuation of application Serial No. 470,700.

For a better understanding of the nature, objects and scope of the invention with which this application is concerned, reference is made to the following specification in which there are described the several embodiments of the invention which are illustrated in the accompanying drawings.

In the accompanying drawings:

Figure 1 is a side elevation of an internal combustion engine on which there are installed intake and exhaust silencers in which are incorporated resonance units in which the invention with which this application is concerned is embodied.

Figure 2 is a central longitudinal section through the silencer installed on the intake tube of the carburetor of the engine illustrated in Figure 1.

Figure 3 is a central longitudinal section through the silencer installed on the exhaust pipe of the engine illustrated in Figure 1.

Figures 4, 5 and 6 are central longitudinal sections through modified forms of silencers in which the invention with which this application is concerned is embodied.

In Figures 1, 2 and 3 of the drawings, the reference character 10 indicates an internal combustion engine on which there is provided a carburetor 11 which is connected to the cylinders of the engine by an intake manifold 12 and on which there is provided an air intake tube 13, and the reference character 14 the exhaust pipe of the engine which is connected to the cylinders of the engine by an exhaust manifold 15. To the air intake tube of the carburetor and to the exhaust pipe, there are connected silencers 16 and 57, respectively, in which are incorporated resonance units of the type with which this application is concerned.

The silencer 16, which is shown in Figures 1 and 2 of the drawings, includes a cylindrical shell 17 over whose opposite ends there are secured heads 18 and 19 and which is subdivided longitudinally into two compartments 20 and 21 by an annular partition 22 whose outer edge is circumferentially secured to the shell 17. Through the central opening in the partition 22, there extends from the compartment 20 into the compartment 21 a tube 23 which is circumferentially secured to the inner edge of the partition 22 and on whose end which is located within the compartment 20 there is provided a perforated annular flange 24 whose outer edge is circumferentially secured to the shell 17. In the head 19, there is provided a central opening of larger diameter than that in the partition 22 through which there extends into the shell 17 a tube 25 of larger diameter than the tube 23 whose inner end surrounds and is circumferentially spaced from the adjacent end of the tube 23.

Through the side wall of the shell 17, there extend into the compartment 20 an annular series of openings 26 through which air may pass from the atmosphere into the tube 23. The end walls 18 and 22 of the compartment 20 are lined with bodies of sound absorbing material which are held against the walls by the element 27 and by the flange 24, respectively. Each of the bodies of sound absorbing material preferably consists of a mat of hair felt 28 covered by a layer of burlap or other porous fabric 29 secured to the mat during the felting operation, or by "punching", or by an adhesive, but may be constructed of any other suitable material or combinations of materials.

The interior of the compartment 21 is divided into a primary resonance chamber 30 and two secondary resonance chambers 31 and 32 by an annular partition 33 whose outer and inner edges are circumferentially secured to the shell 17 and the tube 23, respectively, and an annular partition 34 whose outer and inner edges are circumferentially secured to the shell 17 and the tube 25, respectively. Communication between the secondary resonance chambers 31 and 32 and the primary resonance chamber 30 is established by tubes 35 and 36 which extend through openings in, and are circumferentially secured to, the partitions 33 and 34, respectively.

As shown in Figure 1 of the drawings, the silencer 16 is adapted to be installed on the air intake tube of the carburetor of an internal combustion engine by inserting one end of the tube 25 into the carburetor air intake tube and suitably securing it thereto. When the silencer is so installed and the engine is operating, the suction created by the cylinders on their suction strokes, will draw air through the openings 26, into the compartment 20 and, thence, into the tube 23, whence it will pass through the tube 25, the car-

buretor and the intake manifold into the cylinders of the engine. Since, as is apparent from the drawings, there is an unobstructed path through the silencer into the air intake tube of the carburetor, the silencer will offer practically no resistance to the passage of air therethrough.

The resonance unit (which consists of the resonance chambers 30, 31 and 32, the passages which interconnect them and the passage which interconnects the primary resonance chamber 30 and the main passage 23—25) of the silencer 16 is so proportioned and dimensioned in the manner set forth in my co-pending application Serial No. 470,700 and the corresponding foreign patents, viz., Canadian Patent No. 348,037, British Patent No. 391,180, French Patent No. 720,611 and Italian Patent No. 300,037, that it will respond to and attenuate the objectionable sound waves of relatively low frequency which are ordinarily transmitted through the intake manifold and carburetor of the engine to the atmosphere. The objectionable sound waves of relatively high frequency which are ordinarily transmitted through the intake manifold and carburetor of the engine to the atmosphere are attenuated by the bodies of sound absorbing material with which the compartment 20 is lined. Thus, by their conjoint action, the resonance unit and the sound absorbing material effectually attenuate all of the objectionable sound waves which are ordinarily transmitted through the intake manifold and carburetor of the engine to the atmosphere and eliminate the so-called "intake noises" which are ordinarily found in internal combustion engines.

To illustrate some of the many forms which resonance units in which the invention with which this application is concerned is embodied may assume, I have included in the drawings Figures 3 to 6, inclusive. It is to be understood that the structures illustrated in Figures 3 to 6 of the drawings, as well as those shown in Figures 1 and 2, may be modified in many ways as to details of construction and that modified structural features shown in any of the figures may be incorporated in the resonance units shown in any other or others of the figures.

The resonance unit which is shown in Figure 3 of the drawings includes a shell 40 over whose opposite ends there are secured heads 41 and 42. Through the heads and the interior of the shell, there extends a tube 43, which, through its projecting end 44, is adapted to be connected to the air intake tube of a carburetor so as to form an extension thereof. The space between the shell 40 and the tube 43 is divided by partitions 45, 46 and 47 into resonance chambers 48, 49, 50 and 51 of which the resonance chambers 48 and 50 are directly connected to the interior of the tube 43 by tubes 52 and 53, respectively. The resonance chambers 48 and 49 are interconnected by a tube 54 which extends through the partition 45, the resonance chambers 49 and 50 by a tube 55 which extends through the partition 46 and the resonance chambers 50 and 51 by a tube 56 which extends through the partition 47. By reason of the fact that they are interconnected as described above and the fact that the resonance chamber 48 is directly connected to the interior of the tube 43, the resonance chambers 48, 49, 50 and 51 may be considered, respectively, primary, secondary, tertiary and quaternary resonance chambers. By reason of the fact that they are interconnected as described above and the fact that the resonance chamber 50 is directly connected to the interior of the tube 43, the resonance chambers 48, 49, 50 and 51 may be considered, respectively, tertiary, secondary, primary and secondary resonance chambers. In view of what was said in the sentence next preceding this, it will be apparent that, the resonance unit shown in Figure 3 is the equivalent of a resonance unit of the type shown in Figure 2 plus a resonance chamber directly connected to the passage 23—25 and one of the resonance chambers 31 and 32.

The resonance unit which is shown in Figure 4 of the drawings includes a shell 60 over whose opposite ends there are secured heads 61 and 62. Through the heads and the interior of the shell there extends a tube 63, which through its projecting end 64, is adapted to be connected to the air intake tube of a carburetor so as to form an extension thereof. The space between the shell 60 and the tube 63 is divided by partitions 65, 66 and 67 into resonance chambers 68, 69, 70 and 71 of which the resonance chamber 68 is directly connected to the interior of the tube 63 by a tube 72. The resonance chamber 68 is directly connected to the resonance chambers 69, 70 and 71 by tubes 73, 74 and 75 which extend through the partition 65, the partitions 65 and 66 and the partitions 65, 66 and 67, respectively. The resonance chamber 69 is directly connected to the resonance chambers 70 and 71 by tubes 76 and 77 which extend through the partition 66 and the partitions 66 and 67, respectively. The resonance chamber 70 is directly connected to the resonance chamber 71 by a tube 78 which extends through the partition 67. While the resonance chamber 68 can be considered only as a primary resonance chamber, the resonance chambers 69, 70 and 71, by virtue of the fact that each is connected directly to the other and to the primary resonance chamber 68, can be considered as secondary, tertiary or quaternary resonance chambers. In view of what was said in the sentence next preceding this, it will be apparent that the resonance unit shown in Figure 4 is the equivalent of a resonance unit of the type shown in Figure 2 in which the secondary chambers 31 and 32 are directly interconnected and to which there has been added a resonance chamber directly connected to each of the chambers 30, 31 and 32. Obviously one or more of the tubes 73, 74, 75, 76, 77 and 78 may be omitted and the characteristics of the resonance unit shown in Figure 4 thus modified.

The resonance unit which is shown in Figure 5 of the drawings includes a shell 80 over whose opposite ends there are secured heads 81 and 82. Through the heads and the interior of the shell, there extends a tube 83, which through its projecting end 84, is adapted to be connected to the air intake tube of a carburetor so as to form an extension thereof. The space between the shell 80 and the tube 83 is divided by partitions 85 and 86 into resonance chambers 87, 88 and 89 of which the resonance chamber 88 is directly connected to the interior of the tube 83 by a tube 90. Each of the resonance chambers 87 and 89 is directly connected to the resonance chamber 88, the former by a tube 91 which extends through the partition 85 and the latter by a tube 92 which extends through the partition 86. The resonance chambers 87 and 89 are directly interconnected by a tube 93 which extends through the partitions 85 and 86 and to whose intermediate portion there is connected a tube 94 which extends through the wall of the shell 80 and connects the tube 93 with

the atmosphere. While the resonance chamber 88 can be considered only as a primary resonance chamber, the resonance chambers 87 and 89, by virtue of the fact that each is directly connected to the other and to the primary resonance chamber, can be considered as either secondary or tertiary resonance chambers. It will be obvious that the tube 93 and/or the tube 94 may be omitted and that if both are omitted, the resonance unit shown in Figure 5 will be equivalent to a resonance unit of the type shown in Figure 2.

The resonance unit which is shown in Figure 6 of the drawings includes a tube 100 which is adapted to be connected to the air intake tube of a carburetor so as to form an extension thereof and a shell 101 over whose opposite ends there are secured heads 102 and 103, respectively. The tube 100 and the shell 101 are interconnected by a tube 104 which extends through the head 102 and a partition 105 which sub-divides the interior of the shell longitudinally into a resonance chamber 106 and a cylindrical compartment. The cylindrical compartment is sub-divided into an annular compartment and a smaller cylindrical compartment by a cylindrical partition 107. The annular compartment is sub-divided longitudinally into resonance chambers 108, 109 and 110 by partitions 111 and 112 and the smaller cylindrical compartment is sub-divided longitudinally into resonance chambers 113, 114 and 115 by partitions 116 and 117. The resonance chamber 106 and the tube 104 are interconnected by an opening 118 in the wall of the tube. The resonance chamber 113 is connected to the resonance chambers 108 and 115 by tubes 119 and 120, respectively, which extend through the partition 107 and the partition 116, the resonance chamber 114 and the partition 117, respectively. The resonance chamber 114 is connected to the tube 120 and the resonance chamber 109, respectively, by an opening 121 in the wall of the tube 120 and a tube 122 which extends through the partition 107, respectively. The resonance chambers 110 and 115 are interconnected by a tube 123 which extends through the partition 107. Because of their relation to the tube 100 and to each other, the resonance chambers 106, 108, 109, 110, 113, 114 and 115 which are incorporated in the resonance unit shown in Figure 6 are to be considered, respectively, sub-primary, secondary, secondary sub-secondary, tertiary, primary, sub-secondary and secondary resonance chambers. In view of what was said in the sentence next preceding this, it will be apparent that the resonance unit shown in Figure 6 is the equivalent of a resonance unit of the type shown in Figure 2, plus (1) a resonance chamber communicating directly with the passage which interconnects the resonance chamber 30 and the passage 23—25, (2) an interconnected pair of resonance chambers of which one is connected directly to the passage which interconnects one of the resonance chambers 31 and 32 with resonance chamber 30 and (3) a resonance chamber directly connected to the other of the resonance chambers 31 and 32.

Although the resonance units herein disclosed are particularly adapted for use in attenuating the sound waves which are ordinarily transmitted through the intake manifold and carburetor of an internal combustion engine to the atmosphere, resonance units of the same type may be effectually used to attenuate sound waves in any enclosure of finite dimensions. It will, of course, be understood that, in designing resonance units for use in any installation, it is necessary so to proportion and dimension them in the manner set forth in my co-pending application Serial No. 470,700 and the corresponding foreign patents that they will respond to the sound waves which they are intended to attenuate.

While it will be understood that effectually to attenuate the sound waves which travel through the exhaust pipe of an internal combustion engine toward the atmosphere, it is generally desirable to employ somewhat differently designed resonance units than are employed on the induction systems of such engines and that, in general, it is preferable to employ for this purpose resonance units, such as are disclosed in my co-pending application Serial No. 633,265 in which there are provided a greater number of resonance chambers than are necessary in resonance units which are designed for use on the induction systems of such engines, I have, for the purpose of indicating the applicability of resonance units of the type with which this application is concerned to the exhaust systems of internal combustion engines, shown in Figure 1 of the drawings the resonance unit 57 which is shown in Figure 3 of the drawings installed on the exhaust pipe 14 of the engine 10 with the projecting end 44 of the tube 43 telescopically connected with the portion of the exhaust pipe which is located on the engine side of the resonance unit.

I claim:

1. The combination, with a passage or other enclosure within which sound waves occur, of a side branch which includes a plurality of compartments which communicate with the enclosure independently of each other and intercommunicate independently of the enclosure and is so proportioned and dimensioned that it responds to and attenuates by resonance objectionable sound waves which occur within the enclosure.

2. The combination, with a duct through which sound waves and gases travel, of a resonator which is arranged as a branch of the duct and is so tuned that it responds to and attenuates by resonance sound waves of a pre-selected frequency which travel through the duct, the resonator including a plurality of chambers of which two communicate with the duct independently of each other and with a third independently of the duct and each other.

3. The combination, with a duct through which gases and sound waves travel, of a resonator which is arranged as a branch of the duct and so tuned that it responds to and attenuates by resonance sound waves of a preselected frequency which travel through the duct, the resonator including a wall which encircles and is radially spaced from a portion of the duct, walls which with the duct and the first-specified wall define a compartment, and partitions which subdivide the compartment into three chambers of which two communicate restrictedly with the duct and the third independently of the duct and each other.

4. In a silencer, a duct through which sound waves may travel, a wall which encircles and is radially spaced from a portion of the duct, walls which with the duct and the first-specified wall define a compartment which encircles the duct and is without the path of travel of gases through the silencer, partitions which subdivide the compartment lengthwise into chambers of which the end chambers in a series of three communicate with the duct independently of each other, and orifices in the partitions between the intermediate

and the end chambers in the series of three which connect the intermediate chamber to the end chambers.

5. The combination, with a duct through which gas and sound waves travel, of a resonator which is arranged as a branch of the duct and so tuned that it responds to and attenuates by resonance sound waves of a preselected frequency which enter the duct, the resonator including a wall which encircles and is radially spaced from a portion of the duct, walls which with the duct and the first-specified wall define a compartment which encircles the duct, and a partition which subdivides the compartment lengthwise into a plurality of chambers which communicate with the duct independently of each other and with each other independently of the duct.

ERNEST E. WILSON.