March 12, 1957 L. M. BURROWS 2,784,693

AIR WHISTLE

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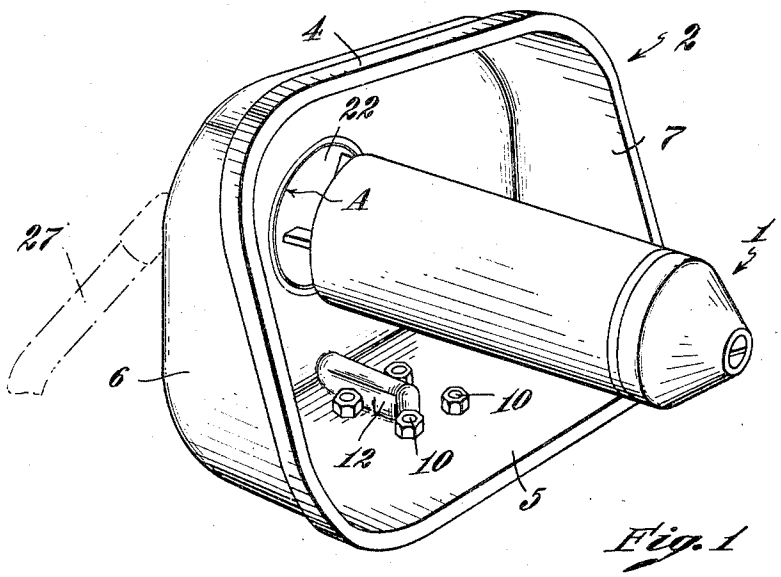


Fig. 1

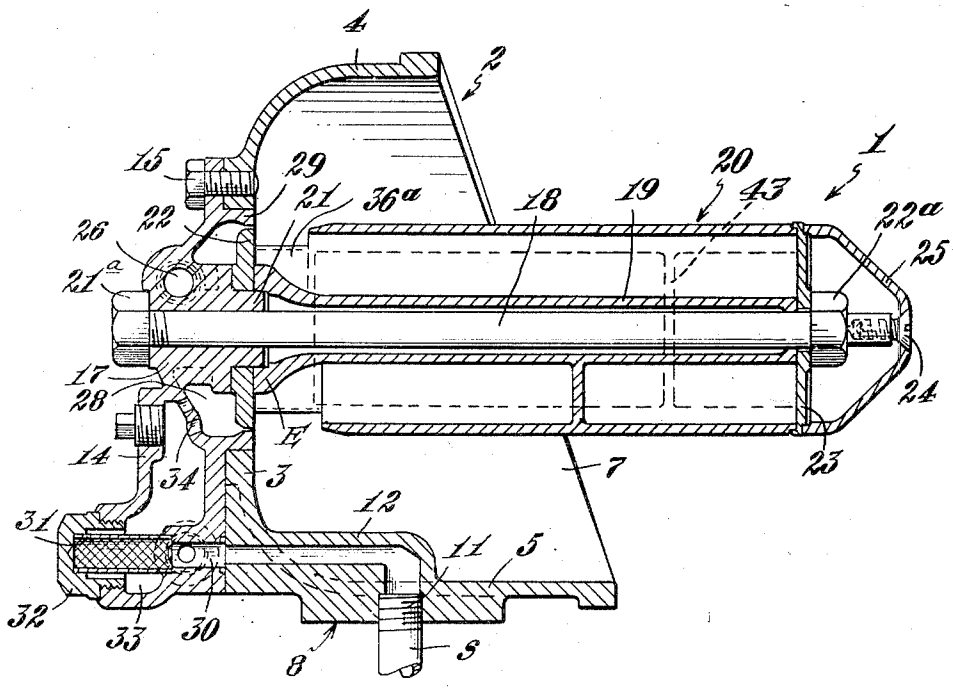


Fig. 2

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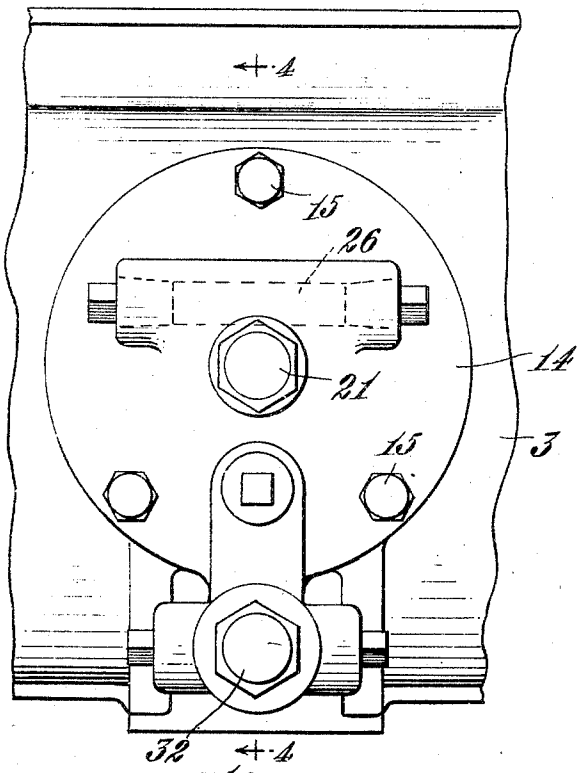


Fig. 3

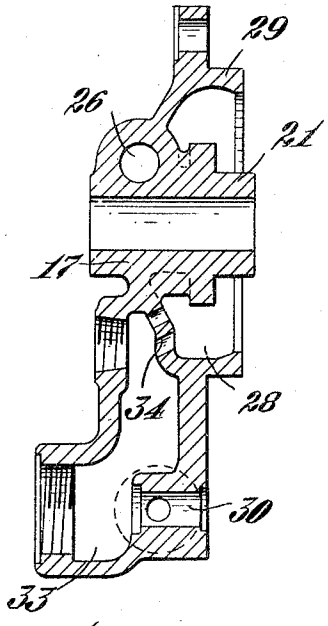


Fig. 4

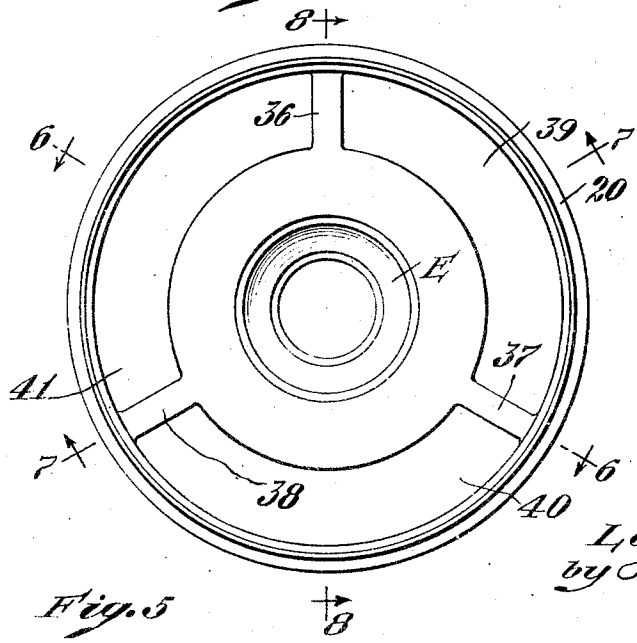


Fig. 5

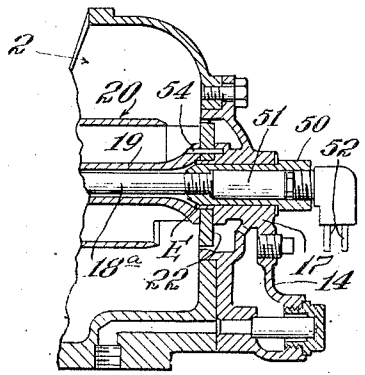


Fig. 23

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AIR WHISTLE

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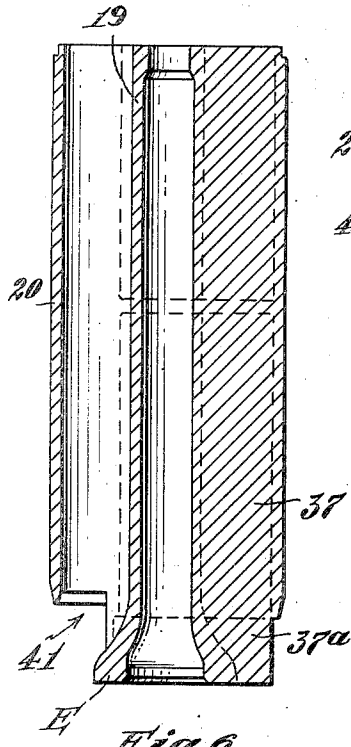


Fig. 6

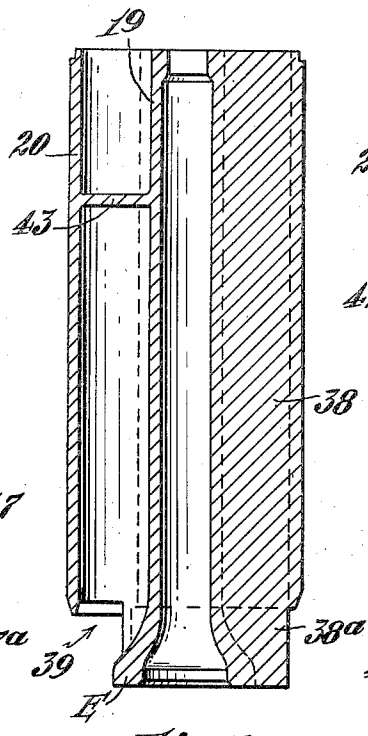


Fig. 7

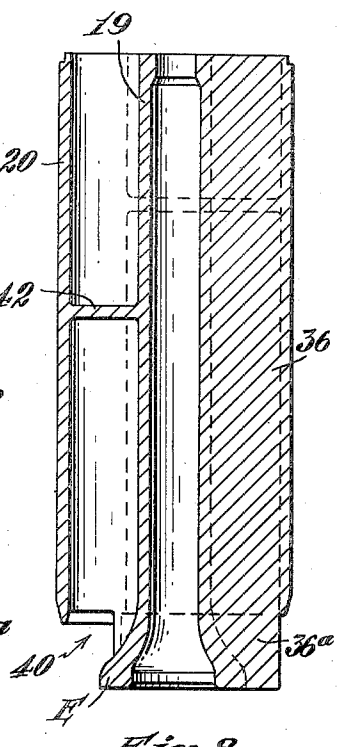


Fig. 8

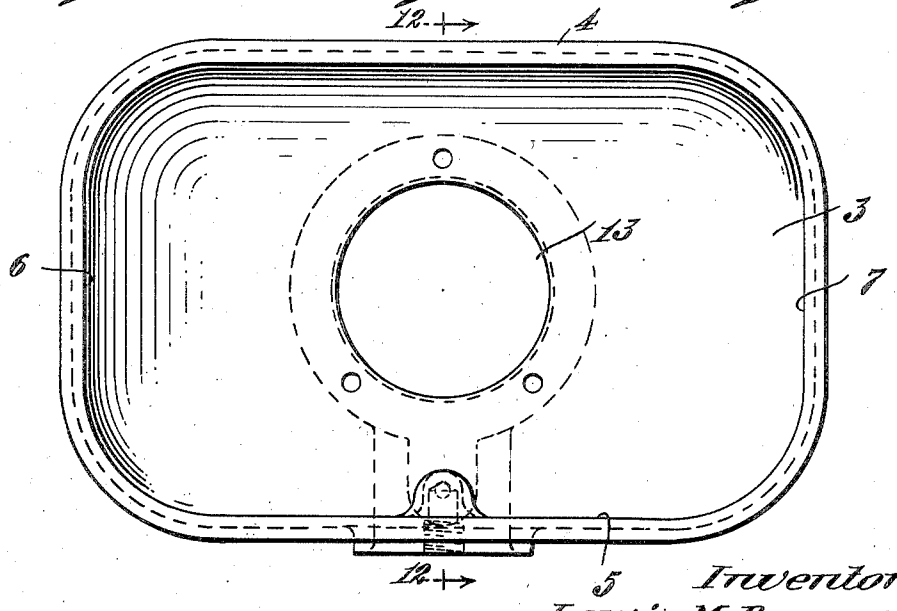


Fig. 9

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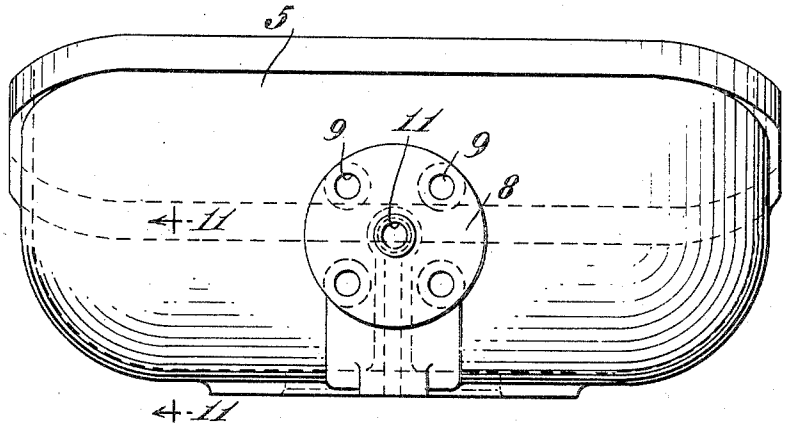


Fig. 10

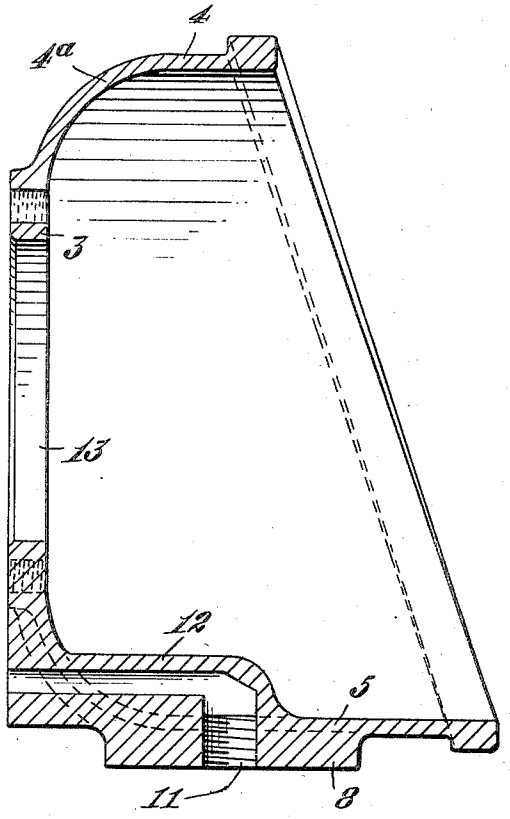


Fig. 12

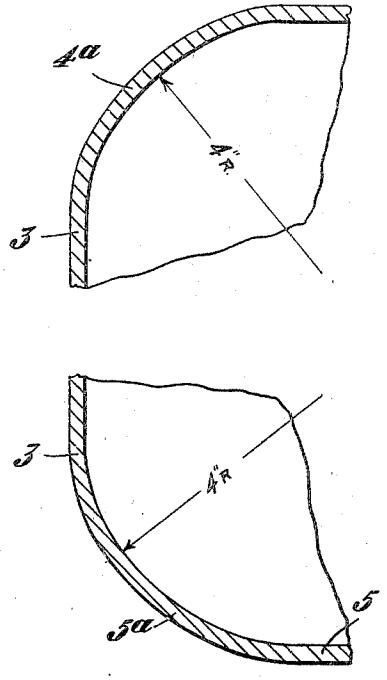


Fig. 11

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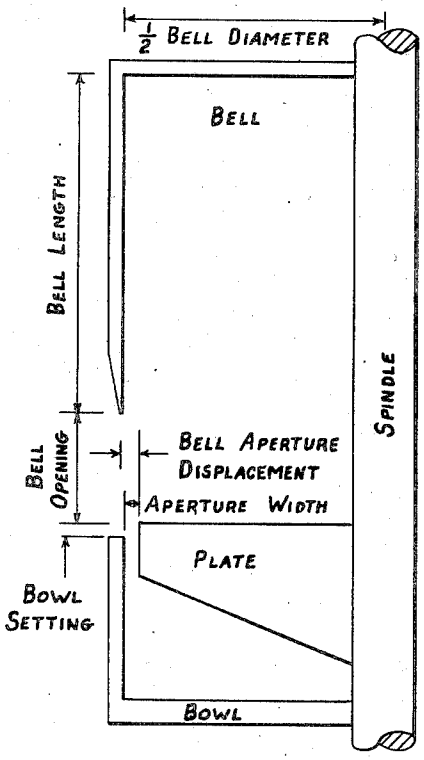


Fig. 13

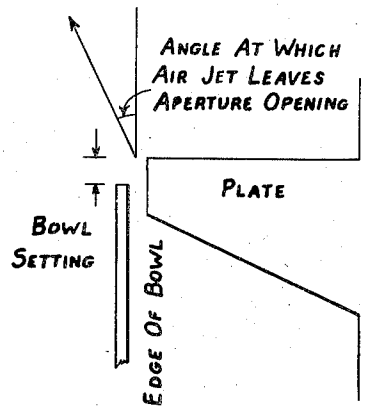


Fig. 14

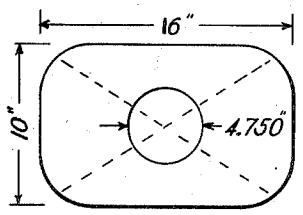


Fig. 18

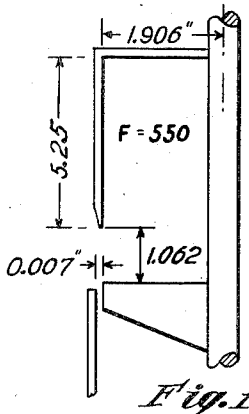


Fig. 15

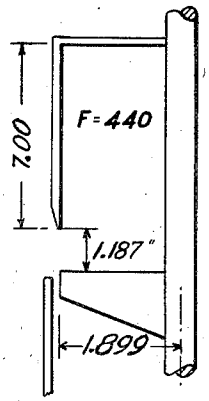


Fig. 16

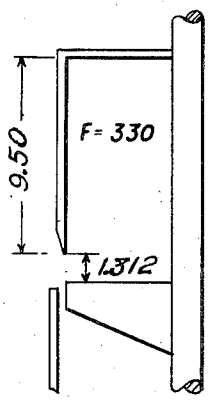


Fig. 17

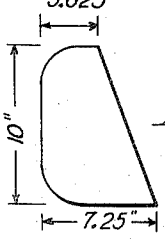


Fig. 19

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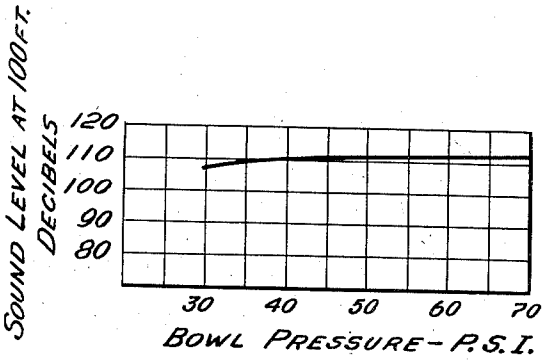


Fig. 20

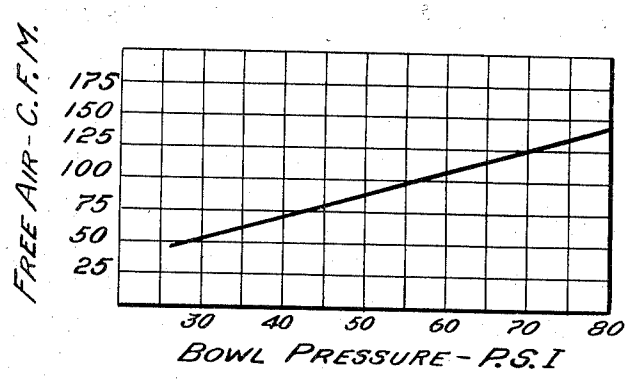


Fig. 21

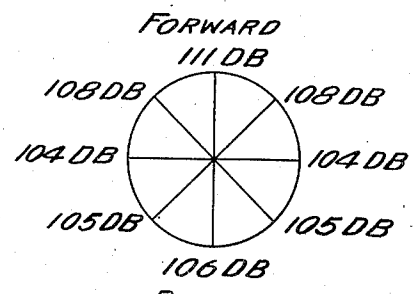


Fig. 22

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United States Patent Office 2,784,693 Patented Mar. 12, 1957

2,784,693

AIR WHISTLE

Lewis M. Burrows, North Quincy, Mass., assignor to Manning, Maxwell & Moore, Incorporated, New York, N. Y., a corporation of New Jersey

Application July 17, 1953, Serial No. 368,657

12 Claims. (Cl. 116—137)

This invention pertains to signals, more especially to a sound-emitting device of the whistle type wherein a compressed gaseous fluid, escaping through an orifice, provides the energy which creates vibrations of audible frequency in the ambient atmosphere. Signals of the whistle type are used for many purposes, a common example being the steam whistle of a locomotive.

The introduction of diesel engines as replacements for the old steam locomotives on the railroads of America created an interesting acoustical problem. The whistle which was used for decades on the steam locomotive is inherently an inefficient device which consumes large quantities of steam. On the modern diesel engine only a very limited amount of steam is available for heating purposes. When the diesels were first introduced, a substitute warning device had to be developed to replace the old steam whistle. The substitute which has found the most extensive usage on nearly all the dieselized railroads of the country is of the pneuphonic horn or diaphone type. In this device, sound is produced by the rapid pulsing of an air stream by means of a circular diaphragm located at the throat of a horn which is often exponential in shape. The compressor which provides air for the train's braking system is used to drive this type of whistle.

The sound emitted by the diaphone is of an entirely different character from that of the old steam locomotive whistle. It sounds very much like the horns used on large trucks and buses and, for that reason, has been directly responsible for several serious grade-crossing accidents. Many observers report that the "blat" which characterizes the sound of the pneuphonic horn is quite unpleasant, wakens people at night, and is general a source of annoyance.

It might be supposed that an air-blown whistle would have been employed on the diesel locomotive, but whistles of usual construction, are, as above noted, very inefficient, requiring large volumes of high-pressure fluid. On the diesel locomotive, the available blowing pressure is fixed by the maximum pressure that the air compressor for the train's braking system is able to maintain in its reservoir, which is between 130 and 140 pounds per square inch. A heavy drain on the air supply may remove more air than the compressor is able to replace; and the pressure in the reservoir will then drop appreciably. If the air consumption of the whistle is large, the resulting reduction in air pressure will cause a decrease in both the acoustic power output and the operating frequency of the whistle. Such a situation would be inacceptable both from the acoustical standpoint and from the point of view of railroad safety. A rapid dimunition of the air in the compressor reservoir may result in the engineer's losing control of the train's braking system. Thus the capacity of the compressor and the air-brake requirements limit the amount of air available to blow the whistle. The minimum air requirements of the braking system are imperfectly known, but the railroads do not wish a whistle to use more than from 100 to 150 cubic feet of air per minute.

The sound emitted by the ordinary railroad steam locomotive whistle is distinct and readily recognized and because of its use for almost a century it has become an accepted American tradition. On the other hand, the diaphone horn now in general use on diesel locomotives, and which is a relatively newcomer, has not replaced the old steam whistle to the satisfaction nor to the safety of the general public.

The principal object of the present invention is to provide an acceptable signal of the whistle type for use on diesel locomotives. A further object of the present invention is to provide a signal whistle of such design as to be applicable, as a practical matter, to a diesel locomotive and which will produce a sound as nearly as possible resembling that of the steam locomotive whistle, a sound which through long association has become meaningful and even pleasant to people in general.

As above noted, the blowing of the customary steam whistle requires the employment of compressed fluid at high pressures and in large amounts. The present invention has as a further object the provision of a whistle having as nearly as possible the same acoustic quality as the customary steam whistle and approximately the same or better carrying power and degree of loudness but which, at the same time, may be operated by the compressed air available on a diesel locomotive without unduly depleting the available supply of compressed air and without requiring an increase in the pressure of the air available. Other and further objects and advantages of the invention will be pointed out in the following more detailed description and by reference to the accompanying drawings wherein

Fig. 1 is a perspective view of a whistle embodying the principle of the present invention;

Fig. 2 is a vertical section to somewhat larger scale than Fig. 1 on the axis of the whistle bell;

Fig. 3 is a fragmentary rear elevation of the whistle assembly, to larger scale than Fig. 2;

Fig. 4 is a section, substantially on the line 4—4 of Fig. 3, showing details of the rear member of the whistle through which the pressure fluid is distributed;

Fig. 5 is a rear elevation, to larger scale than Fig. 2, of the bell removed from other parts;

Figs. 6, 7 and 8 are longitudinal sections through the bell, to smaller scale than Fig. 5, but on the lines 6—6, 7—7 and 8—8 of Fig. 5;

Fig. 9 is a front elevation of the reflector or resonator with other parts removed;

Fig. 10 is a bottom view of the reflector or resonator separate from the other parts;

Fig. 11 is a fragmentary section, approximately on the line 11—11 of Fig. 10 and to larger scale;

Fig. 12 is a section on the line 12—12 of Fig. 9, to larger scale;

Fig. 13 is a diagram for use in defining the component parts of the whistle;

Fig. 14 is a diagram showing the effect, on the direction of the air jet, of placing the edge of the bowl below the plane of the forward face of the orifice plate;

Figs. 15 to 19 are diagrams showing actual dimensions for optimum results;

Figs. 20 and 21 are graphs showing the performance of the whistle;

Fig. 22 is a diagram showing the directional loudness of the emitted sound; and

Fig. 23 is a fragmentary section, generally similar to Fig. 2, but illustrating a modification.

Preliminary investigation showed that little data was available with respect to the power consumed by or the

efficiency of steam whisles or, in fact, any sound-emitting instruments, and that even the theory of sound production of a whistle is uncertain. Accordingly, extended experiment was carried out with a steam whistle of conventional type with the object of determining its manner or sound production; its efficiency in terms of kinetic energy expended in blowing it; the quality of the tone emitted by such a whistle; the sound level (loudness in decibles) at different distances and in different directions from the whistle; the spectrum analysis of the emitted sound to determine what frequency components were dominant; and to determine the effect of variations in the blowing pressure. These experiments were conducted with the most modern types of equipment and the data thus obtained was carefully analyzed.

As the result of this investigation it was determined, among other things, that the efficiency of the conventional steam whistle is exceedingly low, being of the order of a few tenths of 1%. It was also found that the efficiency increased in a varying ratio as the blowing pressure increased. Since the steam whistle employed in making these experiments consumed approximately 1000 cubic feet of steam per minute, at a gauge pressure of approximately 200 pounds per square inch, and since the air available on a diesel locomotive for blowing a whistle would not usually exceed 140 pounds per square inch, and since the maximum permissible quantity of air for blowing such a whistle should not greatly exceed 150 cubic feet per minute, it became apparent that if an air-blown whistle was to be used, its efficiency must be much greater than that of the conventional steam whistle. This situation seemed to indicate that some other type of sounding instrument should be employed, but excessive expense of manufacture; the necessity for auxiliary electrical equipment of various types; inability to emit sounds of sufficient loudness, carrying capacity or quality; or their demand for excessive amounts of compressed air ruled out of further consideration such prior sound-emitting devices as modulated air-flow loud speakers; air driven or electrically driven sirens; the Hartmann air jet generator; longitudinally vibrating rods; the acoustical phonograph, etc., as well as the diaphones already in use. Thus the only alternative appeared to lie in the attempt to devise an air-blown whistle of an efficiency so high, as compared with the usual steam whistle, as to make it applicable to a diesel locomotive.

By the use of an octave band analyzer it was found that the important frequency components of the sound emitted by the usual steam whistle were in the bands, from 150 to 300; 300 to 600; and 600 to 1200 cycles per second. Accordingly, if the air-blown whistle was to simulate the sound emitted by the steam whistle, its frequency should be predominantly within those frequency bands. Furthermore by the use of a sound level meter it was found that the sound level at 100 feet from the steam whistle, blown with steam at a gauge pressure of approximately 200 pounds per square inch, was approximately 108 decibels. For acceptance as a warning signal on a locomotive, the air whistle should produce a sound of approximately the same level of loudness.

That part of the sound emitted by the whistle of a steam locomotive, which is most effective for its intended purpose, is that which is projected forwardly of the locomotive and it has heretofore been proposed to provide reflectors, usually of parabolic type with the purpose of directing the major part of the sound energy forwardly. Apparently such reflectors has not heretofore been found effective for the intended purpose, and experiment appears to show that parabolic reflectors of the type heretofore proposed have little real value in so far as directing sound is concerned.

As noted, little is actually known of the theory of sound production by a whistle. However, it appears to depend upon the production of instability (with consequent rapid

fluctuation or transverse vibration) in the fluid jet. It has been observed that with steam, best results are obtained if the jet blows directly into the bell chamber. Possibly the delivery of steam into the bell chamber creates a pressure condition which diverts the jet across the lip of the bell and in so doing sets up fluctuations or vibrations in the jet. On the other hand when using air, best results are obtained when the radius of the air stream is the same as that of the lip of the bell, that is to say, the orifice must be directly under the lip.

The experiments conducted as above noted show that there are at least nine independent significant variables which contribute to and affect the operation of a whistle, these being (1) the bell opening, (2) the bell diameter, (3) the bowl setting, (4) the orifice width, (5) the bell-orifice displacement, (6) the bell length, (7) the shape of the bell edge, (8) the blowing pressure, and (9) the partitioning between neighboring chambers of the bell if the whistle be designed to sound within different frequency bands. The first seven of these variables determine the velocity, width, length and direction of the air stream which is delivered from the orifice in a thin, circular sheet which strikes the free edge of the bell. Variables (2), (3), (4) and (8) determine the amount of air required to blow the whistle. All of these variables influence the frequency spectrum, the acoustical power output and the radiation pattern of the whistle.

An air whistle designed for the specific intended purpose must establish a sound pressure level of 102 ± 1 decibles at a distance of 100 feet from the whistle, assuming that the whistle will be located approximately 12 feet from the ground (which is the usual diesel height) with the sound-measuring instrument at approximately the height of a person's head from the ground. Among the variables which affect the operation of the whistle, some of them are of more importance than others, for example the bell length is more important with respect to output frequency than either bell diameter or bell setting, but only when each of these factors is at its optimum value does the whistle perform at the desired frequency, and as soon as any one of these designated variables drops below the optimum, the sound quality deteriorates and the fundamental frequency diminishes. The efficiency with which sound is radiated depends upon the ratio of the size of the radiator (that is to say the bell diameter) to the wave length of the sound emitted which, in the case of a frequency of the order of 300 cycles per second would be about 4 feet. The larger the value of the ratio, the more effectively the whistle will be matched to its air load and the higher will be its efficiency. Thus it is important that the bell diameter be made as large as possible, compatible with other factors. Evidently, if the orifice be of excessive width, an unduly large amount of air will be necessary to operate the whistle. Thus, if the quantity of air available for blowing is not to exceed 110 cubic meet, or thereabouts, an annular orifice of large diameter will be necessarily exceedingly narrow.

It has been found that the aperture width can be reduced well below that normally employed in steam whistles, thereby not only obtaining a better economy of air, but producing a steadier, clearer tone. However, there is a low limit to the width of the orifice, it being found that an aperture as small as 0.001 inch rapidly clogs with solid matter contained in the air stream. Moreover, the manufacturing of a whistle having an orifice less than from 0.001 to 0.002 inch involves substantial difficulties, making use of such small apertures impractical. A manufacturing tolerance of 0.002 inch would not be unreasonable. If such a tolerance be allowed and a specified orifice width of 0.003 inch were to be employed, variations in width (within the above tolerance range) might result in an actual variation from the specified width of 62½%. By using a reasonably small bell diameter and a wider delivery orifice (with the same tolerances) the percent varia-

tion in actual manufactured width would be greatly reduced. (It may be noted at this point that practical filters are available to screen out particles from the air which would plug an orifice of 0.005 inch in width.) Taking into account the above factors, it appears that an orifice width of 0.007 inch is the most desirable when using air at the rate of approximately 100 cubic feet per minute. Such a width of orifice permits an orifice whose inner diameter is 3.812 inches, allowing the use of a bell as large as 3.812 inches in internal diameter.

For a given whistle, with all other factors held constant, the sound level reaches a maximum at one particular value of bell opening and variation on either side of this value results in a rapid lowering of the sound level. For example, a whistle operating at 300 cycles per second with a 0.010 inch aperture and with a blowing pressure of eighty pounds per square inch, diminishes in sound output about six decibels when the bell opening is increased or decreased by as much as 0.15 inch from the optimum width. Thus the bell opening for any given frequency is very critical. For a three-tone whistle having frequencies of 330, 440, and 550 the corresponding optimum lengths of the bell openings were found to be 1.312 inches; 1.187 inches; and 1.062 inches. When, in order to simplify construction, it was attempted to employ a uniform length bell opening which was the average of the above three lengths, the result was that the level of sound output was decreased by approximately 50%.

As to the effect of blowing pressure with a bell opening of given width, the sound level appears to vary in direct proportion to the blowing pressure. Likewise, if the bell diameter be varied, all other factors being kept constant, the sound output level seems to increase continuously in accordance with the increase in bell diameter.

If the bowl be moved in one direction or the other along the spindle, it has ben found that a change in bowl setting of as much as 0.010 inch would change the angle at which the air jet leaves the orifice by as much as fifty degrees, and that the amount of air consumed was increased if the orifice plate was arranged either above or below the edge of the bowl. A minimum amount of air is consumed when the orifice plate is level with the edge of the bowl, and with this setting the air jet leaves the orifice at an angle of 90 degrees with the plate.

At one particular value of the bell aperture displacement, the sound level and efficiency are at a maximum and drop at either side of this setting. The length of the bell is a primary factor which determines fundamental frequency and since the frequency decreases as the bell length is increased, the sound level decreases like-wise with increase in bell length.

As already noted, the sound level varies with the blowing pressure, there usually being an optimum pressure for a whistle of any given dimensions, although it is noted that the frequency increases with the blowing pressure. A resonator having certain definite structural characteristics can effectively increase the sound level in a forward direction, as compared with that emitted by the whistle without such resonator, and by the use of this particular resonator the sound in a rearward direction is at the same time increased.

The whistle structure now about to be described with particular reference to the annexed drawings produces a tone (when consuming not more than 110 cubic feet per minute and when blown with air at a pressure of fifty-five pounds per square inch) which closely resembles that of the usual locomotive steam whistle, and has a loudness, in the direction of travel, of approximately 111 decibels measured at a distance of 100 feet from the whistle, as compared with a loudness of 108 decibels emitted by the usual steam whistle, and shows an efficiency, as nearly as it is practical to determine it, as compared with that of the usual steam whistle of more than 10:1.

This whistle is a three-tone or chime type of whistle

producing frequencies of 330, 440 or 550 cycles per second, respectively.

The sound-emitting device or whistle proper is indicated in the drawings by the numeral **1** (Figs. 1 and 2) and the resonator by the numeral **2**. As here illustrated, the resonator constitutes a support for the whistle proper and for a separate base member carrying the parts which define the delivery orifice. The resonator (Figs. 1, 2, 9, 10, 11 and 12) is here illustrated as a unitary casting of cast iron on other appropriate material resistant to corrosion and comprises the vertical rear wall **3**, the horizontal top and bottom walls **4** and **5**, and the vertical end or side walls **6** and **7**, the axis of the whistle proper being here shown as horizontal. Specific structural details and suitable dimensions of the resonator will be described hereinafter. The back wall **3** (Fig. 10) of the resonator has a pad provided with a finished under surface **8** designed to rest upon a suitable support, for instance a bracket secured to the locomotive structure, the pad having openings **9** (Fig. 10) for attaching bolts **10** (Fig. 1). The bottom wall **5** also has an internally screw threaded, vertical bore **11** (Figs. 2 and 12) for the reception of the upper end of an air supply pipe S (Fig. 2) leading from a control valve (not shown) by means of which air from the reservoir on the locomotive may be delivered, when desired, to the whistle.

The bottom wall 5 of the resonator has an integral, elongate upstanding hollow boss **12** (Fig. 1) providing a horizontal passage which leads from the bore **11** to the rear surface of the rear wall **3**. The rear wall has a large aperture **13** (Fig. 9) whose axis is at the center of symmetry of the rear wall **3** and which is designed to receive the orifice-defining elements of the whistle proper. To the back side of the rear wall **3** of the resonator a separate base member **14** (Figs. 2, 3 and 4) is secured by bolts **15**. This base member is a unitary casting and comprises a part **17** having a horizontal bore (coaxial with the aperture **13**) which receives the rear end of a rod **18** (Fig. 2) over which is telescoped the hollow spindle portion **19** of the whistle bell **20**. The part **17** of the base **14** has a cylindrical forward portion **21** on which is fitted the orifice plate **22** (Fig. 2), the latter forming an abutment for the rear or inner inlarged end of the spindle **19**. The bell spindle is clamped to the part **17** of the base by the rod **18**, the latter having a nut **21a** at its rear end which engages the part **17**, and a nut **22a** at its forward end which bears against an end plate **23** (Fig. 2) forming a closure for the forward end of the bell proper and which contacts the forward end of the tubular spindle **19**. The extreme forward end of the rod **18** has an internally screw threaded axial bore for the reception of a screw **24** by means of which a forwardly tapering finish cap **25** is secured in place. This cap has no operative function, so far as the production of sound is concerned, but provides a pleasing finish and also reduces air resistance to the forward motion of the whistle structure. As illustrated in Figs. 2 and 4, the part **17** of the whistle base has a chamber **26** for the reception of a heating element (desirable in cold weather to prevent accumulation of frost or snow within the whistle orifice). This heating element is supplied with electrical current from a suitable source by means of a conductor **27** (Fig. 1). The base **14** has an annular cavity **28** (Figs. 2 and 4) surrounding the parts **17**, the outer wall of this cavity constituting the whistle "bowl," the forward surface of the wall **29** being flush with the forward surface of the orifice plate **22**. The annular space A (Fig. 1) between the outer edge of the orifice plate **22** and the inner edge of the bowl **29** constitutes the air delivery orifice of the whistle.

The base **14** has a bore **30** (Fig. 4) which is aligned with a horizontal passage in the boss **12** of the bottom wall of the resonator and is shaped at its rear end to receive the forward end of a cylindrical filter **31** (Fig. 2) of any suitable material, for example bronze wire mesh,

whose opposite end is received in a socket in a removable plug **32**. The boss **14** has a chamber **33** for the reception of the air which passes radially out through the filter cylinder, and from this chamber a passage **34** leads to the annular chamber **28**.

Because the whistle is designed to produce a compound tone made up of frequencies of the order of 550, 440 and 330 cycles per second respectively, the annular space between the hollow spindle **19** and the cylindrical outer wall or bell proper **20**, is divided (as shown in Fig. 5, by longitudinally extending, radial partitions **36**, **37** and **38**, spaced 120 degrees apart) into the resonance chambers **39**, **40** and **41** respectively of proper lengths to produce the tone frequencies above referred to. It is desirable that the partitions **36**, **37** and **38** extend beyond the free edge of the bell proper to the plane of the forward face of the orifice plate **22**, as indicated at **36a**, **37a** and **38a** respectively (Figs. 6, 7 and 8), such an arrangement contributing very materially to the production of tones of the desired frequencies. The forward ends of the respective chambers **39**, **40** and **41** are defined by transverse partitions or forward end walls, the plate **23** constituting the end wall for the longest chamber **41** (Fig. 6) and septums **43** and **42** (integral with the bell **20** and spindle **19**) forming the forward or end walls of the intermediate and shortest chambers **39** and **40** respectively.

For optimum results with respect to loudness of sound, that portion of the lower edge of the bell proper which corresponds to each of the chambers **39**, **40** and **41** respectively is spaced from the plane of the front face of the orifice plate **22** different distances, to wit 1.187 inches; 1.312 inches and 1.062 inches, for the reasons above described. The lower edge of the bell must be beveled or downwardly tapering to a sharp edge.

In a whistle designed for use under the above-described conditions, an annular delivery orifice of 0.007 inch in radial width and with an inner diameter of 3.812 inches provides for optimum effect, the inner diameter of the corresponding bell being 3.812 inches, for the reasons above described.

As above noted, the front face of the rear wall **3** of the resonator **2** is flush with the front face of the orifice plate **22**. With the parts proportioned as above described, the annular jet of air which emerges from the orifice A is perpendicular to the front face of the rear wall **3** of the resonator and parallel to the axis of the bell and tends to move forwardly to strike the edge of the lip of the bell.

Mathematical analysis shows that for a whistle of the above design, the resonator should be approximately rectangular, longer horizontally than vertically and with the forward edges of its side or end walls spaced approximately sixteen inches apart and with its top and bottom walls spaced approximately ten inches apart in the vertical plane of the forward edge of the top wall; the front to rear depth of the top wall should be approximately 3⅝ inches and the front to rear depth of the bottom wall should be approximately 7¼ inches. Any substantial variation from the above-described dimensions appears to lessen the effectiveness of the whistle, especially with respect to loudness of tone.

A slight modification is shown in Fig. 23 wherein the parts are generally similar to those illustrated in Fig. 2, but with the heating unit differently and more effectively located. In this modified arrangement, the part **17** of the base member **14** has a horizontal bore which receives a generally cylindrical housing **50** for the heating unit **51** which is supplied with current by the conductors **52**. The housing **50** has a radial external shoulder near its rear end which bears against the rear face of the part **17**. At its forward end the housing is internally screw-threaded for the reception of the rear end of the rod **18a** corresponding to the rod **18** of Fig. 2. When the parts are assembled the tightening of the nut **22a** at the forward end of the rod **18a** draws the housing **50** firmly against the rear face of the part **17** and at the same time clamps the base E of the hollow spindle **19** against the forward face of the orifice plate **22**. In this arrangement, the heating unit is concentric with the orifice A and in good heat conducting relation to the parts which define the orifice.

Extended experiment has shown that the forward motion of the locomotive on which the whistle is mounted affects the operation of the whistle and that the whistle is most effective, while the locomotive is in forward motion, when so arranged that the resonance chamber **40** of highest frequency is at the bottom, while the other chambers are located symmetrically at the top of the bell at opposite sides of the vertical plane of the axis of the whistle. To insure that the bell will be held in this position, a pin **54**, projecting forwardly from the part **17**, is arranged to enter a socket of the base E of the spindle **19**.

An air whistle constructed according to the above dimensional relationships and comprising a resonator such as described produces a loudness of approximately 111 decibels (Fig. 22) measured in the forward direction, and surprisingly produces a loudness of 106 decibels in the rearward direction, although at right angles to the direction of travel, the sound is of the order of 104 decibels. Even without the resonator **2**, the whistle proper, constructed as hereinabove described, is of high efficiency as respects loudness, as compared with the steam whistle, delivering a sound of the order of 102 decibels when blown with air 55 pounds per square inch and using only 110 cubic feet of air per minute, as compared with 108 decibels delivered by a steam whistle blown at 200 pounds per square inch and using 1000 cubic feet per minute.

As above pointed out, many variables are involved in the design of an effective air whistle and little theoretical knowledge is available to assist in such design. However, as the result of extended research and experiment (always keeping in mind the limitations as to blowing pressure and quantity of air available for use in blowing an air whistle designed to be mounted on a diesel type locomotive) the above limiting dimensions have been arrived at as productive of the best and loudest tone. Obviously, if sacrifice of tone quality or loudness be permissible in any given case, these dimensions may be departed from more or less and it is to be understood that specific dimensions appropriate to optimum results have herein been disclosed and incorporated in some, at least, of the appended claims, but that such dimensions are not to be considered as limiting, except with respect to the production of an air whistle for use under the particular conditions above described and with the object of obtaining the optimum results under such conditions.

I claim:

1. An air blown whistle which, when blown by compressed air at a gauge pressure of from 55 to 140 pounds per square inch, emits a sound of a quality and loudness approximating the sound emitted by a conventional steam blown whistle when blown by steam at a gauge pressure of approximately 200 pounds per square inch, said air blown whistle comprising a bell, means defining an annular orifice coaxial with the bell and of an area such as to deliver approximately 110 cubic feet of air a minute when supplied with air at said blowing pressure, the inside diameter of the bell substantially equalling the inside diameter of the orifice, radial partitions, integral with the bell proper, dividing the space within the bell into three resonance chambers each of 120° of arc, said partitions extending down below the low edge of the bell substantially to the plane of the orifice, the several resonance chambers being of lengths corresponding to sound vibration frequencies of approximately 330, 440 and 550 cycles per second, respectively, and a resonator of generally rectangular shape having a substantially flat rear wall which lies in the plane of the orifice, top and bottom walls and substantially vertical side walls, the rear wall being ap-

proximately 16 inches long and 10 inches wide, the top and bottom walls being approximately 3⅝ inches and 7¼ inches in width, respectively, and the free edges of the end walls sloping forwardly and downwardly.

2. An air blown whistle which, when blown by compressed air at a gauge pressure of not more than 140 pounds per square inch, emits a sound of a quality and loudness approximating the sound emitted by a conventional steam blown whistle when blown by steam at a gauge pressure of approximately 200 pounds per square inch, said air blown whistle comprising a bell, means defining an annular orifice coaxial with the bell and of an area such as to deliver not more than 140 cubic feet of air a minute when supplied with air at said blowing pressure, the inside diameter of the bell substantially equalling the inside diameter of the orifice, radial partitions, fixed relatively to and joined leak-tight to the bell proper, dividing the space within the bell into three resonance chambers each of 120° of arc, said partitions extending down below the lower edge of the bell substantially to the plane of the orifice, the several resonance chambers being of lengths corresponding to sound vibration frequencies of approximately 330, 440 and 550 cycles per second, respectively, and a resonator of generally rectangular shape having a substantially flat rear wall which lies in the plane of the orifice, top and bottom walls and substantially vertical side walls, the top and bottom walls being approximately 3⅝ inches and 7¼ inches in width, respectively, and the free edges of the end walls sloping downwardly and forwardly.

3. An air blown whistle according to claim 2, wherein the resonance chamber corresponding to the frequency 550 is at the bottom of the bell.

4. An air blown whistle for use on diesel locomotives and which is designed to be blown by compressed air supplied from the braking system of the locomotive and which, when so blown, emits a sound approximating in quality and loudness of that emitted by a conventional steam whistle when blown by steam at a gauge pressure of approximately 200 pounds per square inch, said air blown whistle having an annular orifice of an area such as to deliver not more than approximately 110 cubic feet of air per minute when supplied with compressed air from said source, the whistle comprising a bell coaxial with the orifice and of an internal diameter substantially equalling the inner diameter of the orifice, longitudinally extending partitions integrally joined to the bell proper and dividing the interior of the bell into three resonance chambers of lengths corresponding to acoustic vibrations of 330, 440 and 550 cycles per second, respectively, each chamber being of 120° circumferential extent, those portions of the lower edge of the bell which correspond to the several chambers being spaced from the plane of the orifice approximately 1.3125, 1.1875 and 1.0625 inches, respectively.

5. An air blown whistle according to claim 4, wherein the resonance chamber corresponding to frequencies 330 and 440 are in the upper part of the bell and symmetrically arranged with respect to a vertical plane through the bell axis.

6. An air blown whistle for use on diesel locomotives and which is designed to be blown by compressed air supplied from the braking system of the locomotive and which, when so blown, emits a sound approximating in quality and loudness that emitted by a conventional steam whistle and when blown by steam at a gauge pressure of approximately 200 pounds per square inch, said air blown whistle comprising a bell, an orifice plate and a bowl defining between them an annular orifice coaxial with the bell, the orifice being of a radial width of approximately 0.007 inch thereby to discharge approximately 140 cubic feet of air per minute when supplied with compressed air from said source, the surfaces of the bowl and plate, at opposite sides of the orifice being in the same plane and the bell aperture displacement being zero, lengthwise partitions integral with the bell proper and dividing the interior of the bell into a plurality of compartments of equal circumferential extent, said compartments being of different lengths corresponding, respectively, to different fundamental sonic frequencies, those portions of the lower edge of the bell which extend between adjacent partitions being spaced different distances from the plane of the orifice.

7. An air blown whistle for use on diesel locomotives and which is designed to be blown by compressed air supplied from the braking system of the locomotive and which, when so blown, emits a sound approximating in quality and loudness that emitted by a conventional steam whistle when blown by steam at a gauge pressure of approximately 200 pounds per square inch, said air blown whistle comprising a bell of an inner diameter of approximately 3.8125 inches, an orifice plate and a bowl whose upper surfaces are in the same plane and which define between them an annular orifice through which an annular jet of air is delivered in a direction substantially perpendicular to the plane of the orifice, said orifice being coaxial with the bell and of a radial width such that when supplied with compressed air from said source it will discharge approximately 140 cubic feet per minute, the diameter of the orifice plate equalling the inside diameter of the bell, means dividing the interior of the bell into a plurality of chambers of different lengths corresponding to different fundamental sonic frequencies, and a resonator of substantially rectangular shape whose rear wall is substantially in the plane of the orifice and which comprises upper and lower horizontal walls and vertical end walls, the upper horizontal wall being approximately 3⅝ inches in front-to-rear width and the lower horizontal wall being approximately 7¼ inches in front-to-rear width, the front edges of the end walls inclining downwardly and forwardly.

8. An air blown whistle for use on diesel locomotives and which is designed to be blown by compressed air supplied from the braking system of the locomotive and which, when so blown, emits a sound approximating in quality and loudness that emitted by a conventional steam whistle when blown by steam at a gauge pressure of approximately 200 pounds per square inch, said air blown whistle comprising a bell, means defining an annular orifice coaxial with the bell and in a plane spaced from the free edge of the bell, a resonator having a substantially rectangular, vertical wall of greater horizontal width than height, the center of the orifice being at the center of symmetry of said rectangular wall, the resonator having horizontal upper and lower walls and vertical end walls, the lower horizontal wall being wider from front to rear than the top wall, the inner diameter of the orifice equalling the inner diameter of the bell.

9. An air blown whistle for use on diesel locomotives and which is designed to be blown by compressed air supplied from the braking system of the locomotive and which, when so blown, emits a sound approximating in quality and loudness that emitted by a conventional steam whistle when blown by steam at a gauge pressure of approximately 200 pounds per square inch, said air blown whistle comprising a bell, a resonator having a substantially rectangular wall approximately 16 inches in width and 10 inches in height, said wall being perpendicular to the axis of the bell, means defining an annular orifice of an inner diameter equaling the internal diameter of the bell, said orifice being in the plane of said resonator wall and coaxial with the bell, the orifice being of the order of 0.007 inch in radial width and having its center at the center of symmetry of said resonator wall, means dividing the interior of the bell into three independent chambers of lengths corresponding respectively to sound frequencies of 330, 440 and 550 cycles per second, that portion of the free edge of the bell which corresponds to each of the chambers being spaced a different distance from the plane of the orifice, the resonator having a sub-

stantially horizontal top wall of approximately 4 inches in front to rear width and a horizontal bottom wall of a front to rear width of substantially 8 inches, and having vertical end walls whose edges slope downwardly and forwardly.

10. An air blown whistle for use on diesel locomotives and which is designed to be blown by compressed air supplied from the braking system of the locomotive and which, when so blown, emits a sound approximating in quality and loudness that emitted by a conventional steam whistle when blown by steam at a gauge pressure of approximately 200 pounds per square inch, said air blown whistle comprising a bell, a resonator having a substantially rectangular rear wall approximately 16 inches in width and 10 inches in height, said wall being perpendicular to the axis of the bell, means defining an annular orifice of an inner diameter equaling the internal diameter of the bell, said orifice being in the plane of said resonator wall and coaxial with the bell, the orifice being of the order of 0.007 inch in radial width and having its center at the center of symmetry of said resonator wall, longitudinally extending partitions dividing the interior of the bell into three independent chambers of lengths respectively corresponding to three different fundamental sound frequencies, said partitions extending from the lower edge of the bell substantially to the plane of the orifice, that portion of the lower edge of the bell which corresponds to each respective chamber being spaced a different distance from the plane of the orifice, the resonator having horizontal upper and lower walls and vertical end walls, the upper wall being approximately one-half the width from front to rear of the lower wall.

11. An air blown whistle for use on diesel locomotives and which is designed to be blown by compressed air supplied from the braking system of the locomotive and which, when so blown, emits a sound approximating in quality and loudness that emitted by a conventional steam whistle when blown by steam at a gauge pressure of approximately 200 pounds per square inch, said air blown whistle comprising a bell, a bowl and an orifice plate which define between them an annular orifice coaxial with the bell, the inner diameter of the orifice equalling the inner diameter of the bell, means dividing the interior of the bell into three independent chambers corresponding respectively in length to different sonic vibration frequencies, and a resonator having a substantially vertical, rectangular rear wall approximately 16 inches wide and 10 inches high and provided with an aperture for the reception of the bowl, said resonator having transversely extending upper and lower substantially horizontal walls and vertical end walls, the upper wall being substantially one-half the width of the lower wall in a front-to-rear direction and the front edges of the end walls sloping downwardly and forwardly, the several walls of the resonator merging with each other in smooth curves.

12. An air blown whistle which, when blown by compressed air at a gauge pressure of approximately 55 pounds per square inch, emits a sound of a quality and loudness approximating the sound emitted by a conventional steam blown whistle when blown by steam at a gauge pressure of approximately 200 pounds per square inch, said air blown whistle comprising a bell, means defining an annular orifice coaxial with the bell and of an area such as to deliver approximately 110 cubic feet of air a minute when supplied with air at said blowing pressure, the inside diameter of the bell equalling the inside diameter of the orifice, radial partitions dividing the space within the bell into three resonance chambers each of 120 degrees of arc, said partitions extending down below the lower edge of the bell substantially to the plane of the orifice, the several resonance chambers being of lengths corresponding to sound vibration frequencies of approximately 330, 440 and 550 cycles per second respectively, the lower edges of those portions of the bell which form the outer walls of the respective resonance chambers being spaced from the plane of the orifice approximately 1.312 inches; 1.187 inches; and 1.062 inches, respectively, and a resonator of generally rectangular shape having a substantially flat rear wall which lies in the plane of the orifice, top and bottom walls, and substantially vertical end walls, the rear wall being approximately 16 inches long and 10 inches wide, the top and bottom walls being approximately 3⅝ inches and 7¼ inches in front to rear width respectively, and the free edges of the end walls sloping forwardly and downwardly.

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