Nov. 16, 1943. J. S. PARKINSON ET AL 2,334,502

SOUND-ABSORBING STRUCTURE

Filed Nov. 8, 1940

Fig. 1.

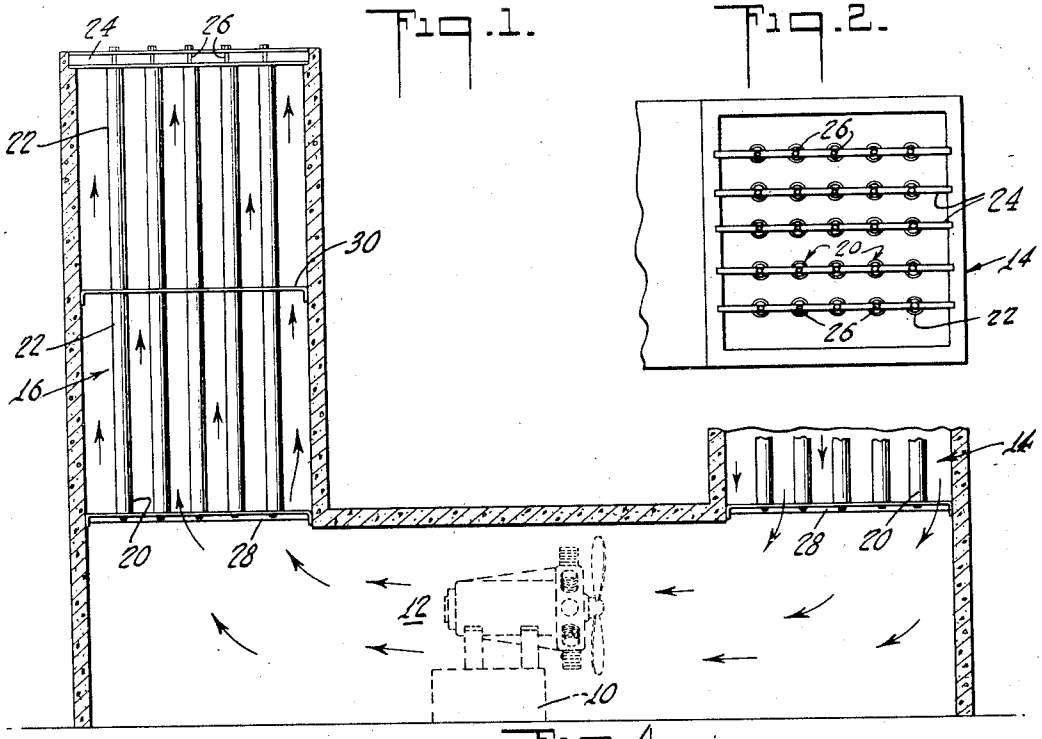


Fig. 2.

Fig. 3.

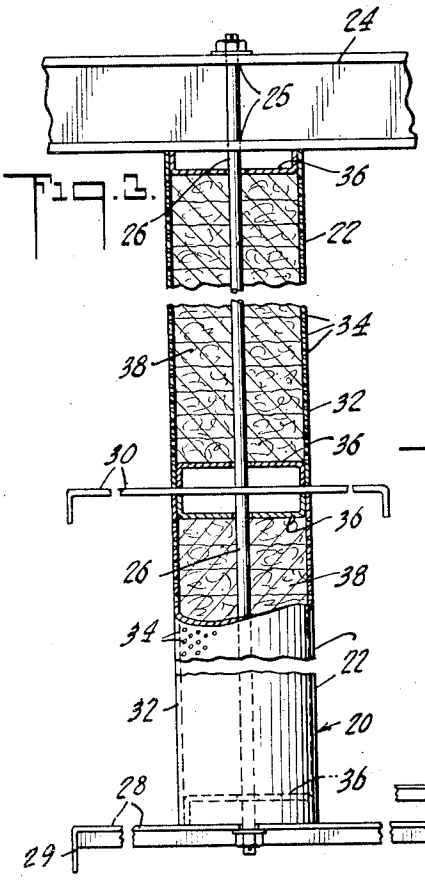


Fig. 4.

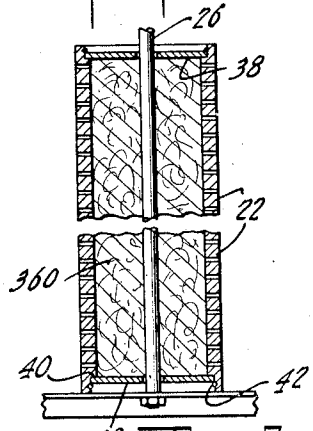


Fig. 5.

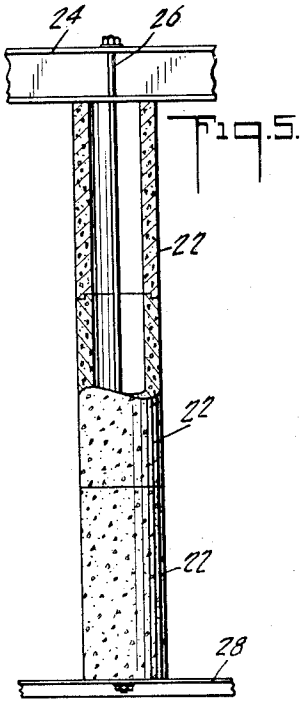


Fig. 6.

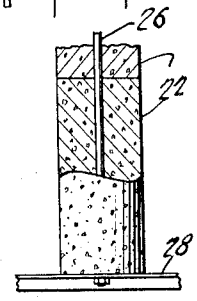
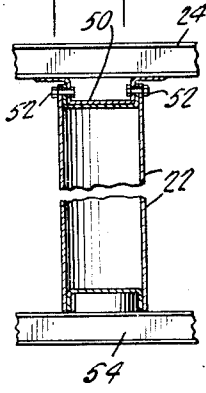


Fig. 7.



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SOUND-ABSORBING STRUCTURE

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19 Claims. (Cl. 181—35)

Our present invention relates to sound-absorbing structures, and in its more specific phase is directed to sound-absorbing treatments of air conduits, such as the air intake and exhaust stacks of test stands employed for the testing of airplane motors, propellers, and the like.

To determine in advance the life and durability of a motor, such as an airplane motor, or propeller under severe conditions, it has been necessary to provide test stands on which the motors may be mounted and run for extended periods of time under substantially normal operating conditions. A stand for this purpose has conventionally comprised a U-shaped structure in which the motor is mounted at the base of the U and the legs of the U form stacks or conduits, the air drawn by the propeller entering through one of the stacks and being expelled through the other.

The excessive noise produced in such testing operations has long presented a serious problem. Heretofore, the stacks have been given a sound-absorbing treatment comprising ribbon walls parallel to the direction of air flow and, for example, on from 12 to 24" centers, the walls being built up of sound-absorbing panels or blocks. Also, in some instances a grid construction, built up from porous blocks, has been tried. The instant invention has for its principal object the provision of an improved sound-absorbing system for stacks of this type or for other air conduits and the like where similar problems in noise quieting are presented.

Another object of the invention is to provide a sound-absorbing system for the purposes referred to which will be substantially lower in cost and of higher efficiency than present constructions.

A further object of the invention is to provide a sound-absorbing system for air conduits in which the necessary supporting or framing elements occupy a minimum of space whereby the greatest proportion of the conduit area allotted to the sound-absorbing treatment can be utilized for the sound-absorbing units per se.

A further object of the invention is to provide a construction of the type referred to, which is inherently stronger than those heretofore proposed, with consequent reduction of cost of both fabrication and erection, and which, moreover, can be employed with equal facility in stacks of large and small diameter. The construction of the instant invention is also one which will permit the height of the stack to be decreased without loss in sound-absorbing efficiency, thus providing for a reduction in cost in the stack structure itself.

Our invention will be more fully understood and further objects and advantages thereof will become apparent when reference is made to the more detailed description thereof which is to follow and to the accompanying drawing, in which:

Fig. 1 is a vertical sectional view, with parts broken away, of a test stand including stacks embodying the invention;

Fig. 2 is a plan view of one of the stacks shown in Fig. 1;

Fig. 3 is an enlarged view, partly in section and partly in elevation, of a sound-absorbing column and support therefor employed in the construction of Fig. 1;

Fig. 4 is a detail sectional view illustrating a modification of the column structure;

Fig. 5 is a view similar to Fig. 3 illustrating another modification of the column structure;

Fig. 6 is a detail view similar to Fig. 4 illustrating a further modification of the column structure; and

Fig. 7 is a view, partly in elevation and partly in section, showing a variation of the column supporting means.

Referring now to the drawing, and particularly to Fig. 1, there is disclosed a test stand structure basically of the type conventionally employed for the testing of airplane motors, propellers, and the like. It will be understood that the structure shown is merely illustrative and that the invention is equally applicable to other types of stacks and to air conduits for other purposes.

In the construction depicted, the test stand comprises a substantially U-shaped building including a motor mounting 10 in a room 12 forming the base of the U, and upstanding air intake and exhaust stacks 14 and 16, respectively. The outer walls of the structure, including the stacks, may be formed of masonry, reinforced concrete, fabricated sheets, or the like, in accordance with conventional practice, and the stacks may be of any desired dimensions, depending upon the size of motor, propeller, and the like, which are to be tested and the noise given off thereby. A control room, not shown, is located adjacent the motor mounting for observing the various testing equipment.

In accordance with the instant invention, the stacks 14 and 16, which are preferably of the same height, are provided with means to absorb a substantial proportion of the noise created by

the motor and propeller, this means comprising a plurality of columns **20** built up of sound-absorbing units **22**. A sufficient number of the units **22** are superposed one on the other to make the columns of the desired height. In the embodiment shown, two of the units are employed in each column, each unit being, say, of a length of 8' to form a column 16' in height. However, as will be understood, individual units may be made of any desired length and the columns may be built up to greater or less heights than that given to meet particular problems. The columns are preferably placed in rows (see Fig. 2) and take up, say, a maximum of 25% of the total area of the stack. Also, it is preferred to uniformly space the columns in both directions, but again, variation in arrangements may be made to cope with particular problems without departing from the scope of the invention.

The columns in accordance with the preferred construction are suspended from I-beams **24**, which are in turn supported by opposed walls of the stacks, preferably adjacent the upper ends thereof, by any suitable means, for example, by embedding the beams in the stack walls as indicated. Rods **26** pass through notches or perforations in the flanges of beams **24** and extend axially through the columns. The lower ends of the rods of each row of columns project through suitable perforations in a supporting member **28**, such as a shallow channel iron. One of the latter preferably extends the length of each row and has its ends secured to the stack walls in any suitable manner, for example, by expansion bolts passing through end flanges **29**. In some instances the ends of members **28** need not be secured to the walls, it being understood that the support for the columns is primarily through their suspension from beams **24**. Rods **26** may be headed at the upper ends, or may be threaded to receive a nut at this location, and are similarly preferably threaded to receive a nut on their ends projecting below member **28** whereby the several units making up each column may be drawn into close engagement to one another. Where the height of the columns **20** is such that weaving or other lateral movement of the same may take place from the action of the air passing at a high velocity through the stack, a reinforcing or stiffening member **30** may be employed. Reinforcing member **30** may be a channel iron, or simply a flat metal strap having perforations to receive the several rods of a row of columns, and including end portions secured to the walls of the stack by expansion bolts or any other suitable means.

Referring now to Figs. 2 and 3, the units **22** making up columns **20** comprise, in the preferred form of the invention, elongated hollow containers filled with a suitable sound-absorbing material **38**. The side walls **32** of the containers are preferably formed of sheet metal and are cylindrical in shape inasmuch as a greater thickness of sound-absorbing material is thereby obtained for a minimum of cross sectional area. However, the units may be of square or other cross section if desired. The walls **22** are provided with a multiplicity of closely spaced perforations **34** having a sufficient total area to permit entry of sound waves into the sound-absorbing material within the container. The containers or units are provided with heads **36**, at least at their lower ends, secured in any suitable manner, for example, by welding, riveting, or the like. The sound-absorbing material **38** may be discs of a mineral wool felt centrally perforated to receive rod **26** as indicated in Fig. 3, or, in lieu thereof, loose mineral wool, nodulated wool, or loose or bonded granular or fibrous sound-absorbing material, and the like may be employed, as indicated generally at 360 in Fig. 4.

As shown in Figs. 4 and 5, other materials than metal may be employed for at least the side walls of the containers or units **22**; for example, Fig. 4 shows the wall as comprising a perforated hardened compressed asbestos-cement tube, such as a perforated section of "Transite" pipe. A tube of this type may be headed by discs **38** of a similar or other material inset on shoulders **40** and secured in place by an expander ring **42** or the like. Alternatively, the heads may be cemented in place or any other suitable fastening means may be used.

Referring to Fig. 5, the containers are shown as composed of a bonded aggregate of any of the numerous types now conventionally employed in the manufacture of porous sound-absorbing building blocks. In such case the inherent porosity of the material may be sufficient to admit the entrance of sound to the absorbent filling, or, if necessary or desirable, further perforations may be made. In any event the inherent porosity of the material in itself provides a sound absorber, amplifying the sound-absorbing function of the contained material. Also, if desired, such bonded aggregate blocks may be employed, per se, as the sound-absorbing material, as illustrated in Fig. 6. In this instance the blocks, preferably cylindrical, are provided with a central hole or perforation to receive suspended rod **26**.

The preferred method of installation of a sound-absorbing treatment in accordance with the invention may vary somewhat, depending upon whether the cross braces **30** are employed. In any event, the rods are preferably first inserted within the perforations or notches in the flanges of beam **24** and a nut, preferably of a locking type, applied to hold the rods firmly in suspended position. If no cross bracing is required, the number of the units **22** required to make up the column height are slipped endwise on each rod of a row and a member **28**, perforated at suitable intervals to receive the rods, is inserted on their threaded ends. Nuts are then drawn tightly on the threaded end portions to secure member **28** to the columns and to hold the several units of each column in firm endwise contiguous relationship. The ends of member **28** are then preferably secured to the side walls of the stack. If a cross brace **30** is to be employed for each row, sufficient of the units are threaded on each rod to extend to the location selected for the cross brace. The cross brace, having spaced perforations similarly as the member **28**, is then threaded on the rods and the remaining units and member **28** installed as before. The ends of the cross braces are then secured to the side walls of the stack.

Referring to Fig. 7, there is illustrated a modified form of supporting means for the columns of particular applicability when the latter require but a single unit **22**. Thus, the units may be fastened at their upper ends to the I-beams **24**, for example by strap **50**, having its end portions welded or otherwise secured to the I-beam, and including a U-shaped central portion fitting within the depressed head of the unit. If it is desired to suspend the unit as in the preferred embodiment, the strap **50** may be secured to the unit as by bolts **52**. The lower end of the unit

rests upon beam 54 which may be formed with an abutment 56, comprising, for example, a disc welded to the beam, to position the lower end of the column. In this instance beam 54 may be of sufficient strength to support the weight of the columns or may be merely a bracing member as before and the suspension of the columns from beam 24 be relied upon for support.

A construction in accordance with any of the forms of the invention has been found to attain the several objects previously referred to, as well as further advantages. Thus, for a given area of stack treatment it has been determined that 12-foot columns of sound-absorbing units of the type of this invention will give a total sound reduction equal to 20 feet of the wall type constructions heretofore employed. At the same time, the cost per foot of the treatment is substantially lowered. Also, the lesser height of treatment permitted by the invention produces an appreciable saving in the cost of the stack required, or, conversely, if very severe noise conditions are to be met, a greater noise reduction can be provided without requiring an excessive height of structure. Furthermore, the construction lends itself to use with stacks or the like of any height or any cross sectional dimension with equal facility. Inasmuch as the construction is inherently stronger than ribbon walls or grids, the cost of fabrication and erection is greatly reduced due to the lighter weight materials which may be employed.

Although the invention has been described as having particular applicability to vertical stacks, it will be understood that it may be employed equally as well for horizontal installations, for example, in a horizontal tunnel. Also, the column type sounding-absorbing units may be employed in many other cases when it is desired to isolate acoustically one locality from another, and their use is not to be considered as limited to air-flow stacks or tunnels.

Having thus described our invention in rather full detail, it will be understood that these details need not be strictly adhered to, but that various changes and modifications will suggest themselves to one skilled in the art, all falling within the scope of the invention as defined by the subjoined claims.

What we claim is:

1. A sound-absorbing structure comprising spaced outer walls and a plurality of columns of sound-absorbing units, each column supported in spaced relationship to the others between said walls and exposing their lateral surfaces to the sound to be absorbed.

2. A sound-absorbing structure comprising spaced outer walls and a plurality of columns of sound-absorbing units, each column in spaced relationship to the others between said walls and exposing their lateral surfaces to the sound to be absorbed, said units comprising sound-porous hollow elements containing sound-absorbing material.

3. A sound-absorbing structure comprising spaced outer walls and a plurality of columns of sound-absorbing units supported in spaced rows between said walls, each column of a row being spaced from the others and exposing its lateral surfaces to the sound to be absorbed, said units comprising perforated hollow elements containing a sound-absorbing material.

4. A sound-absorbing structure comprising spaced outer walls and a plurality of columns of sound-absorbing units supported in spaced rows between said walls and exposing their lateral surfaces to the sound to be absorbed, said units comprising perforated metal containers with a filling of a sound-absorbing material.

5. A sound-absorbing structure comprising spaced outer walls and a plurality of columns of sound-absorbing units supported in spaced rows between said walls and exposing their lateral surfaces to the sound to be absorbed, said units comprising perforated containers formed of a hardened cementitious material with a filling of a sound-absorbing material.

6. A sound-absorbing structure comprising spaced outer walls and a plurality of columns of sound-absorbing units supported in spaced rows between said walls and exposing their lateral surfaces to the sound to be absorbed, said units comprising elongated porous blocks including a bonded aggregate.

7. A stack structure comprising spaced outer walls, a plurality of columns of sound-absorbing units, each column supported in spaced relationship to the others between said walls and exposing its lateral surfaces to the sound to be absorbed, rods extending longitudinally through said columns and supporting the columns thereon, and means carried by said walls for supporting said rods.

8. A stack structure comprising spaced outer walls, a plurality of rows of columns of sound-absorbing units between said walls, each column being spaced from the other columns and exposing its lateral surfaces to the sound to be absorbed, rods extending longitudinally through said columns, means supported from said walls from which said rods are suspended, and members connecting said rods beneath said columns to retain said units on said rods and maintain the lower ends of said columns in fixed relationship to one another.

9. A stack structure comprising spaced outer walls, a plurality of rows of columns of sound-absorbing units between said walls, each column being spaced from the other columns and exposing its lateral surfaces to the sound to be absorbed, said units comprising perforated hollow elements containing a sound-absorbing medium, rods extending longitudinally through said columns, beams supported from said walls and from which said rods are suspended, and means on said rods beneath said columns retaining the columns on said rods and maintaining the lower ends of said columns in fixed relationship to one another.

10. A stack structure comprising spaced outer walls, a plurality of rows of columns of sound-absorbing units between said walls, each column being spaced from the other columns and exposing its lateral surfaces to the sound to be absorbed, said units comprising headed perforated metal containers with a sound-absorbing filling, beams supported from said walls above said rows of columns, and means suspended from said beams supporting said columns.

11. A stack structure comprising spaced outer walls, a plurality of rows of columns of sound-absorbing units between said walls, each column being spaced from the other columns and exposing its lateral surfaces to the sound to be absorbed, each of said columns comprising a plurality of superposed units, said units comprising headed perforated metal containers with a sound-absorbing filling, beams supported from said walls above said rows of columns, and means suspended from said beams supporting said columns, said

means comprising rods projecting axially through said columns and members connecting said rods beneath said columns and affixed to said side walls.

12. A stack structure comprising spaced outer walls, a plurality of rows of columns of sound-absorbing units between said walls, each column being spaced from the other columns and exposing its lateral surfaces to the sound to be absorbed, each of said columns comprising a plurality of superposed units, said units comprising headed perforated metal containers with a sound-absorbing filling, beams supported from said walls above said rows of columns, and means suspended from said beams supporting said columns, said means comprising rods projecting axially through said columns, members connecting said rods beneath said columns and secured to said side walls, and reinforcing elements connecting the rods of a row between adjacent units on each rod and including end portions secured to said side walls.

13. A stack structure comprising spaced outer walls, a plurality of rows of columns of sound-absorbing units between said walls, each column being spaced from the other columns and exposing its lateral surfaces to the sound to be absorbed, beams supported from said walls, and means suspended from said beams supporting said columns, said means comprising rods projecting longitudinally through said columns and members connecting said rods beneath said columns and affixed to said side walls.

14. A stack structure comprising spaced outer walls, a plurality of rows of columns of sound-absorbing units between said walls, each column being spaced from the other columns and exposing its lateral surfaces to the sound to be absorbed, each of said columns comprising a plurality of superposed units, beams supported from said walls, and means suspended from said beams supporting said columns in position, said means comprising rods projecting longitudinally through said columns and members connecting said rods beneath said columns and maintaining said units on said rods, and reinforcing members in contact with said rods between adjacent units supporting said rods from said side walls.

15. A stack structure comprising spaced outer walls, a plurality of columns of sound-absorbing units between said walls, each column being spaced from the other columns and exposing its entire lateral surfaces to the sound to be absorbed, beams supported from said walls, rods supported from said beams extending axially through said columns, and channel members secured to said walls and maintaining said columns on said rods.

16. A sound-absorbing unit for a stack structure or the like comprising a hollow perforated casing, a sound-absorbing filling within said casing comprising a plurality of superposed pads of a felted fibrous material, and aligned apertures in the ends of said casing and said filling to permit the passage therethrough of a supporting rod.

17. A sound-absorbing unit for mounting on a supporting rod of a stack structure or the like, said unit comprising a cylindrical casing forming the outer wall of the unit, said casing having a multiplicity of perforations extending therethrough, a filling of sound-absorbing material within said casing and heads on opposite ends of said casing, said heads having aligned openings dimensioned to receive said supporting rod therethrough.

18. A sound-absorbing unit for mounting on a supporting rod extending axially through the unit, said unit comprising a hollow porous block forming the outer wall of the unit, a filling of sound-absorbing material therein, and end members for the hollow block, said end members having aligned openings dimensioned to receive said supporting rod therethrough.

19. A sound-absorbing structure comprising a plurality of columns of sound-absorbing units, each of said columns being spaced substantially equidistant from adjacent columns and exposing its lateral surfaces to the sound to be absorbed and means supporting said columns, said means comprising beams at opposite ends of said columns and members positioning said columns on said beams.

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