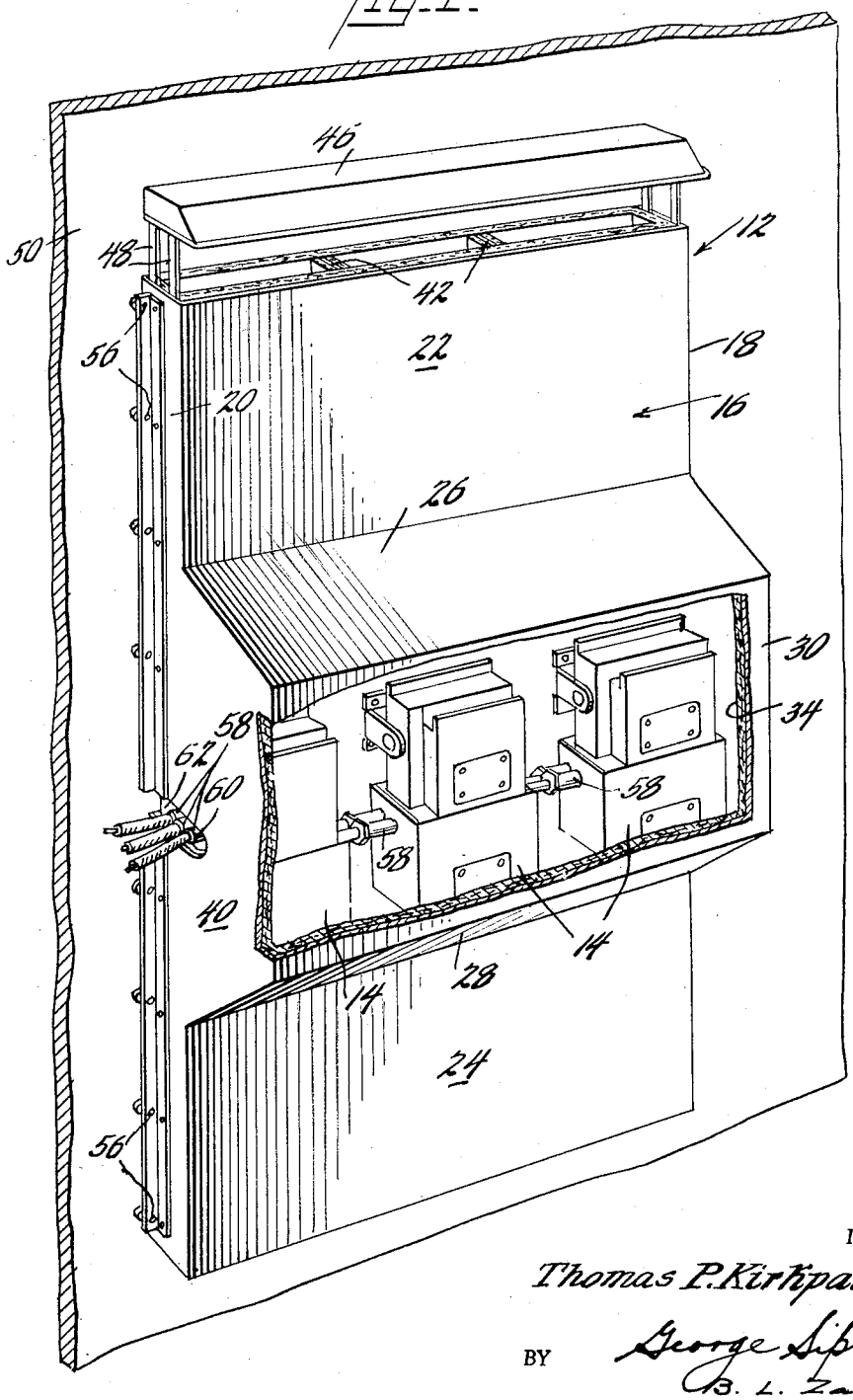
June 30, 1959 T. P. KIRKPATRICK 2,892,507

FLUE TYPE ACOUSTIC HOOD

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FIG. 1.




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FLUE TYPE ACOUSTIC HOOD

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FIG. 2.

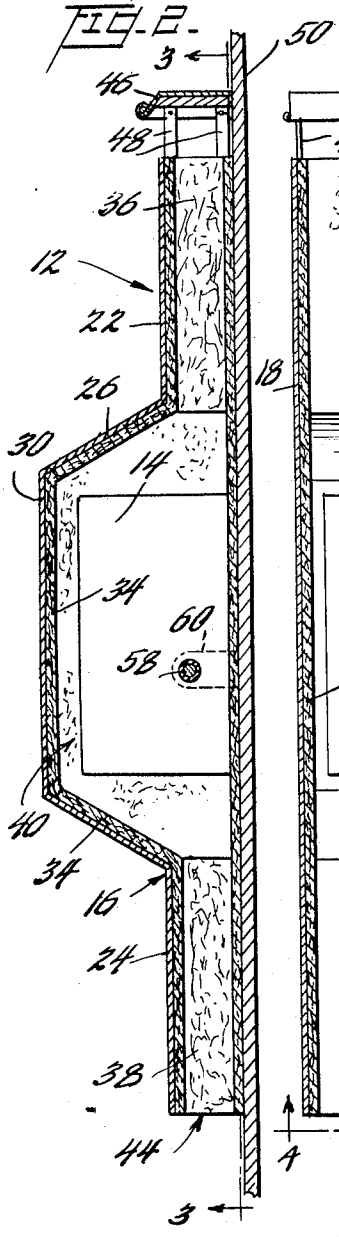
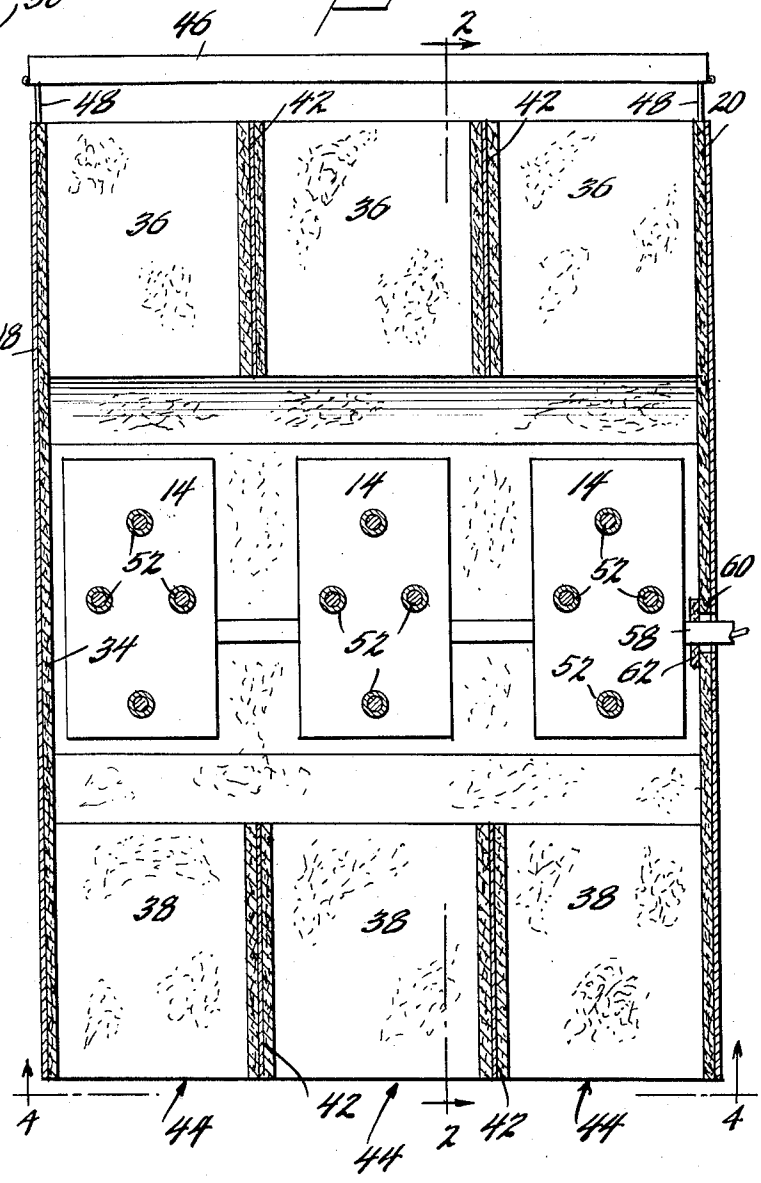



FIG. 3.




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FLUE TYPE ACOUSTIC HOOD

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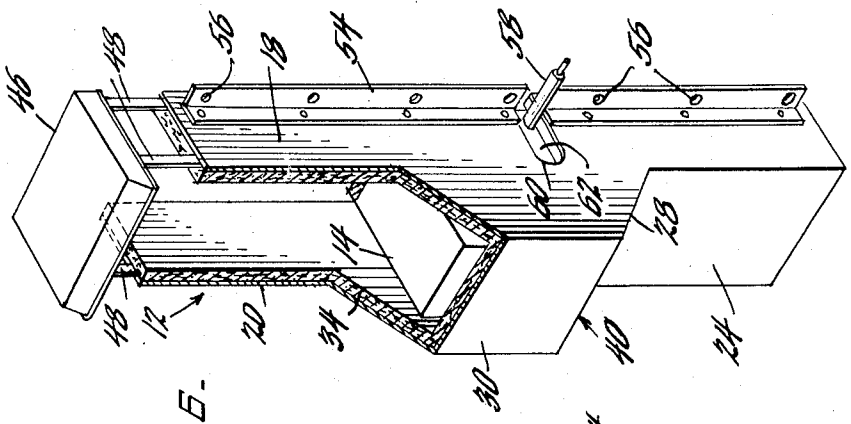


FIG. 6.

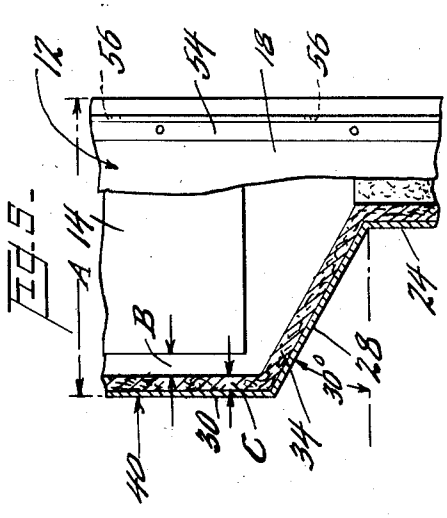


FIG. 5.

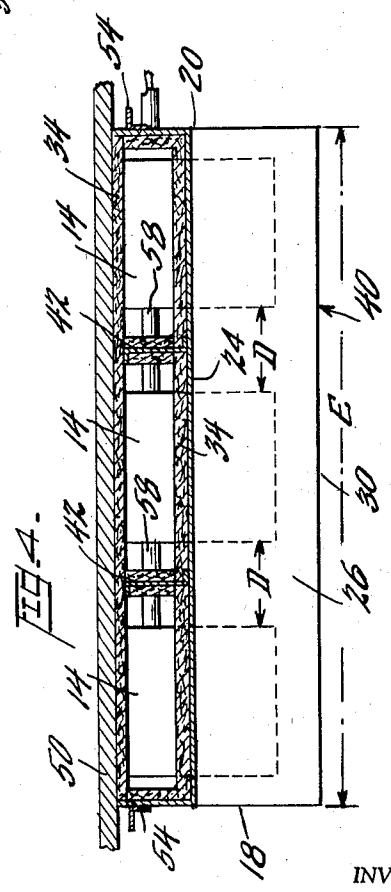


FIG. 4.

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United States Patent Office 2,892,507 Patented June 30, 1959



2,892,507

# FLUE TYPE ACOUSTIC HOOD

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Application January 20, 1956, Serial No. 560,468

2 Claims. (Cl. 181—36)

(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to a means for providing effective noise attenuation for noise producing and heat dissipating devices, and more particularly to an acoustic enclosure, including a flue structure, for a single high frequency transformer, or a plurality of such transformers, said enclosure being adapted to alleviate the noise problem associated from said transformers and at the same time prevent an undue rise in the temperature of said transformers.

Prior art noise attenuation devices consist of completely enclosed transformer units. The primary disadvantages of the prior art devices is that they are subject to excessive temperature rises, or have abnormally large heat radiating surfaces. In general, the prior art devices either excessively raise the operating temperatures or fail to satisfactorily attenuate the noise.

It is therefore an object of this invention to provide a sound-insulated enclosure for equipment of a noisy nature.

A further object is to provide a sound-insulated self-ventilating enclosure for equipment of a noisy, heat dissipating nature, more particularly one or more high frequency transformers.

Another object is to provide a sound-insulated, self-ventilating enclosure for one or more high frequency transformers, the ventilating feature of said enclosure preventing a rise in the temperature of the enclosed transformers.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 is a perspective view of a preferred form of flue-type acoustic hood adapted for use with three transformers, said view being partially broken away and in section, and shows said hood attached to a wall or the like;

Fig. 2 is a vertical sectional view of the acoustic hood of Fig. 1, taken on line 2—2 of Fig. 3;

Fig. 3 is a sectional view of the acoustic hood, of Fig. 1, taken along line 3—3 of Fig. 2;

Fig. 4 is an end view of the acoustic hood, taken along the line 4—4 in Fig. 3;

Fig. 5 is an enlarged, fragmentary, side view of a portion of the hood, with a portion of the side thereof broken away, and in section; and

Fig. 6 is a perspective of a modification of the applicant's invention showing a hood adapted to enclose a single transformer, and having a portion of the front cover cut-away.

Referring now to the drawings, wherein like reference characters designate like or corresponding parts throughout the several views, there is shown in Fig. 1 a perspective view of one embodiment of a transformer enclosing, flue-type, acoustic hood **12**, hereinafter referred to



simply as an acoustic hood. The embodiment shown in Fig. 1 encloses a combination of three transformers **14**. It is however pointed out that the applicant's hood can be adapted to enclose any number of transformers; Fig. 6 for example shows an enclosure for a single transformer **14**.

The three-transformer acoustic hood **12** shown in Fig. 1 is preferably formed of 26-gage sheet metal so shaped and assembled as to have a front member **16** and right and left side panels **18** and **20** respectively, said front member comprising upper and lower panels **22** and **24** respectively. The upper and lower panels **22** and **24** are connected to outwardly extending panels **26** and **28** respectively; each of said outwardly extending panels **26** and **28**, is inclined from the horizontal and toward the center of the hood. Extending between, and connected to the forward edge of each of the inclined panels is a center panel **30**.

Thus the acoustic hood **12** is composed of the side panels **18** and **20**, together with the upper and lower panels **22** and **24**, the inclined panels **26** and **28** and the center panel **30**.

It is pointed out that the acoustic hood can be formed either of one piece of metal by die stamping or the like, or from several panels welded or otherwise joined to one another along the proper edges thereof.

The interior surfaces of the hood **12** are covered with a layer **34** of sound absorbing material such as fibrous glass batt for example, said batt being affixed to said surfaces by means of suitable adhesive. It has been found that a layer of ½ inch, 3 lb./cu. ft. density batt results in considerable noise attenuation, without occupying too much interior space. Further, it has also been found that optimum noise attenuation, and ventilation results, are obtained by dimensioning the hood, and arranging it in relation to the transformers so that there is a minimum space of ½ inch between said transformers and the acoustic batt **34**.

In accordmance with this invention, further noise attenuation is provided by the provision of air ducts **36** and **38** which extend respectively above and below the transformer enclosing portion **40** of the hood; said ducts also provide a means for air to circulate about the transformers thereby preventing an undue rise in the temperature thereof, and even serving to cool them below normal in some cases.

While a certain amount of noise attenuation is attainable in an acoustically insulated air duct of unbroken cross-section, it has been found that even greater noise attenuation can be obtained by dividing said duct into a number of smaller, parallel, longitudinally extending ducts. The benefit of this phenomenon is obtained in the applicant's device by attaching a number of splitters **42** to the front panels **22** and **24** of each of the air ducts **36** and **38**, so that said splitters are at right angles to said front panels **22** and **24** and are parallel to the side panels **18** and **20** of the hood. The splitters **42** are of the same width as the side panels **18** and **22**, and the opposite faces of each splitter are covered with a ½ inch acoustic batt of the type described above. It is pointed out the splitters are coextensive in length with the upper and lower front faces **22** and **24** only, and do not extend into the area of the hood that is adapted to contain the transformers. It should also be noted that according to the preferred embodiment, a vertical air passage **44** is provided above and below each transformer. However, it is entirely possible to provide more than one air passage for each transformer, though the presence of too many air passages in a given cross section would result in an impairment of air flow, thus causing the transformers to overheat.

In order to prevent entry of moisture, dust and/or

other foreign matter into the hood **12**, said hood is provided with a drip shield **46** attached to the upper end of the upper duct **36** and spaced therefrom a minimum of 2 inches by means of the spacer-members **48**, each of which has one end fastened to the hood **12** and the other end fastened to the drip shield **46**. The interior surfaces of the drip shield are covered with a ½ inch acoustic batt of the type previously described. In the event that the upper end of the hood is extremely close to a ceiling or the like, the drip shield **46** may be omitted. However, the upper end of the hood should not be spaced so close to the ceiling that the escape of air at said upper end is inhibited.

In utilizing the applicant's acoustic hood in accordance with the modification shown in Figs. 1–5, any covers which may be on the transformers are first removed. The transformers **14** are fastened to a wall **50**, in spaced relation therefrom by being fastened to ½ inch bosses **52** that are welded or otherwise attached to the wall **50**. The area of the wall adapted to be covered by the acoustic hood **12**, including the space to the rear of each transformer, is covered with a ½ inch acoustic batt of the type described.

The transformers are then enclosed within the center compartment **40** of the acoustic hood by bolting said hood to the wall in the manner shown in Fig. 1. For this purpose an angle iron **54** is rigidly attached to each of the side panels **18** and **20** of the hood, a leg of said angle iron being provided with a series of longitudinally spaced holes **56** through which fastening bolts are adapted to be passed for the purpose of bolting the hood to the wall; said bolts passing into suitable holes in said wall **50**.

It is pointed out that Fig. 5 is drawn to scale, and shows a side view of a portion of the acoustic hood, having the side panel **18** partially broken away and in section. In Fig. 5 which shows a typical embodiment of the applicant's invention, the minimum space (B) between any side of a transformer **14** and the acoustic batt **34** is ½ inch, while the minimum thickness (C) of said batt is ½ inch. The depth (A) from front to rear of the transformer enclosing portion of a hood for 7½ k.v.a. transformers is 9 inches, for larger transformers the dimension A is made accordingly larger. The air ducts **36** and **38** are dimensioned so as to provide an air space having a minimum of 2 inches from the front acoustic batt to the acoustic batt on the wall **50**. Very good noise attenuation has been found to prevail with air ducts 12 inches in length, but they may be made shorter if space limitations so require.

In brief, recommended dimensions for optimum acoustic attenuation and ventilation are, a minimum ½ inch thickness of batt, a minimum ½ inch space between the transformers and the batt, and a 2 inches deep airspace in the ducts **36** and **38**. Further, there should be at least 4 inches space (D) between transformers to facilitate electrical wiring. In a three transformer arrangement for 7½ k.v.a. transformers the overall width (E) of the acoustic hood is 14¾ inches.

It is further pointed out that the stuffing tubes **58** which carry the transformer leads from the hood **12**, do not touch the side wall **20** through which they pass, thereby preventing mechanical transmission of transformer vibrations to the hood. For this purpose, the side wall through which the stuffing tubes pass is provided with a cut-away area **60** that is wider than the maximum dimension of said tubes. On the interior of the hood, an acoustic shield **62** is applied across the cut-away area **60** to prevent the air-borne escape of noise.

Another form of the applicant's invention is shown in Fig. 6 which shows a partially cut-away view of an acoustic hood for a single transformer. The various critical dimensions, and structural features of the single transformer acoustic hood are the same as those set forth in the above description of Fig. 5.

Following will be found the description of, and results obtained from, tests run to determine respectively the effect of the applicant's acoustic hood upon the temperature of the transformers enclosed therein, and the degree of noise attenuation attained.

Three 7½ k.v.a., 400-cycle transformers were mounted as a three phase bank on a ½ inch thick, 5 foot by 4 foot steel plate. The plate was mounted in a vertical position for the full load temperature test. Two runs were performed, one with the hood in place and transformer top covers off, the other run was with the hood removed and transformer top covers in place. The temperature rise of the windings was determined by thermocouple readings. The results of the temperature runs are given in Table 1.

TABLE 1

*Temperature rise*

| Condition | Thermocouple Location | | | | | |
|---|---|---|---|---|---|---|
| | Transformer On Left | | Transformer In Middle | | Transformer On Right | |
| | °C. | °C. | °C. | °C. | °C. | °C. |
| Hood Removed | 130.7 | 136.9 | 152.5 | 148.3 | 140.0 | 149.1 |
| Hood In Place | 126.0 | 136.9 | 150.2 | 145.1 | 140.6 | 150.2 |

It should be noted that with the hood in place there was little or no temperature rise, and in certain instances there was actually a drop in transformer temperature.

During the noise tests, the transformers were operated at 440 volts and at no load. The transformers were mounted as noted above. The plate with transformers attached was placed in a horizontal position on a platform covered with a 3 inch thickness of fibrous glass blanket. This assembly was raised 1 foot over a grilled catwalk in an anechoic chamber, thereby providing essentially free field conditions for air-borne noise measurements.

Air-borne noise measurements were made at nine positions, 3 feet each from the leading edge of the nearest transformer. Readings were taken at each of the following three conditions.

(1) Units bulkhead mounted and hood removed.

(2) Units enclosed in the hood with 6 inch air ducts above and below the hood.

(3) Units enclosed in the hood with 12 inch air ducts above and below the hood.

The results of the noise measurements are given in Table 2.

TABLE 2

*Air-borne noise test results*

BROAD-BAND NOISE LEVELS—SPECTRA ANALYSES

[Decibels referred: 0.0002 dyne/cm.²]

| MIC Pos. | Condition A | | | | Condition B | Condition C | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Broad Band | 800 c.p.s. | 1,600 c.p.s. | 2,000 c.p.s. | Broad Band | Broad Band | 800 c.p.s. | 1,600 c.p.s. | 2,400 c.p.s. |
| 1 | 59.5 | 52.0 | 58.0 | 43.0 | 48.5 | 47.0 | 40.5 | 45.0 | (1) |
| 2 | 61.5 | 60.0 | 58.0 | 40.0 | 51.0 | 47.5 | 45.5 | 39.5 | (1) |
| 3 | 57.5 | 56.5 | 52.5 | 39.0 | 51.0 | 50.5 | 48.5 | 42.0 | (1) |
| 4 | 64.0 | 57.0 | 63.0 | 39.0 | 51.0 | 44.5 | 42.0 | 38.0 | (1) |
| 5 | 59.0 | 49.0 | 57.0 | 44.0 | 45.0 | 42.0 | 38.0 | 38.0 | (1) |
| 6 | 63.5 | 45.0 | 62.0 | 55.0 | 55.5 | 46.0 | 44.0 | 36.0 | (1) |
| 7 | 60.0 | 50.0 | 57.0 | 55.5 | 55.0 | 49.0 | 47.5 | ------ | 34.0 |
| 8 | 60.0 | 59.0 | 52.5 | 41.0 | 56.0 | 50.5 | 48.5 | 42.0 | (1) |
| 9 | 58.5 | 42.0 | 54.0 | 47.0 | 54.0 | 46.0 | 41.0 | 36.0 | 35.0 |
| Avg | 60.4 | 52.3 | 57.1 | 44.8 | 51.9 | 47.0 | 43.9 | 39.5 | |

Condition A—Units without hood.
Condition B—Units in hood with 6" ducts.
Condition C—Units in hood with 12" ducts.
[1] Less than 30 decibels.

AVERAGE ATTENUATION

[Decibels referred: 0.0002 dyne/cm.$^2$]

| Frequency, c.p.s. | Condition A-B | Condition B-C | Condition A-C |
|---|---|---|---|
| Broad Band | 8.5 | 4.9 | 13.4 |
| 800 | | | 8.0 |
| 1,600 | | | 17.6 |
| 2,400 | | | 14.8+ |

The noise levels obtained show an overall attenuation of approximately 14.0 db by use of the acoustic hood with 12 inch ventilation ducts **36** and **38**, and 8.5 db attenuation by use of a hood with 6 inch ducts. Comparison of the spectra analyses shows the major attenuation was accomplished at approximately 1600 c.p.s., the major component of the transformer noise. After installation of the hood the major component was found to be 800 c.p.s.

While certain dimensions have been recommended, as to the thickness of acoustic batt, spacing of transformers from said batt, and overall dimensions of the transformer enclosure and ducts, it is pointed out that the dimensions referred to may be determined either by recognized acoustic calculations or by experiment, to provide selective frequency attenuation that may be chosen to produce optimum or other desired noise reduction for the particular noise producing device being enclosed.

It is pointed out that greater attenuation can be obtained by use of longer ventilation ducts and thicker acoustical batt.

What is claimed is:

1. An acoustic hood for high frequency, noise producing transformers, said hood including a forwardly extending centrally located compartment adapted to enclose a plurality of transformers, a pair of ventilating ducts connected with the interior of said compartment, adjacent the rearmost portion thereof and extending outwardly therefrom at diametrically opposed sides thereof, one duct extending upwardly and the other downwardly of said compartment; each duct being divided into a plurality of parallel, longitudinally extending air passages equal in number to the number of transformers present; the air passages in one duct being juxtaposed to and spaced from those in the other duct, said transformers being located in said forwardly extending compartment between respective juxtaposed air passages, whereby air may flow in through one duct, across said transformers, and out of the opposite duct, thereby preventing a temperature rise in said transformers, the interior surfaces of said compartment and air ducts being covered with a layer of acoustic batt.



2. An acoustic hood for high frequency, noise producing transformers comprising, a forwardly extending compartment, said forwardly extending compartment comprising a pair of side panels, a front panel and upper and lower panels, said upper and lower panels extending upwardly and downwardly of said front panel in a direction rearward therefrom, a pair of ventilating ducts connected with the interior of said compartment adjacent the rearmost portion thereof and intersecting the rearmost edge of said upper and lower panels respectively, said ducts extending outwardly from said compartment at diametrically opposed sides thereof, one duct extending upwardly and the other extending downwardly of said compartment, a plurality of parallel, longitudinally extending air passageways formed in each duct and equal in number to the number of transformers present; the air passageways in one duct being juxtaposed to, and spaced from, those in the other duct, said transformers being located in said forwardly extending compartment between said juxtaposed air passageways, whereby air may flow in through one duct, across said transformers, and out the opposite duct, thereby preventing a temperature rise in said transformers.

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