3396

NATIONAL BUREAU OF STANDARDS REPORT

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GLASS FIBER DUCTS IN COLEMAN BLENDER UNITS

by

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Paul R. Achenbach

Report to

Federal Housing Administration
Washington, D. C.

NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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Heating and Air Conditioning Section
Building Technology Division

to

Office of the Commissioner, Underwriting
Federal Housing Administration
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ABSTRACT

At the request of the Federal Housing Administration a study was made of glass fiber ducts submitted by Coleman Co., Inc. to determine their suitability as a substitute for metal ducts in the blender units manufactured by this company for warm air heating systems. Such flexible ducts appear to have advantages in remodelling the heating systems in existing houses because less alteration and repair of the wall is needed than for metal ducts. The tests showed that the fiber glass ducts could readily be installed in an existing dry wall partition as a part of the Coleman air blending units, but that they were not well-suited to existing wet wall construction where extruded plaster keys reduce the cross section area of the stud space. Air leakage through the duct material might cause an appreciable loss of heat in a poorly-constructed wall but would probably be unimportant in tight construction, especially on inside partitions. The fiber glass material showed good resistance to mold growth and flame spread, but it was attacked readily by rats without a hunger motive. For the type of installation and rate of air delivery recommended by the manufacturer the fiber glass ducts do not appear to transmit less noise to the room than metal ducts.

I. Introduction

At the request of the Office of Assistant Commissioner, Underwriting, Federal Housing Administration, in a letter dated October 22, 1952 studies were made of glass fiber ducts and glass fiber material submitted by the Coleman Co., Inc. to determine their suitability as substitutes for metal ducts in warm air heating systems, and especially as ducts in the stud spaces of residential construction. The duct specimens and the sheet material were examined for ease of installation in existing walls, air leakage, sound absorption, insulating value, flame spread, mold resistance, and rodent resistance.

II. Description of Duct Application

The glass fiber ducts were designed to be used as a part of air-blending units manufactured and marketed by Coleman Co., Inc. The blenders are a wall stack, grille combination for introducing a mixture of warm air from a furnace

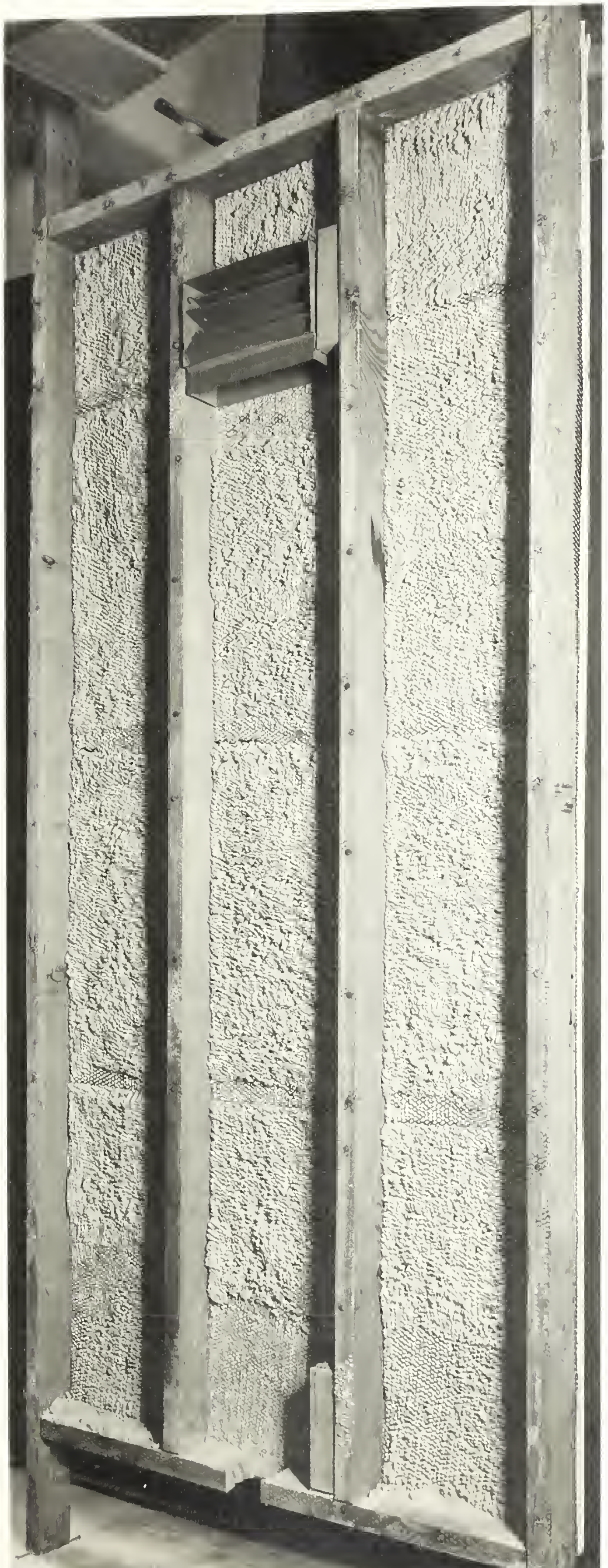


Fig. 1

and recirculated air into a room by providing for the mixing within the wall stack.

The complete blender as submitted by the manufacturer consisted of three parts -- the inlet stack head, the outlet stack head and the glass fiber duct. In addition two steel straps with attached seals were included in the package. As used in a house, the mixture of warm air and recirculated air may be introduced into the room either at baseboard level or above head level through one grille with the alternate grille being used as the opening through which the recirculated air enters the blender.

The two stack heads were of metal and were essentially short square elbows with overall dimensions of 12 in. x 8 in. x $4\frac{1}{2}$ in. with the grille opening being 12 in. x 6 in. and the other opening being 12 in. x $3\frac{1}{4}$ in. for attachment of the glass fiber duct. One stack head was fitted with turning vanes to direct the air at the outlet grille, whereas the other contained a short piece of $3\frac{1}{2}$ in. pipe which conveyed the stream of warm furnace air into the fiber glass duct. This piece of $3\frac{1}{2}$ in. pipe was located in the stack head so the stream of warm air aspirated room air into the blender. The stack head with the turning vanes is shown in the upper part of Fig. 1.

The glass fiber duct was prefabricated from a $\frac{1}{4}$ in. thick semirigid sheet of treated glass fibers. The rectangular shape was maintained because the corners were partially cut and mechanically creased and the one inch overlap of the material at the edges was stapled together. The manufacturer also provided 20 flat samples 8 in. x 8 in. and 20 boxes 8 in. x 8 in. x 6 in. high of the same duct material for exposure to mold spores and rodents.

III. Test Procedure.

To evaluate the ease of installation of the fiber glass blenders, air leakage and sound characteristics, two sections of interior partition wall were constructed. Both wall sections were alike in that they were constructed of nominal 2 x 4 in. lumber spaced 16 in. on centers with three stud spaces and were 8 ft in height. They were different in that one was of dry wall construction and the other of wet wall construction. The wet wall panel was lathed on both sides with expanded metal lathe and plastered with a scratch coat, brown coat, and a white finish coat between 3/4 in. grounds. The dry wall panel was covered on both sides with 4 ft x 8 ft sheets of $\frac{1}{2}$ in. plaster board. A blender unit was installed in the center stud space of each wall panel following the manufacturers' instructions. To install the blender in an existing dry wall partition using a duct system under the floor, holes were located and cut in the plasterboard wall as follows: (1) a vertical line was drawn about 15 in. upward from the floor at the inside edge of one of the studs in the center of the panel; (2) at a distance of 2 in. from the floor along this line, a line was drawn parallel to the floor to the approximate location of the other stud; (3) at a distance of $7\frac{1}{2}$ in. up from the point selected in step #2 a line was drawn parallel to the floor to the approximate location of the other stud; (4) measuring along the two lines parallel to the floor 12 3/8 in.

from the line on the inside of the stud, marks were made. After connecting the two marks, a 12 3/8 in. x $7\frac{1}{2}$ in. rectangle was cut out for the inlet stack. (5) the bottom line of the hole for the outlet stack was located 6 ft $7\frac{1}{4}$ in. above the floor and the same size hold - 12 3/8 in. wide and $7\frac{1}{2}$ in. high - was laid out for the upper stack.

Since the stack heads were not as wide as the space between studs, blocks approximately 6 in. long were fastened to the studs at top and bottom to provide a solid member for securing the blender heads and mounting the grilles. These blocks are visible in Figure 1.

Removing the damper assembly from the blender stack head, the bottom of the blender head was placed on the sole of the partition with one side flush against the stud and the location of the hole for the warm air supply pipe was marked, after which the stack head was removed. The opening for the $3\frac{1}{2}$ in. pipe was cut out using a brace and bit and key hole saw.

The glass fiber duct was fitted over the $3\frac{1}{4}$ in. by 12 in. collar of the outlet stack and securely fastened with the metal strap provided for this purpose. The open end of the duct was placed in the top opening and fed downward into the stud space until most of it was in the partition. By reaching upward through the lower hole, the duct was pulled into position while being pushed in at the top. The upper stack head was centered in the opening so the grille would cover the hole, and there nailed to the stud on one side and the block on the other. The glass fiber duct hanging in the partition covered the lower opening in the wall. The front side of the duct was cut off so the lower end extended about one inch below the upper edge of the hole. The collar of the lower stack head was then inserted into the glass fiber duct and pushed up as far as possible. The stack head was centered both ways so the grille would cover the opening and the stack head was nailed to the stud on one side and the block on the other. A rear view of this installation is shown in Fig. 2 with the plasterboard removed.

The same procedure was followed with the section of wet wall partition as with the dry wall partition with the following additional operations: (1) the plaster keys that were extruded through the metal lath on the wall opposite the two openings had to be removed so the stack heads could fit into position. (2) the glass fiber duct could not be pushed downward far enough to be reached from the lower hole because of the plaster keys so a chalk line was fastened to the open end of the duct and it was pulled downward while being pushed from the top until it was in place. The plaster keys had extended through the metal lath in some places far enough to practically close the opening in the fiber glass duct after it was installed in the partition.

The static pressure in the blender was determined at three places when normally installed in the stud space and with approximately 75 cfm of air

Fig. 2

at a temperature of 140°F being introduced through the $3\frac{1}{2}$ in. inlet pipe. A warm air supply was provided by means of a small blower and electric heaters. The air leakage through the fiber glass duct was determined by direct measurement with a gas meter for a range of static pressures inside the duct, with the duct lying in an open room having both ends blocked except for the supply pipe.

Sound readings were taken for similar installations using the fiber glass duct in the stud space in one case and a metal duct in the other case. The sound meter was located one foot from the face of the partition and midway between the upper and lower grilles. Readings were taken with the blower running and with it shut off.

The flame spread test was performed by the Fire Protection Section of the National Bureau of Standards under the conditions proposed as Criteria for Substitute Duct Materials in National Bureau of Standards Report 2540. The test consisted of applying a continuous flame of specified characteristics to the inside surface of the duct, measuring the rapidity of flame spread, and observing the extent of surface involvement during a 40-minute test period.

The rodent repellency tests were conducted by the Fish and Wildlife Service of the Department of the Interior. Samples were placed between laboratory rats and their food supplies and the time that elapsed before the samples were gnawed through was observed. Other samples were placed on a floor of a room housing wild rats with no motivation for attack and the damage over night was observed.

The mold test was conducted by the Testing and Specifications Section of the Organic and Fibrous Materials Division of the National Bureau of Standards. The test was conducted in accordance with Federal Specification CCC-T-191b Methods 5751.1 and 5756 for mildew susceptibility. Two sets of ten specimens were prepared from the sample. One set was tested in accordance with Method 5751.1 and the other in accordance with Method 5756. Two controls were employed for each set to test the viability of the organism.

IV. Test Results

The Coleman air blender with a fiber glass duct can be installed neatly in a relatively short time in an existing partition with dry wall construction when the detailed instructions of the manufacturer are followed. Considerable time was needed for installation in the wet wall construction because it was necessary to break off the plaster extruded through the lathe before the stack heads would fit in place. No way was devised for breaking off the plaster keys in the stud space between the stack heads. For this reason the air passage in the fiber glass duct was seriously restricted after the installation was completed. The plaster keys are visible in Fig 1 as well as the areas opposite the grilles where they were removed.

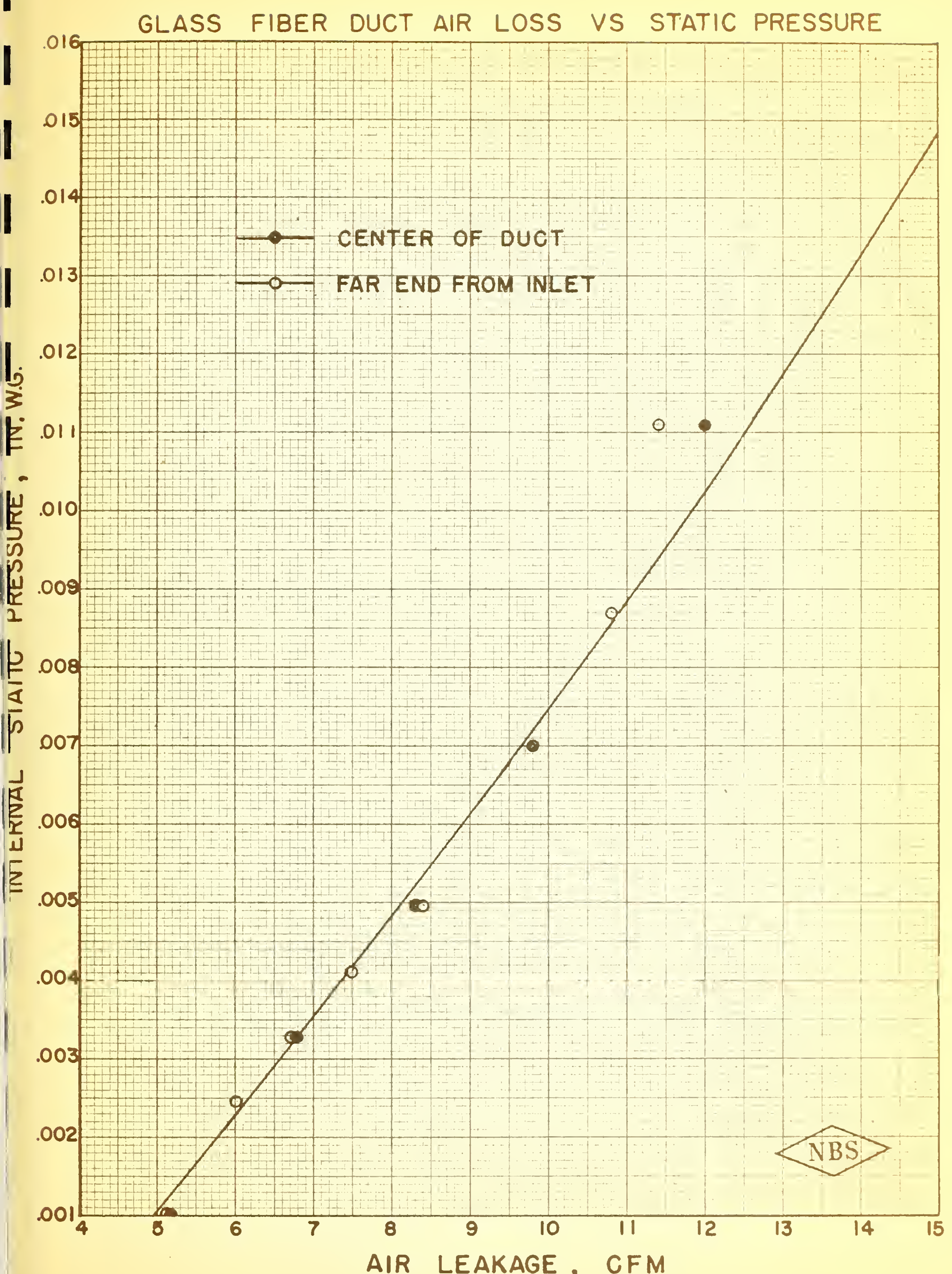
Static pressures measured within the duct at a station 4 in.from the top, midway between top and bottom, and at a station 4 in from the bottom of the fiber glass duct were 0.01, 0.017, and - 0.001 in.W.G. respectively when 75 cfm of air at a temperature of 142°F was introduced at the lower end through the $3\frac{1}{2}$ in.pipe. These pressure readings indicate air leakage from the stud space into the duct near the bottom and outward leakage from the duct in the upper half of the stud space. Smoke measurements revealed a flow of air into the stud space around the supply pipe at the bottom. There would probably be an exchange of air between the room and the stud space around both the upper and lower grilles unless they were fitted with gaskets.

Fig.3 shows graphically the relation between static pressure and air leakage through the walls of a duct section placed in an open room. This graph indicates the maximum air leakage that might occur in an installation where the stud space provided no resistance to loss of air. The air leakage from the glass fiber duct in an actual installation in a partition would be variable depending on the tightness of the particular stud space. In many cases the warm air that leaked through the fiber glass would still enter the room to be heated at cracks around the supply grille. If the $3\frac{1}{2}$ in. warm pipe was not properly caulked where it passed through the plate, some basement or attic air would probably be drawn into the stud space and possibly into the blender.

The insulating value of the glass fiber duct is unimportant when the duct is installed in an inside partition. In an installation in an outside partition the insulating value of the fiber glass is probably voided by the leakage of warm air through the material into the stud space around the duct. A computation of the probable increased heat loss from a stud space in an outside wall caused by the installation of such a blender indicated that the 500 Btu/hr reduction in heat delivery,as recommended by the manufacturer for such an installation,is an ample allowance.

The sound level measurements indicated that the increase in noise level one foot from the partition containing the blender,as a result of operating a given blower and distribution system,was the same whether the blender used a metal stack or a fiber glass stack in the stud space. Since the air velocity was so low that no air noise was audible in the duct, it was throught that most of the sound was transmitted to the rigid members of the partitions through the metal stack heads which were nailed to the studs.

The flame spread tests showed that at no time was there any flame issuing from the specimen, or spread of flame on the surface of the specimen. In one of the tests, the flame impinged on a double thickness of the material, as representative of the lapped joint, and one layer of the material in this case melted at the point of flame application. No melting was observed when the flame impinged on a single thickness of the material.


GLASS FIBER DUCT AIR LOSS VS STATIC PRESSURE
CENTER OF DUCT
FAR END FROM INLET
INTERNAL STATIC PRESSURE, IN. W.G.
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AIR LEAKAGE, CFM
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FIG. 3

The Rodent repellency test showed that hungry rats gnawed through the fiber glass material in an average of 22 minutes to reach a food supply. This is roughly equivalent to the time required for penetration of solid fiber box board. For individual specimens the time for penetration ranged from 3 to 92 minutes.

The panels placed on the floor of a room housing wild rats, with no motivation for attack, were badly damaged over night.

These tests results indicate that this material does not offer appreciable resistance to rodent attack, and that its use is not to be recommended in areas where it might be exposed to rodents.

The mold growth tests indicated that none of the test specimens showed visual evidence of mildew growth upon completion of the test. The viability controls were heavily covered with reproductive growth. The sample complied with the requirement of the tests in Federal Specification CC-T-191b.

V. Conclusions

The test results and experience obtained with the specimens of glass fiber duct indicate that they are well-suited to and easily installed in an existing dry wall partition, but not well-suited to existing wet wall partitions where extruded plaster keys reduce the cross section area of the stud space. The protruding keys make it very difficult to insert the duct in the stud space and deform the duct sufficiently to seriously reduce the air passage inside the duct.

Air leakage from the duct can be considerable, depending on partition construction, but in a tight stud space the leakage would be unimportant except that it probably voids the thermal insulation value of the fiber glass. In many cases the air that leaked from the duct into the stud space would be partially or wholly recovered by leakage into the room around the grille. In a poorly-constructed partition the wall stack might promote exchange of air between attic and basement or vice versa.

The duct material has good resistance to mold growth and it neither spreads flame nor was it penetrated by flame under the test conditions.

At the air velocities recommended by the manufacturers there was no measurable difference in noise transmission with fiber glass and metal stacks in the stud spaces.

The material does not appear to offer appreciable resistance to rodent attack.

THE NATIONAL BUREAU OF STANDARDS

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