April 28, 1970 W. P. MANNING ET AL 3,509,568

INLET ATTENUATOR ASSEMBLY

Filed July 8, 1968

Fig. 1

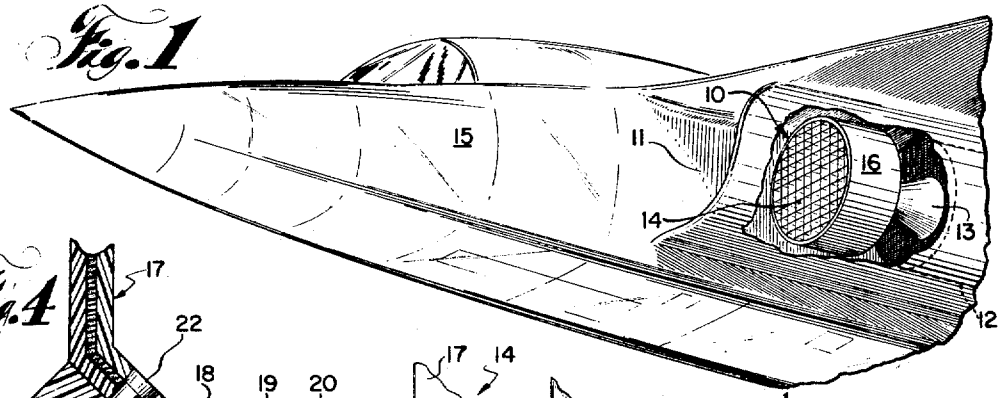
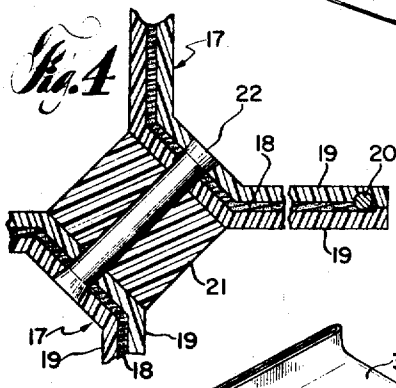


Fig. 4



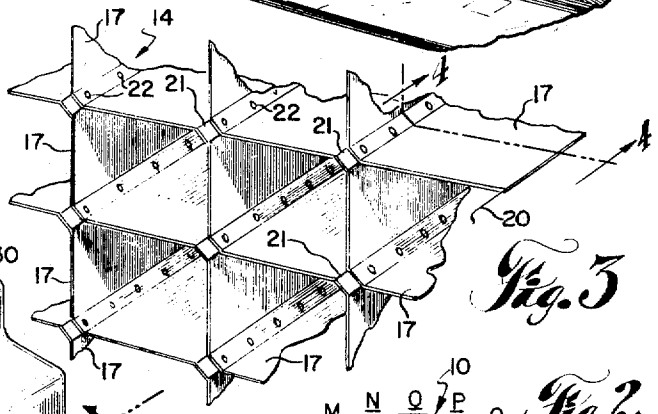


Fig. 3

Fig. 5

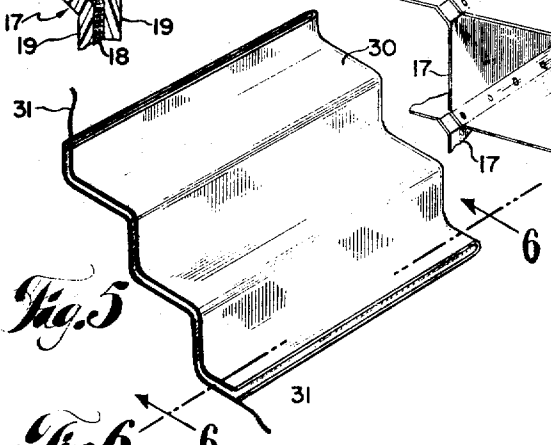


Fig. 6

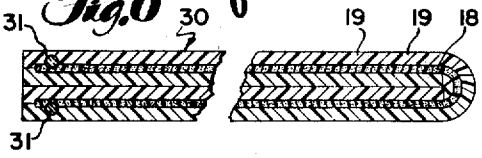
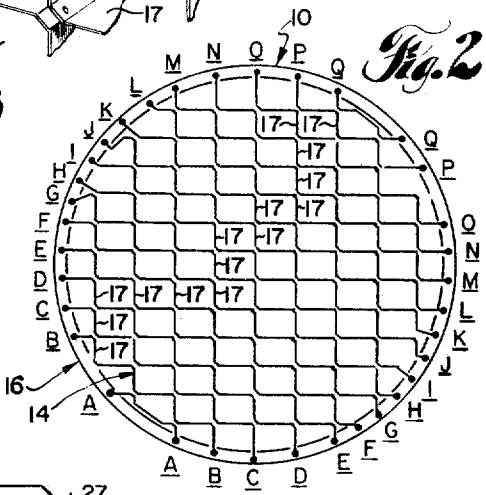


Fig. 2



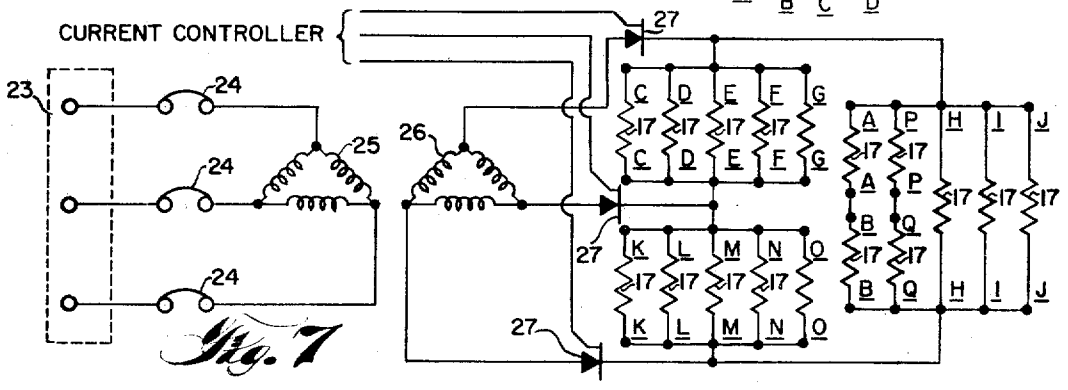


Fig. 7

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3,509,568

INLET ATTENUATOR ASSEMBLY

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U.S. Cl. 343—18 3 Claims

ABSTRACT OF THE DISCLOSURE

An assembly for combination with an engine air inlet duct, such as a turbo-jet engine or ram-jet engine air inlet duct, to significantly attenuate electromagnetic energy entering at small frontal aspect angles relative to the engine face. The assembly incorporates a lattice arrangement of attenuator sheets of particular configuration to efficiently effect attenuator anti-icing with minimum adverse effect on electromagnet energy attenuation properties.

SUMMARY OF THE INVENTION

A lattice of corrugated resistive/conductive attenuator strips joined together at adjacent ridge regions cooperates with a generally annular support structure for combination with an engine air inlet. Each resistive/conductive strip is provided with terminal electrical busses that are connected to a conventional electrical power supply for resistive heating purposes. The electrical bus arrangements, in combination with the necessary attenuator strip configurations, function to provide efficient anti-icing without unnecessarily decreasing assembly attenuation of entering electromagnetic energy.

DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates an engine air inlet duct having the attenuator assembly of this invention incorporated therein;

FIG. 2 is a schematic elevational view of the lattice of attenuator strips incorporated in the assembly of FIG. 1;

FIG. 3 is a perspective view showing details for joining successive corrugated attenuator strips into the lattice arrangement of FIGS. 1 and 2;

FIG. 4 is a sectional view taken at line 4—4 of FIG. 3;

FIG. 5 is a perspective view of an alternate form of corrugated attenuator strip;

FIG. 6 is a sectional view taken at line 6—6 of FIG. 5; and

FIG. 7 is a schematic electrical diagram for the lattice arrangement of FIG. 2.

DETAILED DESCRIPTION

FIG. 1 illustrates an inlet attenuator assembly **10**, preferably having the features of this invention, in combination with air inlet duct **11** and turbo-jet engine **12**. Assembly **10** is normally located in duct **11** forward of engine spool fairing **13** and incorporates the features of this invention in its lattice portion **14** to obtain an anti-icing capability without affectng the degree of electromagnetc energy attenuation that is otherwise achieved by such lattice portion. Although the combination is illustrated as having application to an aircraft system **15**, other types of vehicular systems with other types of engines may advantageously utilize the invention.

As shown by FIG. 2 lattice **14** is located generally within annular support structure **16** and is comprised of successive corrugated resistive/conductive attenuator strips **17** joined together at adjacent ridge regions. Details of one form of satisfactory fastening arrangement are shown in FIGS. 3 and 4. The external configuration of support

structure **16** corresponds to the internal configuration of duct means **11** at the zone of installation. For convenience of illustration, assembly **10** is illustrated in the drawings as having a circular external configuration. The joined attenuator strips **17** are also normally secured at their end regions to support structure **16** by conventional fastening means. The successive attenuator strips that comprise lattice **14** have electrical terminals designated A through Q in FIG. 2. Such designations correspond to the terminal designations utilized in the schematic electrical diagram of FIG. 7.

Attenuator strips **17** are each fabricated of a conventional electromagnetic energy attenuation material but in corrugated rather than flat sheet form. The material is normally a laminated construction having at least one lossy layer **18** sandwiched between protective layers **19**. See FIG. 4. Lossy layer **18** is normally a fabric impregnated with a resin that includes a resistive/conductive filler such as powdered carbon or aluminum in a prescribed quantity ratio. In the instant invention lossy layer **18**, in addition to functioning as an electromagnetic energy absorber, serves as a resistance element for effecting attenuator strip heating for anti-icing purposes. Protective layers **19** are generally also comprised of a fabric impregnated with a thermosetting resin and normally are non-conductive in an electrical energy sense. In most instances, the different layers utilize glass fabrics and thermosetting resins, such as a polyester resin, and are laminated into the prescribed corrugated configuration from partially cured pre-impregnated sheet materials. It is important that resistive/conductive layer **18** be electrically continuous throughout the length of each attenuator strip **17**. An electrical bus in the form of conducting wire **20** is located within the laminate in contacting relation to resistive/conductive layer **18** at each strip end region. Such conductors electrically connect the different lossy layers **18** in lattice **14** to the various power supply terminals shown schematically in FIGS. 2 and 7.

FIGS. 3 and 4 illustrate in detail one manner for joining attenuator strips **17** together at adjacent corrugation ridge region. Non-conducting spacer elements **21**, non-conducting locating pins **22**, and adjacent attenuator strips **17** are assembled as illustrated. A conventional adhesive compatible with the resin systems of strips **17** and spacers **21** is used to bond the assembly elements together to complete lattice **14**. Conductors **20** are preferably housed within support structure **16** for connection to an electrical power supply.

FIG. 7 schematically illustrates a method for incorporating the attenuator strips **17** of lattice **14** into an electrical power supply system. The elements of the power supply typically include, in addition to a 3-phase generator (not shown), terminal block **23**, circuit breaker elements **24**, and primary and secondary windings **25** and **26** of a power transformer. Current control rectifiers **27** are also typically incorporated into the system and operate in a conventional manner from a standard current controller (not shown). In the FIG. 7 arrangement, the individual attenuator strips **17** comprising lattice **14** are arranged to provide a nearly-balanced 3-phase load across the terminals of transformer winding **26**. If operated at a frequency such as 400 cycles per second, the electrical system has minimum adverse effect on the attenuation performance of lattice **14** during anti-icing operations.

An alternate form of attenuator strip taking advantage of the features of this invention is shown in FIGS. 5 and 6. Such attenuator strip is referenced generally as **30** and utilizes the same general lossy layer/protective layer construction shown in FIG. 4. See FIG. 6. The difference in construction for lattice **14** is that the electrical busses **31** are oriented lengthwise of the corrugated strip and prefer-

ably are positioned at a trailing edge region relative to airflow. Attenuator strip **30** differs from attenuator strip **17** primarily in the length of resistance path between conductors, the shortest distance between wires **31** along layer **18** of FIG. 5, 6 being significantly less than the shortest distance between wires **20** of the typical strip **17** in FIGS. 2, 3, 4.

We claim:

1. In an electromagnetic energy attenuator assembly having a resistance heating capability, in combination:

(a) Electrical energy power supply means,

(b) Elongated attenuator strips each having a generally rectangular planform and a corrugated configuration in evaluation, and

(c) Means joining said attenuator strips together at adjacent corrugation ridge regions in electrically non-conducting relation.

said attenuator strips each having a continuous resistive/conductive attenuator layer substantially coextensive with said rectangular planform and electrically connected at opposite extremes to said electrical energy power supply means for resistance heating.

2. The invention defined by claim **1**, wherein said attenuator strips each have end margins and longitudinal margins substantially greater in length than said end margins, said attenuator strips being connected at opposite extremes to said electrical energy power supply means by a pair of spaced apart conductor elements each contacting said resistive/conductive attenuator layer substantially throughout the extent of each said end margin.

3. The invention defined by claim **1**, wherein said attenuator strips each have end margins and longitudinal margins substantially greater in length than said end margins, said attenuator strips being connected at opposite extremes to said electrical energy power supply means by a pair of spaced apart conductor elements each contacting said resistive/conductive attenuator layer substantially throughout the extent of each said longitudinal margin.

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U.S. Cl. X.R.

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