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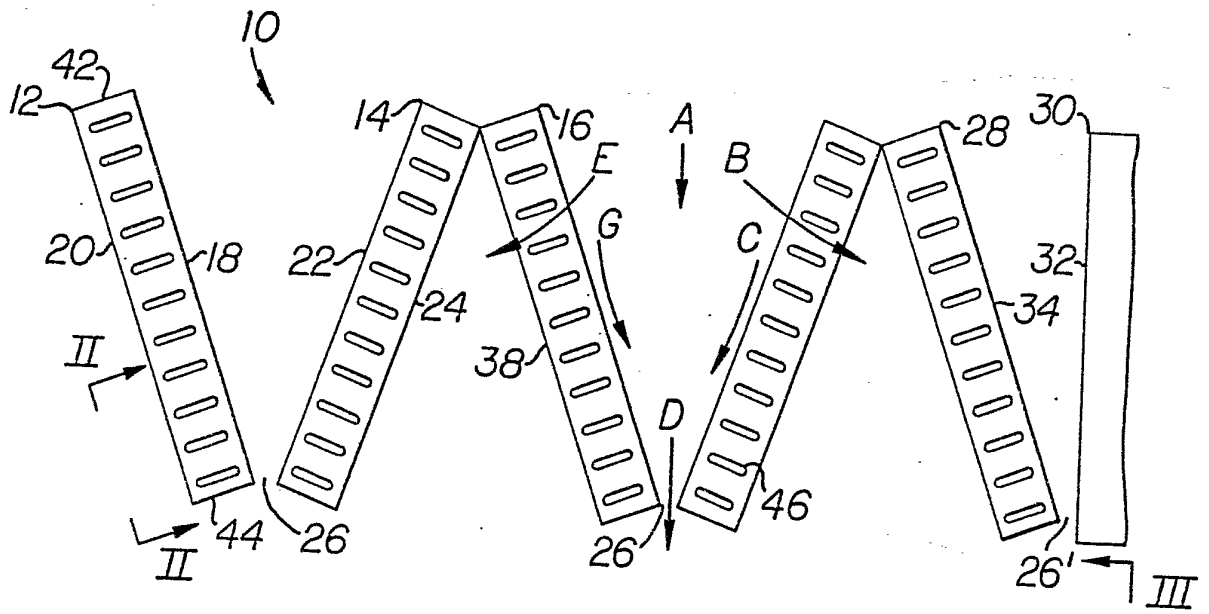
(54) Title: SELF PURGING HEAT EXCHANGER



(57) Abstract

A self purging heat exchanger (10) has first and second cores (12, 14) arranged in a "V" configuration with the inner, directly adjacent ends being spaced apart for purging debris which enters between the cores (12, 14). Each core (12, 14) has a plurality of closely spaced fins (40) which define an inlet surface (18, 22) and an elongated tube (46) which extends through the fins (40) and is spaced from the inlet surface (18, 22). Debris which enters the heat exchanger (10) travels along the inlet surfaces (18, 22) to the space (26) between the cores (12, 14) without being impeded by the tubes (46).

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Description

Self Purging Heat Exchanger

Technical Field

This invention relates to a heat exchanger and, more particularly, to core construction for continuous purging of debris.

Background Art

Heat exchangers of the type used in earth-moving vehicles must have sufficient capacity to cool the engine by the passage of air through and around the heat exchange element. In the past, it has been necessary sometimes to use large fans operating at high speeds to provide sufficient air flow through the heat exchanger element. Unfortunately, large fans use excessive power, cause vibration and noise which is undesirable. Because of current noise regulations, the use of large fans is now restricted and other means must be found to provide effective cooling without excessive noise.

One way to increase cooling capacity is taught by Roelf J. Meijer and Jan Mulder in U.S. Patent No. 4,034,804 which issued July 12, 1977. Meijer and Mulder disclose a radiator operable with a flow of air for cooling a quantity of water and formed as zig-zag or folded walls, each of which contains air ducts. Cooling water pipes are arranged in a number of flat cores, the upper and lower sides of which are located in the front and rear planes, respectively, of the radiator. The cores are connected together alternately on their front and rear sides in an air-tight manner.

The zig-zag pattern increases the cooling capacity by increasing the surface area exposed to the flow of air without increasing the size of the radiator.

There is, however, a problem with debris plugging the cores and reducing cooling capacity. Under some field conditions, where large quantities of air-borne fuzz and debris are present, the debris and fuzz may be readily caught by the front edges of the water tubes which are flush with the front of the core and also embedded between the cooling fins.

At the junction of the cores at the rear of the radiator, air flows downward which increases the opportunity for air-borne debris to collect on the fins thereby reducing cooling. Furthermore, at low vehicle speeds, there may not be any air flow at the junction - hence no cooling. Meijer and Mulder recognize that plugging may be a problem and provide a fine gauze to be placed around the outside of each core. This in effect is a mere screen which itself can become plugged.

Since the air flow changes direction abruptly inside the radiator from a horizontal flow to a downward vertical flow, areas exist where there is little or no flow and plugging occurs. Because of the change in direction of the air flow, even the fine gauze will clog.

Recognizing that clogging is a problem with zig-zag or folded core radiators, Erwin Bentz devised a novel way to easily unclog a radiator core as described in U.S. Patent No. 4,076,072 granted February 28, 1978. Bentz uses reversible cores which can be rotated 180 degrees to expose a clean core surface to incoming air while the reverse, clogged core surface is cleaned by the exit flow of air through the core. While this reversibility allows the clogged cores to be cleaned easily, reversing the cores takes time and is done when the radiator is visibly clogged. Apparatus is provided for rotating all the cores at one time, but again, this is done in response to a visual observation.

It is therefore desirable to have a heat exchanger which has a large cooling capacity and does not require the use of excessively noisy fans. It is also desirable to have a heat exchanger which is self purging during operation thereby preventing clogging. The core should be arranged such that the air stream does not make abrupt changes in direction and such that there are no area of zero velocity air flow.

Disclosure of Invention

In one aspect of the present invention, a heat exchanger has a plurality of closely spaced fins defining an inlet surface. An elongated tube extends through the fins and is spaced from the inlet surface.

In another aspect of the present invention, a heat exchanger has first and second cores each having inlet and outlet surfaces. The inlet surfaces of the first and second cores face one another and the cores are angularly oriented one relative to other in a general "V" configuration with the inner directly adjacent ends being spaced apart.

Since the elongated tube is spaced from the inlet surface, debris traveling along the surface is not caught by the tube and clogging does not occur because of the tube. Arranging the cores in a "V" configuration increases the cooling capacity without increasing overall size thereby decreasing the need for large fans. The space at the bottom of the "V" facilitates the purging of debris to prevent clogging during operation. Air flows through the cores at increased density without a drastic change in direction.

Brief Description of Drawings

FIG. 1 is a sectional view of a heat exchanger consisting of a number of cores arranged in a zig-zag pattern;

FIG. 2 is a diagrammatic sectional view of a core taken along line II-II of FIG. 1;

FIG. 3 is a diagrammatic end view of the core taken along line III-III of FIG. 2; and

FIG. 4 is somewhat enlarged partial sectional view similar to FIG. 1 but illustrating only one core.

Best Mode For Carrying Out The Invention

Referring to FIG. 1, a self purging heat exchanger 10 has a number of cores, such as first, second and third cores 12,14, and 16 for example, arranged in a zig-zag pattern as viewed from the top or along a horizontal cross-section.

The first core 12 has an inlet or upstream surface 18 and an outlet or downstream surface 20. The second core 14 has an inlet surface 22 and an outlet surface 24 and is positioned with the inlet surface 22 facing toward the inlet surface 18 of the first core 12. The cores 12,14 are angularly oriented one relative to the other in a general "V" configuration with the inner, directly adjacent ends being spaced apart a distance in the range of about 5 to 10 mm. If the space or gap 26 is less than about 5 mm wide air flow therethrough is extremely limited and debris will accumulate in the gap 26. Conversely, if the gap 26 is more than about 10 mm wide, too much air flows therethrough which reduces the air flow through the cores 12,14 and particularly along the inlet surfaces 18,22.

Where there is only one core or an end core, such as core 28, a gap 26' is provided between the core 28 and the surface 32 of a supporting frame 30. The gap 26' has a width in the range of about 3 to 10 mm. If the gap 26' is less than about 3 mm, there is insufficient width for debris to escape. If the gap 26' is larger than about 10 mm, air flow through the core 28 and particularly along the inlet surface 34 is reduced.

The cores 12,14 define an angle in the range of about 20 to 70 degrees, preferably 40 degrees, while core 28 and frame 30 define an angle in the range of about 10 to 35 degrees, preferably 20 degrees. The core 28 and frame 30 also have a general "V" configuration. Cores 28 and 12,14 may be used together with advantage, particularly where two or more liquids require cooling.

The third core 16 has inlet and outlet surfaces 36,38 and is positioned with the outlet surface 38 facing toward the outlet surface 24 of the second core 14 in a general inverted "V" configuration. The inner directly adjacent ends of the inverted "V" are arranged to be substantially air-tight so that no air flows therethrough but is diverted through the inlet surfaces 22,36. The third core 16 may be substantially parallel to the first core 12 or may be nonparallel thereto. Additionally, each "V" may be symmetrical or nonsymmetrical with other "V's".

Referring to FIGS. 1-3 each core, core 12 for example, is comprised of a plurality of closely spaced fins 40 defining the inlet and outlet surfaces 18,20 and defining first and second end surfaces 42,44. The number of fins per mm is in the range of about 0.79 to 1.57. The fins preferably have a straight longitudinal profile but can have a wavy, serpentine profile. Straight fins are preferred from the standpoint of purging while wavy fins dissipate more heat for given core dimensions. Because of the close fin spacing, the waviness is acceptable where the nature of the debris to be purged allows it to roll along the surface of the core.

Referring to FIG. 4, each core has at least one tube 46 extending through the fins 40 and spaced from the inlet surface 18 a distance "F" in the range

of about 2 to 4 mm. The tube 46 is preferably spaced from the outlet surface 20 a similar distance "R". At distances less than about 2 mm the tube 46 is exposed and catches debris thereby contributing to core plugging. At distances greater than about 4 mm heat transfer from the front of the tube 42 adjacent the inlet surface 18 is affected and the fins 40 are subject to mechanical stress and bending.

Each core has a thickness "T" in the range of about 15 to 40 mm as measured between the inlet and outlet surfaces 18,20. Where there are a plurality of tubes they are spaced apart about 10 mm or so.

By this construction a heat exchanger 10 is formed which has a core thickness to hydraulic diameter of about 20 to 24. The hydraulic diameter is defined as four times the flow area divided by the perimeter of the opening for the flow and refers to the space between the fins 40, met within the tubes 46.

Industrial Applicability

During operation, air approaches the heat exchanger 10 from the front as shown by arrow "A" in FIG. 1 flows through the cores as shown by arrows "B" and "E". There is a flow of air through the gaps 26, as shown by arrow "D", which causes a substantial tangential air flow component, "C" and "G", along the cores. This tangential flow slides and rolls debris along the core surfaces without catching on fins 40 or tubes 46. The tubes 46 do not catch debris because they are recessed and the fins 40 do not catch debris because the debris slides and rolls in the same direction as the fins 40. Because of the close spacing of the fins 40, debris does not enter between the fins 40.

The gap 26 is sufficiently wide to allow debris to escape rather than become caught in the gap 26. Because of the gap 26 the tangential flow, "C" and

"G" keeps the debris sliding and rolling toward the gap 26. Since there is no significant downward flow or downward tendency for the debris to move, other than gravity, the fins 40 do not catch the debris.

One core or any number of cores can be used to cool one or more liquids in the same cooling space of a vehicle. The water from the engine, engine oil, and refrigerant can all be cooled in the same basic space by varying the angular orientation to accommodate the required number of cores.

The heat exchanger 10 has a large cooling capacity because the closely spaced fins 40 readily dissipate heat thereby reducing the need for large capacity fans. Because of the gap 26 and the resulting tangential air flow during operation, the heat exchanger 10 purges itself to prevent clogging. Air flowing through the cores is compressed for better cooling, but is not directed downward in a manner to catch debris on the fins 40. Because the tubes 46 are recessed, they do not catch debris either.

Other aspects, objects and advantages of this invention can be obtained from a study of the drawings, the disclosure and the appended claims.

Claims

1. A heat exchanger (10), comprising:

a plurality of closely spaced fins (40) defining an inlet surface (18); and

at least one elongated tube (46) extending through the fins (40) and being spaced from the inlet surface (18) a distance in the range of about 2 to 4 mm.

2. A heat exchanger (10), comprising:

a first core (12) having an inlet surface (18) and an outlet surface (20); and

a second core (14) having an inlet surface (22) and an outlet surface (24) and being positioned with the inlet surface (22) facing toward the inlet surface (18) of the first core (12), said cores (12,14) being angularly oriented one relative to the other in a general "V" configuration with the inner, directly adjacent ends being spaced apart a distance in the range of about 5 to 10 mm.

3. A heat exchanger (10), as set forth in claim 2, including

a third core (16) having an inlet surface (36) and an outlet surface (38) and being positioned with the outlet surface (38) facing toward the outlet surface (24) of the second core (14) in a general inverted "V" configuration.

4. A heat exchanger (10), as set forth in claim 2 wherein the first and second cores (12,14) each include

a plurality of closely spaced fins (40) defining the inlet and outlet surfaces (18,22;20,24) and first and second end surfaces (42,44) of the cores; and

at least one elongated tube (46) extending through the fins (40) and being spaced from the inlet surface (18,22) a distance in the range of about 2 to 4 mm.

5. A heat exchanger (10), as set forth in claim 2, wherein the first and second cores (12,14) define an angle in the range of about 20 to 70 degrees.

6. A heat exchanger (10), as set forth in claim 2, wherein the first and second cores (12,14) each have a thickness in the range of about 15 to 40 mm as measured between the inlet and outlet surfaces (18,22;20,24).

7. A heat exchanger (10), as set forth in claim 4, wherein the number of fins (40) per mm is in the range of about 0.79 to 1.57.

8. A heat exchanger (10), as set forth in claim 4, wherein the fins (40) have a serpentine longitudinal profile.

9. A heat exchanger (10), comprising:

a frame member (32) having a surface (30); and

a core (28) having an inlet surface (34) and being positioned with the inlet surface (34) facing toward the surface (30) of the frame member (32), said core (28) and frame member (32) being angularly oriented one relative to the other in a general "V" configuration with the inner directly adjacent ends being spaced apart a distance in the range of about 3 to 10 mm.

10. A heat exchanger (10), as set forth in claim 9, wherein the core (28) and frame member (32) define an angle in the range of about 10 to 35 degrees.

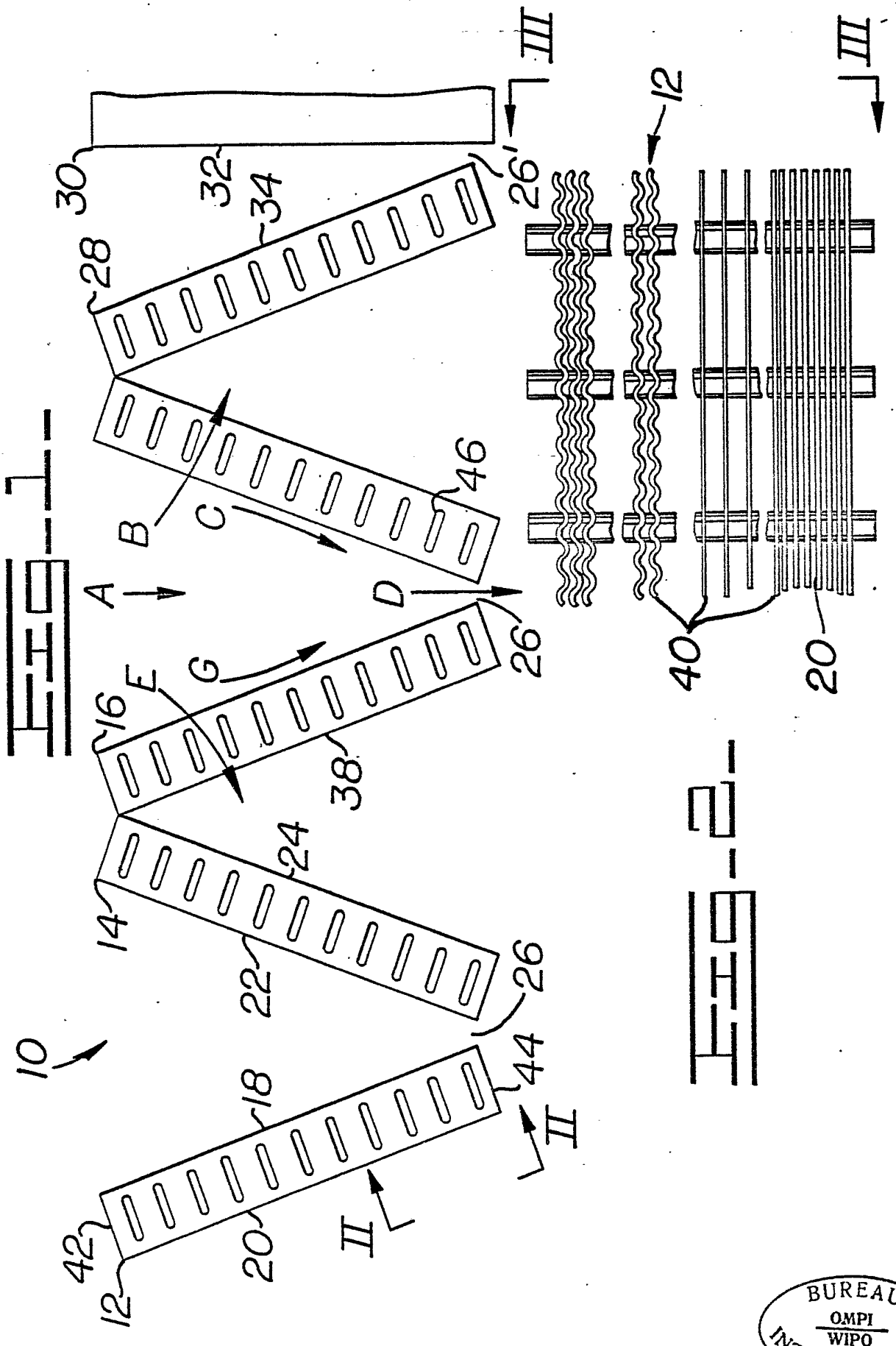


FIG-1

FIG-2

FIG-4

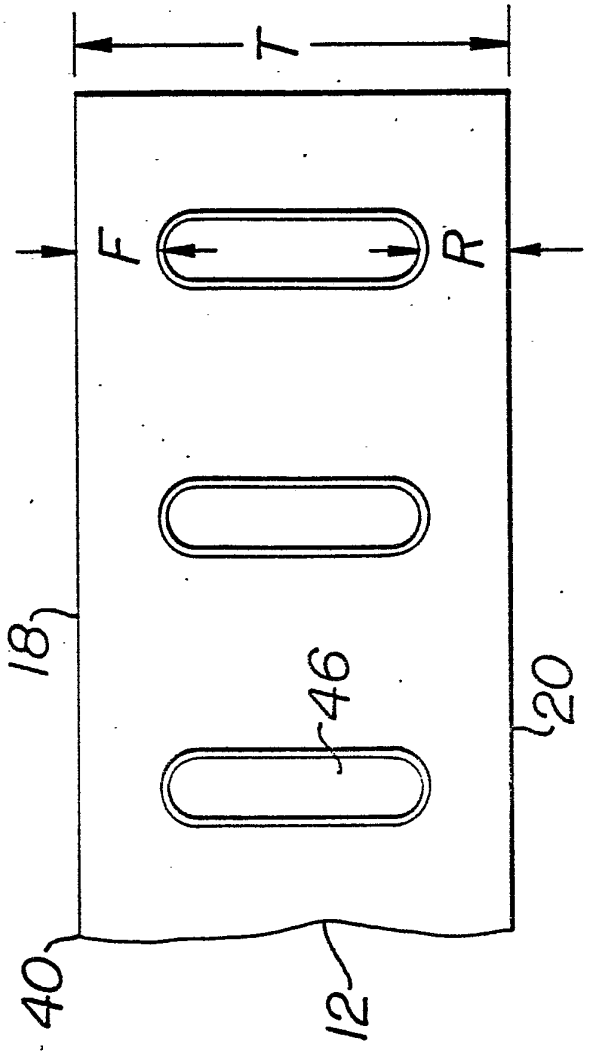
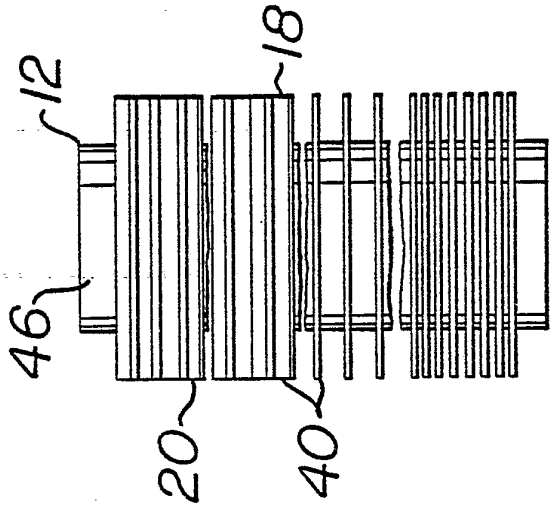


FIG-3



INTERNATIONAL SEARCH REPORT

International Application No PCT/US78/00175

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

INT. CL. F28 F 7/00
U.S. CL. 165 151

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
U.S.	165- 151

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X	US, A, 4,116,265 PUBLISHED 26 SEPTEMBER 1978 STAEBLER	1-7, 9 & 10
X	US, A, 3,080.916 PUBLISHED 12 MARCH 1963 COLLINS	1-7,9 & 10
X	US, A, 2,733,899 PUBLISHED 7 FEBRUARY 1956 LEHMANN	1-7, 9 & 10
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IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
27 NOVEMBER 1979	18 DEC 1979
International Searching Authority [1]	**Signature of Authorized Officer [20]**
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