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(54) Title: FIN-TYPE HEAT EXCHANGER		
(57) Abstract A highly effective fin-type heat exchanger (A), which is easily reproduceable, versatile in application, low cost, comparatively compact, and light in weight. The construction provides for a low resistance to a flowing medium, by utilizing an array of highly heat conductive fins (3, 26), each fin (3) projecting in one continuous piece, through a partition (1, 23) of lower thermal conductivity, which separates two mediums. This intersection is sealed, to prevent cross-contamination between the two mediums. High thermal exchange ability is achieved by a configuration in which the flowing medium sequentially impacts the array of highly heat conductive fins (3), which extract the heat contained in this medium, and conduct the heat through the separating partition (1, 23), into the second medium. The apparatus and method have particular utility in a number of applications such as: waste heat recovery (Figs. 1-6, 9 and 12); water heaters (Fig. 8); a combination muffler and heater (Fig. 10); earth tubes (Fig. 7); solar thermal transfert (not shown); or numerous thermal dissipating applications, where the fins (3, 26) are either embedded into (Figs. 13 and 14) or project through (Fig. 11) a lesser conductive member (23, 28, 29), and extend outwardly into the ambient atmosphere.		

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FIN-TYPE HEAT EXCHANGER

BACKGROUND OF THE INVENTION

Previous heat exchangers in attempting to overcome the major problems associated in heat transfer utilized various means to improve thermal exchange efficiency, much as those listed below:

	MEANS	TECHNIQUE
	Surface Contact	Increase surface area Surface structure (e.g., corrugations)
10	Surface Impact	Flow patterns Turbulence
	Surface Temperature	Counterflow Progressively staged heat transfer
15	Surface Contact Duration	Cavity expansion Flow restriction Multiple pass
	Transfer Effectiveness	Material selection Cleaning Continuous transfer elements

Typically, each additional step used for improvement adds to the exchanger's cost due to manufacturing complexity and materials so tradeoffs had to be made between efficiency and economics.

Heretofore, prior inventors have tried maximizing the thermal transfer ability of an exchanger, by varying the means mentioned to meet specific applications. Whereas, in applications requiring low flow resistance to the moving medium, e.g., air, the efficiencies of prior heat exchangers were low, due to their construction. Some devices utilize heat conductive plates or fins projecting into a first medium which are attached to a partition separating the other, second medium. These devices have a large surface area contact with the first medium, yet not in both mediums. Other devices, attempting to overcome flow resistance, have the separating partition molded of one material, with fins on both sides thereof. These devices are expensive to manufacture and heavy in weight. Further devices improved efficiency by passing fins through the partition, thereby partially extending the fins into both mediums. This reduced contact resistance, since the fins were continuous. Most of the devices mentioned tend to align and affix the fins parallel to the flow of the medium. This



causes the least medium turbulence, while maintaining a large surface contact in the medium. However, to increase the efficiency of this type of exchanger, more fins must be added, thereby increasing flow resistance and expense of manufacture.

5 Therefore, a primary object of this invention is to provide a configuration of fins extending both internally and externally through a partition which forms an inner chamber, whereby a low flow resistance of the medium contained in this chamber is achieved. Another object of this invention is to provide fins with large exposed surface
10 areas, constructed of high thermally conductive materials placed so as to sequentially and directly impact the flowing medium while maintaining a low flow resistance. Yet another object of the invention is to provide a cumulative thermal storage and transfer capacity associated with the mass of the thermally conductive fins. Yet another
15 object of the present invention is to provide a configuration of high thermally conductive fins projecting into a flowing medium whereby higher thermal exchange is achieved by maximizing the turbulence of this medium. Still another object of this invention is to provide a staged, progressive heat exchange so as to maximize the temperature gradient between the two exchanging mediums. Still a further
20 object of this invention is to provide a simple cleaning means for the fins, so as to maintain thermal transfer effectiveness. A further object of this invention is to expand the cavity in which the medium is flowing. Still another object of this invention is to provide a
25 construction which utilizes a minimum of costly high thermally conductive materials only where the heat exchange is desired to be maximized. Still a further object of this invention is to provide a construction which is easily expandable by placing extra sections of the invention in series for additional thermal accumulation and exchange. Still a
30 further object of this invention is to provide a convenient means for ease of installation for an intended usage. Another object of this invention is to provide a heat exchanger of novel construction which is simple and inexpensive to manufacture or reproduce. A further object of the present invention is to provide such a heat exchanger
35 which is light in weight and suitable for use in a variety of applications.

SUMMARY OF THE INVENTION

The present invention resides in a heat exchanger being of a simple and easily reproducible construction, with an associated low cost to manufacture, wherein a partition, which forms an enclosure and separates two media, has an array of highly heat conductive fins which project and traverse through the full width of and generally to the center of the enclosure, thereby being perpendicular to the flow of the inner medium and partially extending into both media whereby the fins become a thermal link between the two media.

Another characteristic of this invention, is the use of dissimilar thermally conductive materials. The aforementioned enclosure is constructed of a lower thermally conductive material as compared to the fins which are made of a very high thermally conductive material. The use of dissimilar materials further directs the thermal exchange between the two media and conserves the usage of expensive highly conductive materials. In another embodiment of the present invention, an outer enclosure encases the aforementioned enclosure whereby the outer medium can be circulated past the fins extending from the inner enclosure which are in a direct thermal relationship between the two media.

This novel invention utilizing many techniques for increasing heat exchange has the following combined advantages:

1. A very low flow resistance to the moving medium.
2. The usage of dissimilar thermally conductive materials to direct the transfer of heat to desired regions so as to reduce the exchanger's external heat loss, as in units constructed of a single material, and to reduce the unit cost by using costly materials with high thermal conductivity only where heat exchange is desired to be maximized.
3. Cavity enlargement for the inner moving medium so that it may move freely while interacting with the fins to have an increased surface contact duration with the highly conductive fins for extended thermal exchange.
4. The extension of each fin being in one solid piece, into two separated media by projecting it through the partition separating the two media, thereby eliminating most losses associated with



contact resistance, as in exchangers with fins fastened or attached to the partition.

5. Each fin has large surface area exposure to the two mediums thereby causing a head-on impact and increased turbulence to augment heat exchange.

5 6. Each fin is mounted perpendicular to the flow of the moving medium thereby causing a head-on impact and increased turbulence to augment heat exchange.

7. The arrangement of multiple fins, placed in a laterally staggered fashion relative to one another causes the internal medium to flow in
10 a serpentine pattern sequentially impacting each successive fin without diminishing the mass of the flow. The superiority of this arrangement particularly when combined with dissimilar thermally conductive materials is momentary compression and entrapment of the medium upon impacting each fin and a progressively staged heat exchange. In
15 practice, the fins nearest the source medium inlet assume a high temperature, whereas progressively towards the outlet they are reduced in temperature. An increased thermal exchange results when a higher temperature gradient exists between the fin and the receiving medium, whereby this advantage is gained by the usage of the
20 laterally staggered fin arrangement or countercurrent flow techniques. Another advantage with this arrangement is a vertically induced draft caused by the heated fins within the inner enclosure.

8. The length of the heat exchanger can be easily varied, which also alters the number of fins or thermal transfer stages. There-
25 fore, depending on the amount of heat exchange desired, the length of the unit may be readily chosen and is easily accomplished just by adding further sections.

9. The fins extending into the outer medium can accomodate various mediums and flow directions of those mediums, e.g., crossflow,
30 countercurrent, etc..

10. By increasing the mass of the fins, this exchanger begins to accumulate heat in the fins thereby providing a means for thermal storage and subsequent dispersal.

11. The entire heat exchanger is easily reproducible, low in cost,
35 compact in size, light in weight, and has versatility in application.

The embodiments of this invention later described have particular utility in applications wherein problems have previously plagued



industry. Present day flue waste heat recovery exchangers suffer from low performance and high cost which has brought them into low regard with the public in general. This is mainly due to their tube type construction which does not provide sufficient impact surface area and turbulence to the escaping heated gases. To overcome these problems, the employment of generally known techniques would be restricted by regulations demanding very low resistance to the flow of the exhaust gases. However, these problems have been overcome with the present invention and experiments have shown the present invention, with its low cost, far surpasses the performance of even the most highly acclaimed and expensive units on the market today. Another particular application in which prior exchangers have low performance is in the field of earth tubes. These devices, mainly comprised of tile tubes, saturate the closely surrounding earth with heat due to their lack of effective thermal exchange to the surrounding medium. With the present invention, the deployment of highly heat conductive fins, with large exposed surface areas extending far into the surrounding medium, widely disperse the heat far away from the tube. Whereby, the exchange of much larger quantities of heat can be achieved, thereby cooling buildings inexpensively. A particular reduction in power consumption is obtained when this invention's earth tube is utilized in conjunction with heat pumps. A further application in which the state of the art is commonly inefficient concerns combustion type domestic and commercial water heaters, in which a large portion of the thermal energy produced by burning of fuel is exhausted out the vent stack. The present invention is applied internally to the water heater, wherein the heated gases in the vent stack communicate with protruding thermally conductive fins located therein, and capture this normally wasted heat, channeling it directly into the water contained in the tank, thereby reducing fuel consumption of the unit. Another application of this invention is to passive solar walls, e.g., trombe walls. These walls have been enjoying an increased popularity due to rising energy costs. However, without a means for effectively conducting the solar energy into the wall, a long time is required for full thermal saturation of the wall, therefore, decreasing their effectiveness. With the present invention embedded internally into such mass walls, with high thermally conductive materials projecting



through to the outer conductively plated face of the wall, solar absorbtion is enhanced, as well as thermal transfer ability, due to the placement of the invention, which provides a conduit means internal to the wall, with ports for room air intake and heated air exhaust for heat dispersal.

In solar applications, such as flat plate collectors, there is a disadvantage in that the conductive plate is only attached to the outside of a conduit or tube. The tube and collector plate are constructed of a similar highly thermally conductive material, and welded or pressed together so as to conduct the thermal solar energy to the liquid contained in the conduit. The present invention as applied to a solar flat plate collector has a multiple advantage, in that the high thermally conductive plate passes completely through the conduit or tube, separating this tube into halves, which are attached to the plate by flanges located on the edges of each tube half. This simple construction is easily mass-produced, and yields high thermal transfer efficiency, and further, reduces unit cost by not needing the highly thermally conductive materials to be used throughout.

The thermal dissipator of the present invention, using the advantages of fins and dissimilar conductive materials, comprises: a first member or housing having a low thermal conductivity, into which high thermally conductive fins are embedded or pressed, in which these fins directly cool the first member by utilization of thermally conductive fins extending externally and substantially beyond the first member into an outer medium or ambient atmosphere. An application of this invention to an oil pan or container of a vehicle engine or transmission, or an electrical transformer housing, or hydraulic fluid reservoir, yields an effective cooler for the oil contained therein. Previous units, in this application, have predominantly been constructed of the same material throughout, with either external fins attached, or internal tubes attached to the container, so as to provide an increased surface radiator for thermal dissipation. This works to an extent, although failure of members still occurs due to heat buildup. With the application of fins of a highthermal conductivity projecting through the container wall, communicating with the hot oil, and providing for an increased internal surface area thermal dissipation occurs at an intensified rate, due



to the natural thermal flow of heat present through the fins into the cooler, preferably moving ambient atmosphere. As is also the case with bearings and housings containing bearings, the heat buildup associated with usage and loading often hastens bearing fatigue and failure. The present invention embedded into such a housing, which
5 contains a bearing or being a brake drum for instance, serves as an effective thermal radiator, which projects substantially into the ambient atmosphere. The highly heat conductive fins are embedded into the housing so as to communicate with and touch the hottest area of the member desired to be cooled, and project through this lesser
10 thermally conductive barrier or housing into the cooler ambient atmosphere, for effective heat dissipation.



BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects, advantages, and applications of the invention will become apparent from the following detailed description of several preferred embodiments as illustrated in the accompanying drawings, forming a part hereof, and in which:

5 Figure 1, is an isometric view of the present invention as applied to flue waste heat recovery units.

Figure 2, is an isometric view of an alternative configuration of a flue waste heat recovery unit.

10 Figure 3, is a cutaway top view along lines A-A of the unit depicted in figure 4.

Figure 4, is a frontal cutaway view of the flue waste heat recovery unit shown in figure 1.

15 Figure 5, is a cutaway view of the flue waste heat recovery unit depicting a typical airflow pattern of the outer medium within the unit shown in figure 1.

Figure 6, is a cutaway view of the flue waste heat recovery unit depicting a typical airflow through the inner chamber of the invention, as in figure 1, describing a serpentine airflow pattern.

20 Figure 7, illustrates a building or structure utilizing a submerged or buried application of this invention less the outer casing as applied for cooling premises.

25 Figure 8, illustrates a water heater or steam boiler unit, cutaway view, utilizing the conductive fins with said fins dispersing heat directly into the liquid medium.

Figure 9, is an isometric cutaway view of an alternate flue waste heat recovery embodiment.

30 Figure 10, is a cutaway view of an embodiment of the invention as adapted to an engine exhaust waste heat recovery unit and muffler combination.

Figure 11, is an isometric view depicting an application in the heat exchanger mode, employing highly heat conductive fins or plate of generally thicker material than that of the barrier or wall through which the fins protrude, as would be applied to a transmission pan,

35 Figure 12, illustrates a cutaway isometric view of a plate-type waste heat recovery embodiment of the invention.



Figure 13, is an isometric cutaway view of a heat dissipating roller bearing, utilizing embedded fins.

Figure 14, is an elevational view of a vehicle brak drum utilizing attached heat dissipative fins.



DETAILED DESCRIPTION

The construction of the invention as applied to flue waste heat recovery is in general best illustrated in the provided views in FIGS. 1-6 showing the relationship between the various parts. The term "fluepipe" is herein generally employed for clarity to include such apparatus and conducting means as chimney, smokestack, ducts, and the like. The term "furnace" herein is utilized for clarity and would include all combustion heating devices, e.g., furnaces, stoves, boilers, etc., utilizing discharge or exhaust flues. The term "room air" is herein generally employed for clarity to mean atmospheric mediums, whether liquid or gas, to be used for heating or cooling purposes.

In general, the waste heat recovery unit assembly shown in FIG. 1, is indicated by the letter "A", as being essentially a replacement for an existing section of fluepipe, and is composed of an enlarged inner enclosure (1) and outer enclosure (2) which are shown as being rectangular in form in this particular embodiment, though round, square, oval, or other symmetrical or asymmetrical construction may be employed. The inner enclosure (1) is connected to the outer enclosure (2) by means of a pair of end plates (5), thereby forming and sealing outer chamber (14). End caps (7) are generally comprised of covers with starting collars attached so as to fit directly onto existing fluepipes. The end caps (7) fasten to the inner enclosure (1) forming inner chamber (13). Heat conductive fins (3) are inserted, by pressure, into the inner enclosure (1) through slots which are slightly narrower than the thickness of fins (3), thereby sealing the joints. The fins (3) traverse and project substantially into the outer chamber (14) and generally into the middle of the inner chamber (13). Approximately half of the number of fins (3) are interposed with and evenly spaced from the other half of the number of fins (3) mounted on the opposite side of the inner enclosure (13). Thereby, the fins (3) form a laterally staggered array, as shown in FIG. 6. This configuration maximizes turbulence with minimal resistance to the flow of heated flue gases rising in the inner chamber (13) and causes the gases to stay essentially in one mass and sequentially head-on impact each fin (3) whereby the gases are momentary compressed, entrapped, and the deflected to the subsequent fin as the gases travel in a



serpentine pattern through the inner chamber (13), thereby transferring the heat from the gases through the fins (3) into the outer chamber (14).

It is important to note that in the embodiments which follow, the prior principles of operation, description, and the configuration of fins (3) attached to the inner enclosure (1) remain the same.

In FIG 5, room air is forced by a fan (6) through inlet (16) into an outer chamber (14), then circulated upwardly, communicating with the fins (3) which traverse the outer chamber (14), proceeding then over the airflow dividers (8), down the opposing side of the outer chamber (14), completing the U shaped airflow pattern, and thereupon exiting through the outlet (15) and register (10). A ductwork may be attached to outlet (15) alternatively, so as to disperse the heated air throughout the premises.

The main body of unit "A" should preferably be constructed of materials that are of a lesser thermal conductivity, e.g., tin, iron, steel, etc., as compared to the highly thermally conductive materials that comprise the fins (3), e.g., copper, aluminum, and alloys. These fins (3) may have improved surfaces, e.g., coated, corrugated, clad, or constructed in many physical configurations, e.g., mesh attachment, tapered, etc.

Shown in figures 3 and 4 is an attached fin cleaning apparatus, for overcoming surface fouling, and maintaining thermal transfer efficiency. Singularly comprised of a rod (4), which passes through lineally aligned precision fitted guide holes (17), positioned in both inner and outer enclosures (1 & 2) so that when the rods (4) are manually pulled outward, the attached scraper blade (9) presses against and cleans the full width and length of the fin's (3) upper portion. By manual operation of said scraper combination (9 & 4), sequentially starting at the top scraper, then on to the next lower one, the debris accrued and removed is finally deposited into the firebox of the attached stove. Scraper combination (9 & 4) when in a closed position, rests against and parallel to inner enclosure's (1) interior wall, during normal use of the waste heat recovery device "A". However, if both the upper and the lower surfaces of the fin (3) were desired to be cleaned, only a slight modification would be required.



Furthermore, for convenient operation when the waste heat recovery unit "A" is installed, a bi-metallic thermostat (11) is provided which activates the fan (6) when a certain ambient outer chamber (14) temperature is present. This feature, combined with a fan speed
5 control and line switch (12), provides convenient operation of the waste heat recovery unit.

Figure 7 describes a further application of this heat exchanger, wherein the inner enclosure (1) is shown embedded into a subterranean medium (20), e.g., earth, mud, or water. The room air present in
10 building (18) is drawn by a fan (6) through the inner enclosure (1), and transfers the heat of the room air into the cooler subterranean medium by means of the array of thermally conductive fins (3) attached to the inner enclosure (1), and protruding therefrom. The inner enclosure (1) should preferably be constructed of corrosion-
15 resistant material, e.g., plastic, stainless steel, tile. The fins (3) should preferably be constructed of corrosion-resistant and highly thermally conductive materials, e.g., copper, aluminum, brass, alloys. The fin (3) extension length into the subterranean medium (20) is determined by this medium's thermal conductance and saturation
20 capacity.

Figure 8 describes a further application of the present invention embodied as a water heater. Heat conductive fins (3) extend into the water (22) contained in the tank (21), and project through the walls of and into the interior of the inner enclosure (1). The
25 heated products of combustion rise from the combustion chamber (20), and sequentially impact upon each successive thermally conductive fin (3), thereby transferring the heat present in said gases through the fins (3) directly into the water (22) which surrounds the inner enclosure (1). The thermostat (11) regulates the temperature of the
30 water (22) within the tank (21).

In another embodiment of the invention as a waste heat recovery unit shown in Figure 9, this unit makes advantage of counter-current flow of the two adjacent mediums for increased heat exchange. This unit may be attached to a furnace or stove by essentially replacing
35 a section of the existing fluepipe with this unit. The medium e.g., room air, to be heated is forced by a fan (6) through an inlet at the top of the unit, and passes substantially the full length of the outer



chamber (14), and subsequently emerges from the mesh covered outlet port (15) in a directed flow determined by the manual positioning of deflector (30).

Figure 10 depicts the usage of this invention as a vehicle heater and muffler combination, being similar in construction and operation as the device in Figure 1. The vehicle engine exhaust gases pass through the existing exhaust manifold (24) and continue through the inner enclosure (1), where the gases sequentially impact the heat conductive fins (3), thereby transferring the heat present in the gases to the fins (3), which conduct the heat to the outer chamber (14). The thermally conductive fins (3) are sealed, e.g., welded or glued to the inner enclosure (1) so as to prevent cross-contamination, thereby providing for safe and convenient operation. The fan (6) forced air, either from passenger compartment or outside, enters at the inlet port (16) and is heated as it passes by the array of fins (3), located within the outer chamber (14). This heated air is then ducted through the exit port (15) to the cabin or passenger compartment. The vehicle engine exhaust gases, after being utilized, emanate from the tailpipe connector (25) and out the existing tailpipe.

Shown in Figure 11 is an embodiment of the present invention as an oil cooler consisting of a pan or casing (23) constructed of dissimilar thermally conductive materials. The materials of construction of this unit are similar to those described for unit "A" of Figure 1. The array of high thermally conductive fins (3) project through the wall of the pan (23) into an outer atmosphere. The hot oil contained in the pan (23) lies in direct contact with the array of thermally conductive fins (3), and is cooled through the use of the fins (3) by transferring the heat present in the oil to the outer, preferably moving atmosphere or ambient air. The intersection of the pan (23) and the fins (3) are sealed by conventional techniques.

Shown in figure 12 is an embodiment of the present invention as a waste heat recovery unit, which forms essentially a replacement section of an existing fluepipe, or the like, and utilizes a highly heat conductive fin (26) to which has attached upon opposite sides, two flanged tube halves forming an inner enclosure (1). Attached to each end of the inner enclosure (1) and fin (26) assembly, which is shown as running the entire length of the outer enclosure (2), are means for the attachment to existing pipes, ducts, and the like. A

fan (6) forces room air into a plenum integral with the top of this unit, where the air accumulates and is evenly distributed down into the outer chamber (14), wherein the room air picks up heat present in the fin (26), and inner enclosure (1), prior to discharge into the lower plenum and out the register (10). Preferably, the materials utilized in construction are similar to those described for Figure 1.

Figure 13 illustrates new applications utilizing dissimilar thermally conductive metals, as applied to bearings, motor housings, clutch housings, and the like, shown herein as being applied to a roller bearing (27), which has been installed into a housing (28). The housing (28) is constructed of a thermally lower conductive material as compared to the embedded, highly thermally conductive fins (26), which contact the bearing's outer race and project radially outward from the housing (28). The thermal energy generated within the bearing (27) is quickly conducted and dissipated through the fins (26) to the ambient atmosphere or medium.

In Figure 14, radially projecting high thermally conductive fins (26), e.g., copper, aluminum, brass, alloys, are embedded into a lower thermally conductive brake drum (29), e.g., cast iron, steel, whereby the heat produced by frictional braking forces within the brake drum (29) is conducted and dissipated to the outer atmosphere through the embedded fins (26).

While the preceding descriptions contain many specifics, these should not be construed as limitations on the scope of the invention, but rather as an exemplification of preferred embodiments thereof. With rising fuel prices, conservation measures are enlarging the applications for heat exchangers. The particular applications listed below, and the embodiments shown in the drawings are examples of the versatility of this invention.

AIR-AIR HEAT EXCHANGERS:

- Recyclic Dryers (fibers, clothes, grains, papers, etc.)
- Cooling Towers
- Flue Waste Heat Recovery
- Fireplace Inserts
- Vehicle passenger compartment air heater
- Integrated devices, e.g., Combustion chambers with exchangers:
 - wood and coal stoves, fireplaces, furnaces, boilers, etc.



AIR-LIQUID HEAT EXCHANGERS:

- Heaters (Preheaters, Boilers, Distillation Processes, Refining Processes, etc.)
- 5 Solar thermal storage transfer (focused concentrators, water reservoirs and tanks, etc.)
- Flue Waste Heat Recovery as applies to Water Heaters
- Coolers for Machinery (Transformer oil, Hydraulic oil. Transmission and Motor oil, etc.)
- Conventional hot water space heating systems, with individual
- 10 room controlled heat exchangers
- Vessel engine compartment cooling

AIR-SOLID HEAT EXCHANGERS:

- 15 Passive and active Solar thermal storage (Trombe walls, water tanks, eutectic phase change materials, etc.)
- Molding and Casting operations
- Earth Heat utilization (Geothermal Heating, Cooling tubes for buildings, etc.)
- Heating floors, sidewalks, driveways, swimming pool walls, etc.

20 HEAT DISSIPATION AND COOLING:

- Housings; (Ball, pin and roller bearings; bushings; transmissions; transformers; electric motors, engines, hydraulic and pneumatic pumps, compressors, and reservoirs; etc)
- High intensity Lamps
- 25 Guns and Cannons
- Electrical Resistors
- Heat sinks (soldering welding, etc.)
- Accordingly, the scope of the invention should be determined not by the embodiments illustrated, but by the appended claims, and
- 30 their legal equivalents.



CLAIMS

I hereby claim:

1. A finned heat exchanger comprising:
 - a. A partition, forming an enclosure which separates an inner and outer medium; with
 - b. Any number of highly heat conductive fins projecting through said partition, partially extending into both mediums, forming a thermal link between said mediums, positioned perpendicular to the flow of the inner medium; and
 - c. Said fins are arranged in a laterally staggered configuration, in which approximately half of the number of said fins are inserted into one side of said enclosure, generally evenly spaced longitudinally so as to not reduce the original flow volume, whereas the other half of the number of said fins are inserted into the opposite side of said enclosure, interposed with, and generally evenly spaced from said fins of the opposing side, whereby this configuration maximizes inner medium turbulence with minimal resistance to the flow of the medium in the inner chamber, and causes the medium to stay essentially in one mass and sequentially head-on impact each fin, whereby the medium is momentarily compressed, entrapped, bounced and deflected to the subsequent fin, as the medium travels in a serpentine flow through the inner enclosure, thereby transferring heat from the inner medium to the said fins; and
 - d. Said partition is constructed of a material of a lower thermal conductivity as compared to the material of said fins, thereby directing a thermal exchange between said inner and outer mediums; and
 - e. A means for inlet and outlet connections of said enclosure, so as to affix it to pipes, ducts, registers, tubes, conduits, channels, and the like; and
 - f. Said enclosure is larger in cross-sectional area, as compared to said inlet connection to which said enclosure attaches.
2. A heat exchanger according to claim 1, wherein the mass of said fins is sufficient to become a means of thermal storage during



during the thermal exchange between said mediums.

3. A heat exchanger according to claim 1, wherein:
 - a. Said enclosure with fins outwardly extended, is surrounded and substantially encased by an outer enclosure, thereby forming a chamber for an outer medium; and
 - 5 b. A means for attachment of said outer enclosure to aforesaid inner enclosure.
4. A heat exchanger according to claim 3, wherein there is:
 - a. A means for insulating the exterior surface of said outer enclosure; and
 - 10 b. A means for attaching said insulating means to said outer enclosure.
5. A heat exchanger according to claim 3, wherein there is:
 - a. A means for connecting an inlet and outlet to said outer enclosure; and
 - 15 b. A means for moving said outer medium; and
 - c. A means for connection of said outer enclosure to pipes, ducts, tubes, registers, conduits, channels, and the like.
6. A heat exchanger according to claim 5, wherein a movable deflector is attached to said outlet means, for controlling the direction
20 of the exiting medium.
7. A heat exchanger according to claim 5, wherein there is a means for protectively finishing the exterior of said outer enclosure.
8. A heat exchanger according to claim 5, wherein there is a means for physically inspecting said inner and outer enclosure.
- 25 9. A heat exchanger according to claim 5, wherein there is:
 - a. A means for collecting condensation formed by removing heat from the enclosed medium; and
 - b. A means for removal of said condensation from the said heat exchanger.
- 30 10. A heat exchanger according to claim 5, wherein:
 - a. Said fins project through said outer enclosure into a third medium; and
 - b. A means for sealing the junction of said fins to said outer enclosure.
- 35 11. A heat exchanger according to claim 5, therein:
 - a. There is a means for subdividing said outer enclosure into two or more compartments; and



- b. A means for inlets and outlets is provided for each said compartment; and
 - c. A means for moving the mediums contained in said compartments is supplied.
- 5 12. A heat exchanger according to claim 5, with a cleaning apparatus comprised of;
- a. A handle connected to one end of a rod which passes through two lineally aligned holes in the surfaces of said outer and inner enclosures; and
 - 10 b. A blade is attached to the other end of said rod, whereby said blade scrapes accumulated debris from the surface of said fin, to maintain thermal transfer efficiency.
13. A heat exchanger according to claim 5, wherein;
- a. There is a means for removing debris present in the medium
15 of said inner enclosure; and
 - b. A means for attachment to said inner enclosure.
14. A heat exchanger according to claim 5, wherein said moving means is attached to said outer enclosure.
15. A heat exchanger according to claim 14, wherein there is a means
20 for increasing the humidity of the enclosed medium.
16. A heat exchanger according to claim 14, with a cleaning apparatus comprised of;
- a. A handle connected to one end of a rod which passes through two lineally aligned holes in the surfaces of said outer
25 and inner enclosures; and
 - b. A blade is attached to the other end of said rod, whereby said blade scrapes accumulated debris from the surface of said fin to main tain thermal transfer efficiency.
17. A heat exchanger according to claim 14; with a means for control-
30 ling the velocity of said inner medium.
18. A heat exchanger according to claim 14; wherein
- a. A means for thermostatically controlling said moving means is included; and
 - b. A means for manual override of said thermostatic control.
- 35 19. A heat exchanger according to claim 14, wherein there is;
- a. A means for collecting condensation formed by removing heat



- from the enclosed medium; and
- b. A means for removal of said condensate from said heat exchanger.
20. A heat exchanger, according to claim 14, with a means for controlling the velocity of said outer medium.
21. A heat exchanger according to claim 5, wherein said inner enclosure also serves as a combustion chamber.
22. A heat exchanger according to claim 21, wherein said moving means is attached to said outer enclosure.
- 10 23. A heat exchanger according to claim 22, wherein there is;
- a. A means for collecting condensation formed by removing heat from the enclosed medium; and
- b. A means for removal of said condensate from said heat exchanger.
- 15 24. A heat exchanger according to claim 22, wherein there is a means for increasing the humidity of the enclosed medium
25. A heat exchanger according to claim 22, wherein a means for moving said inner medium is provided.
26. A heat exchanger according to claim 22; wherein
- 20 a. A means for thermostatically controlling said moving means is included; and
- b. A means for manual override of said thermostatic control.
27. A heat exchanger according to claim 22, with a means for controlling the velocity of said inner medium.
- 25 28. A heat exchanger according to claim 22, with a means for controlling the velocity of said outer medium.
29. A heat exchanger according to claim 22, with a cleaning apparatus comprised of;
- a. A handle connected to one end of a rod which passes through two lineally aligned holes in the surfaces of said outer and inner enclosures; and
- 30 b. A blade is attached to the other end of said rod, whereby said blade scrapes accumulated debris from the surface of said fin to maintain thermal transfer efficiency.
- 35 30. A heat exchanger according to claim 1, wherein a means for moving said inner medium is provided.



31. A heat exchanger according to claim 30, with a means for controlling the velocity of said inner medium.
32. A heat exchanger according to claim 30; wherein
- a. A means for thermostatically controlling said moving means is provided; and
- 5 b. A means for manual override of said thermostatic control.
33. A heat exchanger according to claim 30, wherein there is;
- a. A means for collectin condensation formed by removing heat from the enclosed medium; and
- b. A means for removal of said condensate from said heat
- 10 exchanger.
34. A heat exchanger according to claim 30, wherein said outer medium is a concrete or masonry mass.
35. A heat exchanger according to claim 34; herein
- a. A heat conductive plate is attached to the exterior surface
- 15 of said mass; and
- b. A means for attachment of said plate to said fins.
36. A heat exchanger according to claim 30; wherein
- a. Said enclosure with said fins outwardly extended, is surrounded and substantially encased by an outer enclosure,
- 20 thereby forming a chamber for an outer medium; and
- b. A means for attachment of said outer enclosure to aforesaid inner enclosure; and
- c. A means for connection of said outer enclosure to pipes, ducts, tubes, conduits, registers, channels, and the like.
- 25 37. A heat exchanger according to claim 36, wherein there is;
- a. A means for connecting an inlet and an outlet to said outer enclosure; and
- b. A means for moving said outer medium; and
- c. Said moving means is attached to said outer enclosure.
- 30 38. A heat exchanger according to claim 36, wherein there is;
- a. A means for connecting an inlet and an outlet to said outer enclosure; and
- b. A means for moving said outer medium; and
- c. Said moving means is attached to said outer enclosure.
- 35 39. A heat exchanger according to claim 38, wherein the motive force of said movin means of said outer medium is coupled to said

moving means of said inner medium, thereby one motive force moves both said inner and outer mediums.

40. A heat exchanger according to claim 38; wherein
- 5 a. A means for thermostatically controlling said moving means is included; and
- b. A means for manual override of said thermostatic control.
41. A heat exchanger according to claim 38, with a means for controlling the velocity of said inner medium.
42. A heat exchanger according to claim 38, wherein there is;
- 10 a. A means for collecting condensation formed by removing heat from the enclosed medium; and
- b. A means for removal of said condensate from said heat exchanger.
43. A heat exchanger according to claim 38, wherein a heat conductive plate is attached to said fins.
- 15 44. A finned heat exchanger comprising;
- a. A fin constructed of a highly thermall conductive material; and
- b. A pair of fluted tube halves in which said fin is sandwiched between said tube halves, thereby forming an inner enclosure tube in which a medium can be circulated; and
- 20 c. A means for attachment and sealing of said tube halves flutes to said fin; and
- d. A means for connection of said inner enclosure to pipes, ducts, tubes, registers, conduits, channels, and the like.
- 25 45. A finned heat exchanger according to claim 44, in the form of a waste heat recovery device; including
- a. A means for an outer enclosure, with provided inlet and outlet; and
- 30 b. A means for connection of said inlet and outlet to pipes, ducts, registers, tubes channels, conduits, and the like.
46. A finned heat exchanger according to claim 44, in the form of a flatplate solar collector; wherein
- a. There is a means for an outer enclosure.
- 35 47. A finned heat exchanger in the form of a finned housing member for clutches, bearings, brake drums, electric motors, gun barrels, lamps; and the like, comprised of;



- 5
- a. Any number of highly heat conductive fins; and
 - b. A housing member, being of a lower thermal conductivity as compared to said fins, and in which said fins are embedded into said member, and project perpendicularly from the outer surface of said member, radially projecting from a central axis, so as to pass substantially into the ambient atmosphere for the purpose of heat dissipation.
48. A finned heat exchanger in the form of an oil pan, transformer, reservoir transmission and engine block cooler, comprised of;
- a. Any number of highly heat conductive fins; and
 - b. A container which is of a lower thermal conductivity as compared to said fins, and in which said fins project perpendicularly to an axis, and penetrate through the wall of said container, and continue substantially into the ambient atmosphere, thereby said fins extend partially into the medium in said container, and partially into said atmosphere; and
 - c. A means for sealing the junction of said fins to said container.



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FIG. 1

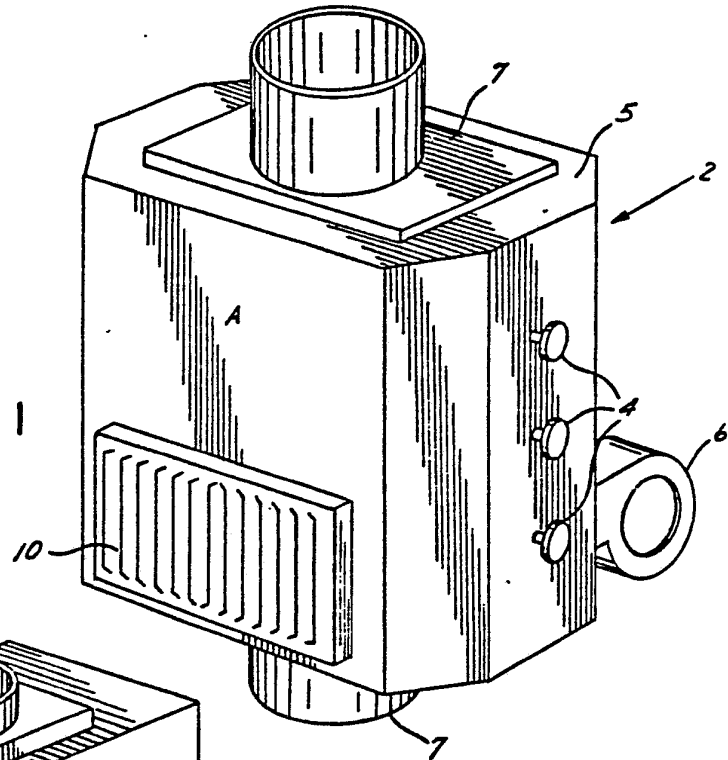


FIG. 2

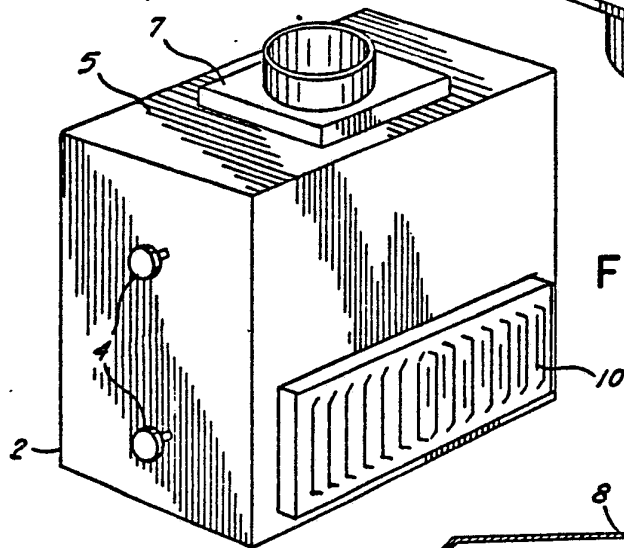
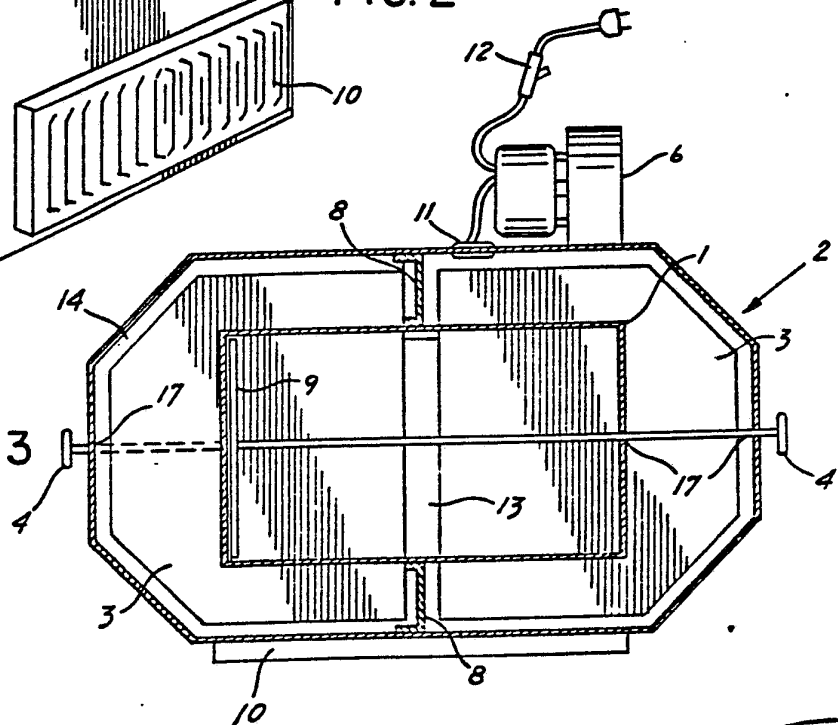


FIG. 3



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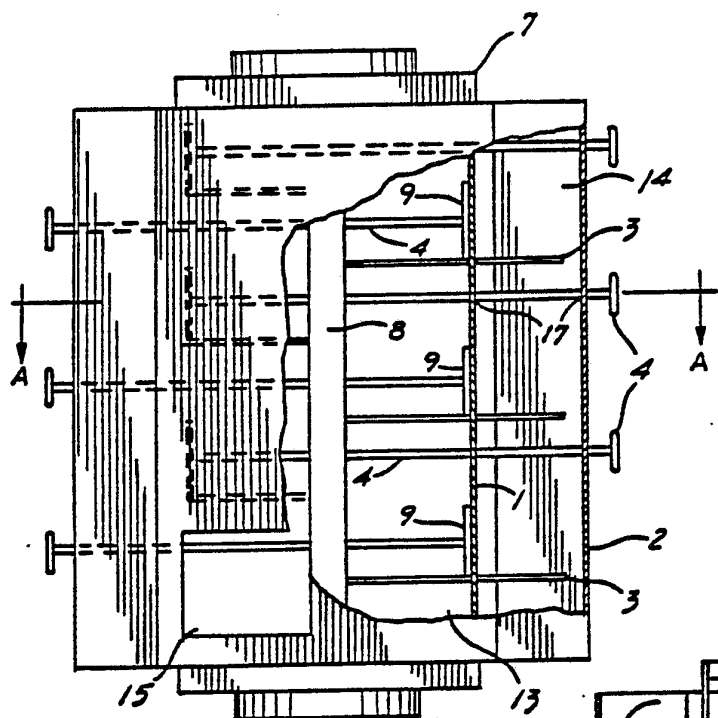


FIG. 4

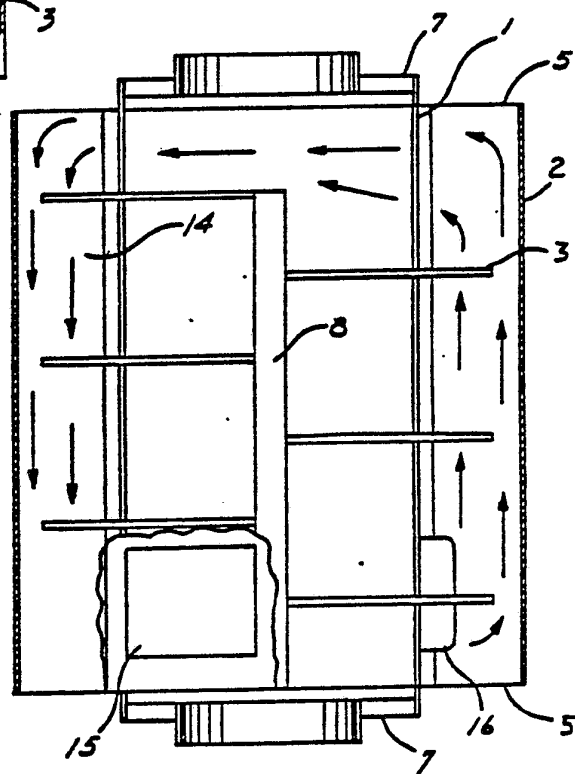


FIG. 5

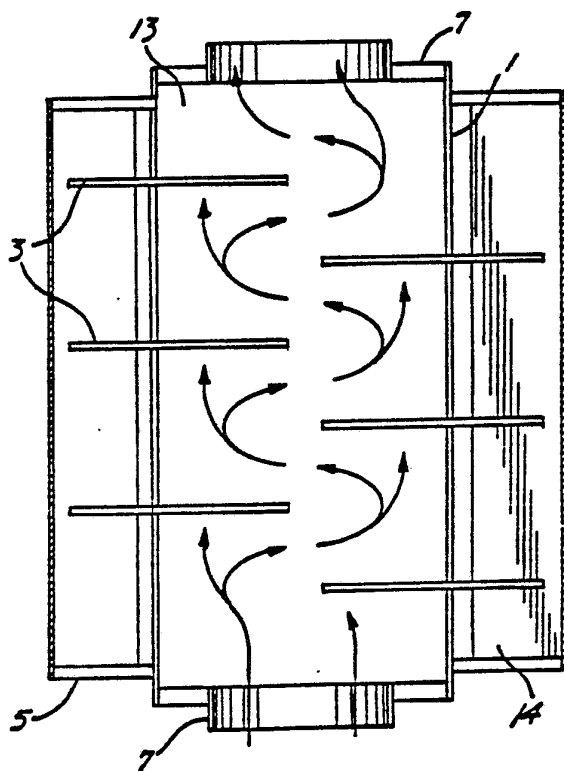


FIG. 6

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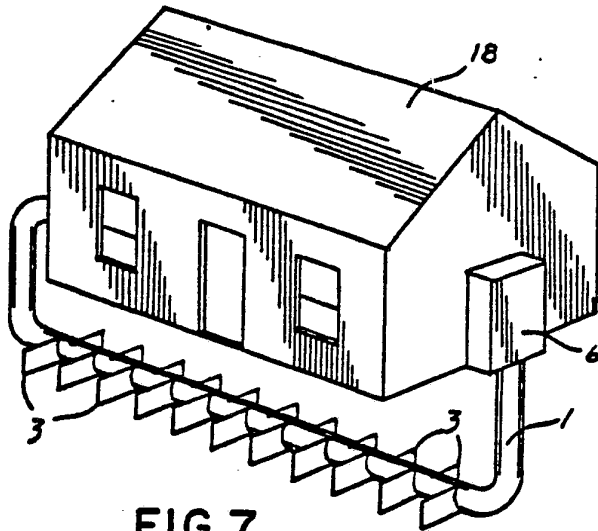


FIG. 7

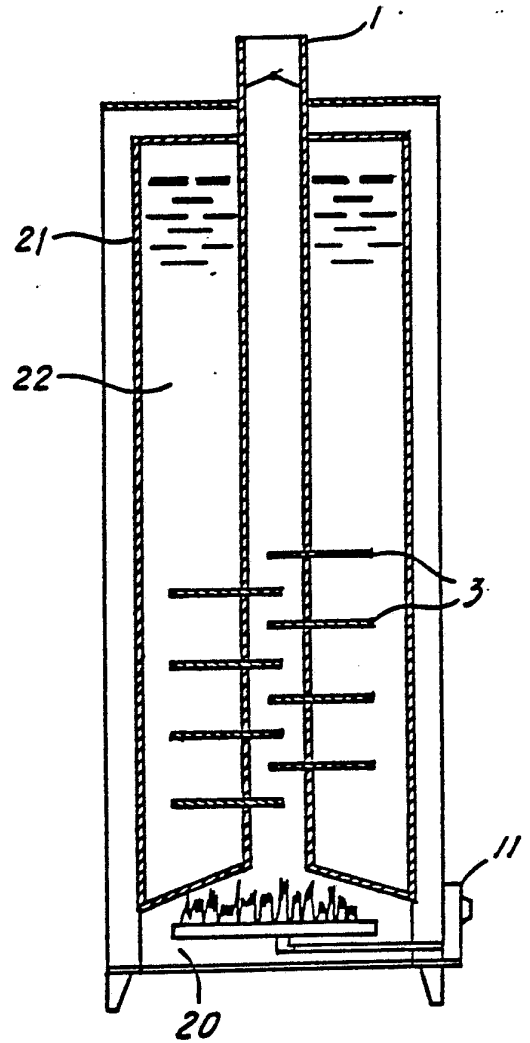


FIG. 8

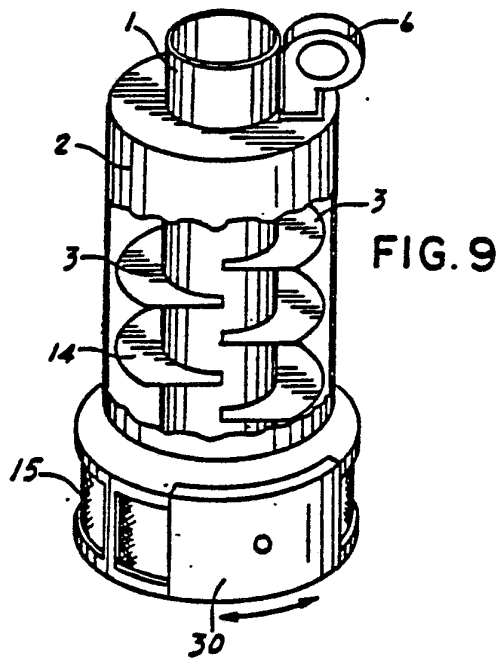


FIG. 9

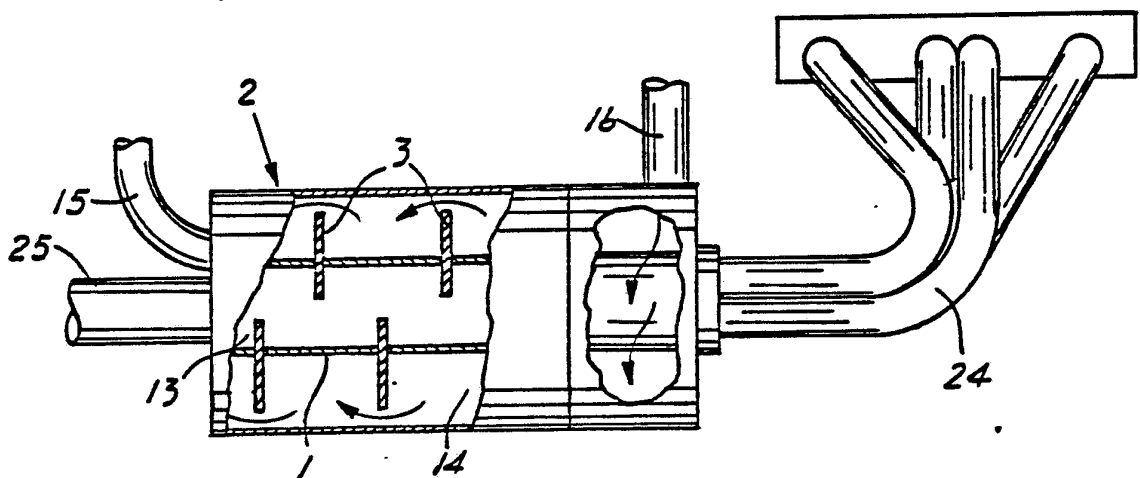


FIG. 10

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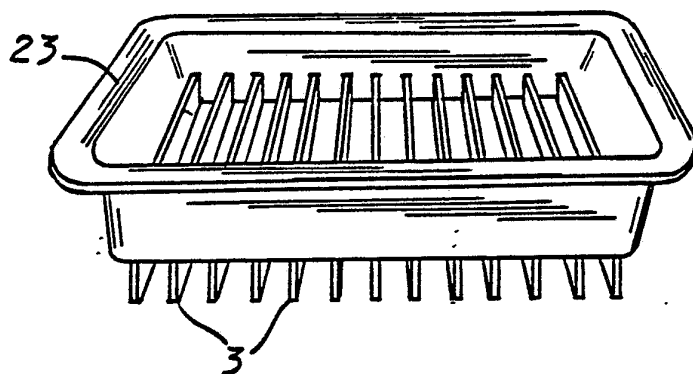


FIG. 11

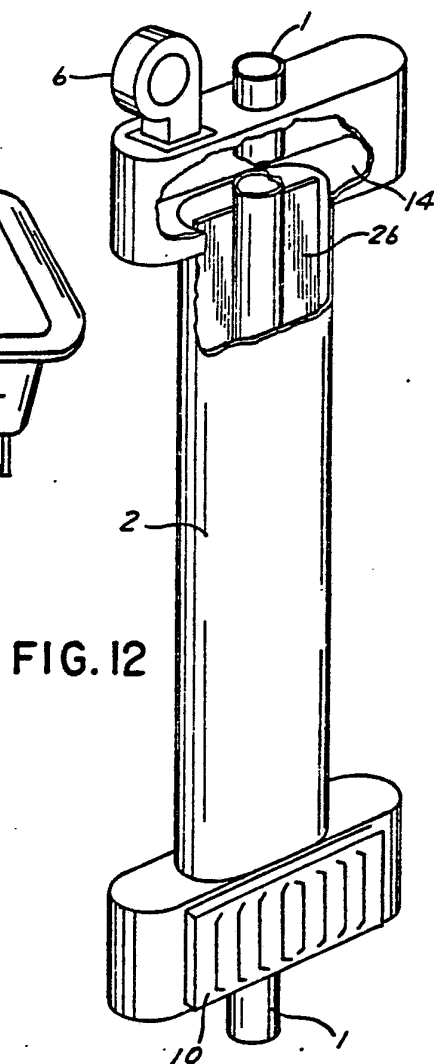


FIG. 12

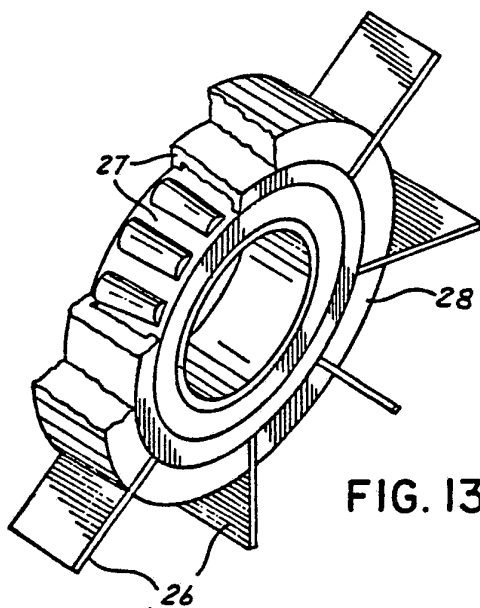


FIG. 13

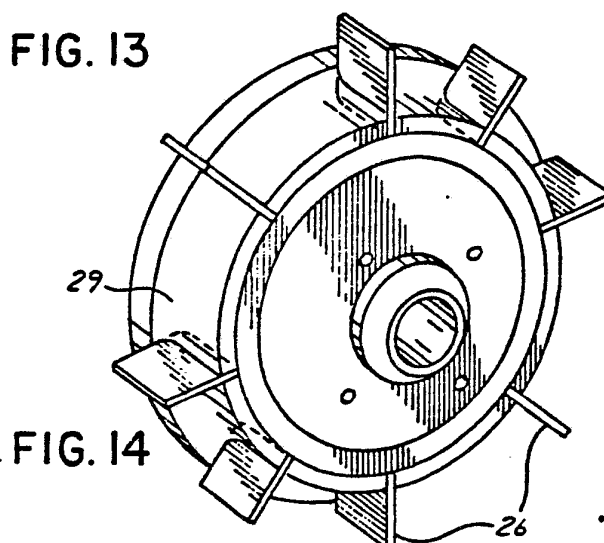


FIG. 14

INTERNATIONAL SEARCH REPORT

International Application No PCT / US 83 / 00730

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. 3 F24B 7/02; F24H 1/00; F 28D 7/10; F28 F 1/42, 9/22, 9/24, 13/06 U.S. CL 165/45, 51, 154, 156, 164, 179, DIG 2; 237/55																																									
II. FIELDS SEARCHED Minimum Documentation Searched ⁴ <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 30%; text-align: left; border-bottom: 1px solid black;">Classification System</th> <th style="text-align: left; border-bottom: 1px solid black;">Classification Symbols</th> </tr> <tr> <td style="padding: 5px;">U.S.</td> <td style="padding: 5px;">237/55, 165/45, 51, 154, 156, 164, 165, 179, 185, DIG. 2, DIG. 1 2</td> </tr> </table> Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched ⁵			Classification System	Classification Symbols	U.S.	237/55, 165/45, 51, 154, 156, 164, 165, 179, 185, DIG. 2, DIG. 1 2																																			
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III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴ <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 10%; text-align: left; border-bottom: 1px solid black;">Category [*]</th> <th style="text-align: left; border-bottom: 1px solid black;">Citation of Document, ¹⁶ with indication, where appropriate, of the relevant passages ¹⁷</th> <th style="text-align: left; border-bottom: 1px solid black;">Relevant to Claim No. ¹⁸</th> </tr> <tr> <td style="padding: 5px;">Y</td> <td style="padding: 5px;">DT, A, 2732,372, Elnaes, 26 January 1978</td> <td style="padding: 5px;">1-7, 14</td> </tr> <tr> <td style="padding: 5px;">X</td> <td style="padding: 5px;">US, A, 1,508,860, Stuart, 16 September 1924</td> <td style="padding: 5px;">1-2</td> </tr> <tr> <td style="padding: 5px;">Y</td> <td style="padding: 5px;">US, A, 641,911, Wilkins et al, 23 January 1900</td> <td style="padding: 5px;">1-7, 14</td> </tr> <tr> <td style="padding: 5px;">E</td> <td style="padding: 5px;">US, A, 4,390,352, Grün, 28 June 1983</td> <td style="padding: 5px;">1-2</td> </tr> <tr> <td style="padding: 5px;">A, E,</td> <td style="padding: 5px;">US, A, 4,397,293, Pibernat, 9 August 1983</td> <td></td> </tr> <tr> <td></td> <td style="padding: 5px;">US, A, 2,468,909, Yeager et al, 3 May 1949</td> <td style="padding: 5px;">5, 14</td> </tr> <tr> <td style="padding: 5px;">A</td> <td style="padding: 5px;">US, A, 2004252, Sorensen, 11 June 1935</td> <td style="padding: 5px;">1</td> </tr> <tr> <td style="padding: 5px;">A</td> <td style="padding: 5px;">US, A, 4364514, Toporek, 21 December 1982</td> <td></td> </tr> <tr> <td style="padding: 5px;">A</td> <td style="padding: 5px;">US, A, 3743250, Fitzhugh, Jr. et al, 3 July 1973</td> <td></td> </tr> <tr> <td style="padding: 5px;">A</td> <td style="padding: 5px;">US, A, 1196546, Jacobson, 29 August 1916</td> <td></td> </tr> <tr> <td style="padding: 5px;">A</td> <td style="padding: 5px;">OE, A, 121056, Renggli, 19 July 1926</td> <td></td> </tr> <tr> <td style="padding: 5px;">A</td> <td style="padding: 5px;">FR, A, 605845, Bruel et al, 2 June 1926</td> <td></td> </tr> </table> [*] Special categories of cited documents: ¹⁵ "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "G" document member of the same patent family			Category [*]	Citation of Document, ¹⁶ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No. ¹⁸	Y	DT, A, 2732,372, Elnaes, 26 January 1978	1-7, 14	X	US, A, 1,508,860, Stuart, 16 September 1924	1-2	Y	US, A, 641,911, Wilkins et al, 23 January 1900	1-7, 14	E	US, A, 4,390,352, Grün, 28 June 1983	1-2	A, E,	US, A, 4,397,293, Pibernat, 9 August 1983			US, A, 2,468,909, Yeager et al, 3 May 1949	5, 14	A	US, A, 2004252, Sorensen, 11 June 1935	1	A	US, A, 4364514, Toporek, 21 December 1982		A	US, A, 3743250, Fitzhugh, Jr. et al, 3 July 1973		A	US, A, 1196546, Jacobson, 29 August 1916		A	OE, A, 121056, Renggli, 19 July 1926		A	FR, A, 605845, Bruel et al, 2 June 1926	
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A	FR, A, 605845, Bruel et al, 2 June 1926																																								
IV. CERTIFICATION Date of the Actual Completion of the International Search ² 29 August 1983		Date of Mailing of this International Search Report ² 04 OCT 1983																																							
International Searching Authority ¹ ISA / US		Signature of Authorized Officer ²⁰ S.J. Richter: def																																							

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

A	US, A, 4022272, Miller, 10 May 1977	47-48
A	US, A, 4345644, Dankowski, 24 August 1982	47-48
T	US, A, 4381819, Paolino, 3 May 1983	
A	GB, A, 2025599, Long, 23 January 1980	
A	DT, A, 2517126, Brown Boveri, 4 November 1976	

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE ¹⁰

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers....., because they relate to subject matter ¹² not required to be searched by this Authority, namely:

2. ☐ Claim numbers....., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out ¹³, specifically:

VI. ☒ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING ¹¹

This International Searching Authority found multiple inventions in this international application as follows:

Patentably distinct species

I Figure 9

IV Figure 8

VI Figure 11

II Figures 3-6

V Figure 10

VII Figures 13 or 14

III Figure 7

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☒ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.