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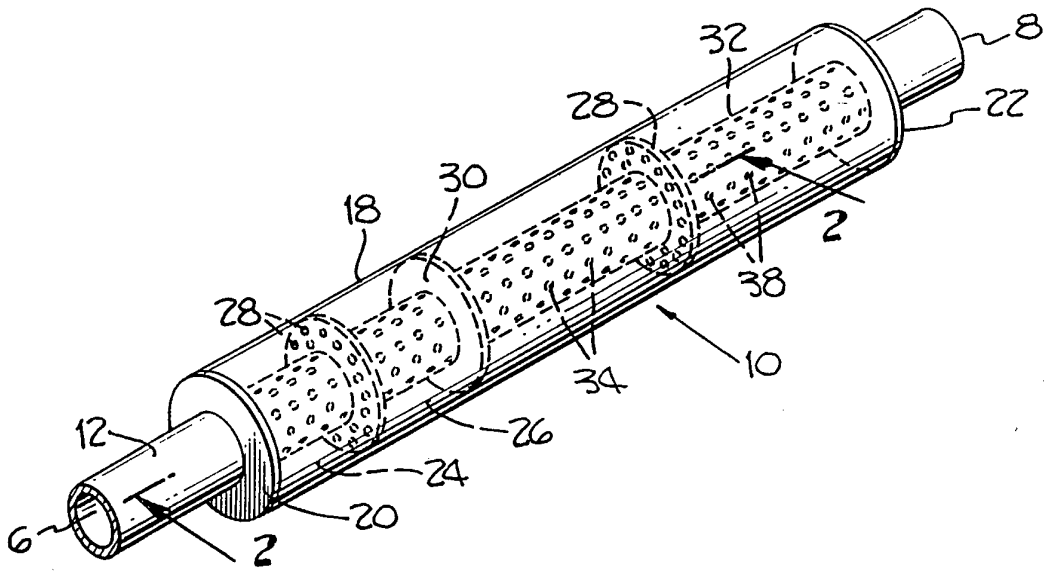

(57) Abstract

Environmental control filter (10) having a fluid entry pipe (12) including a forced air inlet (16) extending through an axially extended outer shell (18) having a near end cap (20) and distal end cap (22). The entry pipe (12) having a foraminous inner pipe (32) provided with perforations (34). A first perforated baffle (28) alternating with a second impervious baffle (30) surrounding the foraminous pipe (32) extending through the outer shell (18). The outer shell (18) being filled with filter material (36) between the foraminous pipe (32). The foraminous pipe (32) is provided with pipe closing partitions (40) at the same level as the perforated baffles (28). The control filter (10) is provided with an exit pipe (8) from the distal end cap (22).

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Description

ENVIRONMENTAL CONTROL SYSTEM FILTER PURIFICATOR

Technical field

The instant invention relates to articulated, sectioned, fixed media, fluid flow filters and particularly to fluid flow filters that are employed in connection with the filtering of contaminants from flowing gaseous or other fluids such as may be encountered in the exhaust gases of internal combustion engines or domestic furnaces or other heaters using fossil fuels, or even in an application employed for the removal of pollutants from ambient urban smog-filled air, for example. It is contemplated that the instant invention is also applicable to the removal of contaminants from liquid fluids as well.

It is important that the contaminated fluid to be filtered by having contaminants removed therefrom be kept flowing at a rate such that excessive back pressures are not built up so as to restrict the free elimination of the contaminants from the fluids to be filtered in the primary operating system. It is especially important to maintain such free flow and to eliminate back exhaust pressures in internal combustion engines as used for automotive applications in order to maintain good performance of the engine. When such fixed media filters are utilized in household or industrial furnaces or hot water heaters or the like, it is also important to maintain a steady flow of the contaminated gases in order to minimize the eventuality of inflammation of the combustible contaminants that have been filtered out and retained in the filtering material, say activated carbon, glass or cellulose fibers or the like, of the filter elements.

Background Art

The prior art includes United States Patent number 3,406,501, to D.R. Watkins for AUTOMOBILE ENGINE EXHAUST FILTER, issued October 22, 1968. The device described in the Watkins patent, as the title implies, is directed to an exhaust filter attached by clamping to the tailpipe of an automobile. A hollow cylindrical shell receives a replaceable filter cartridge filled with the filtering material which is secured therein by means of an endcap. The exhaust gasses enter

the filter under the exhaust pressure normally present in an automobile exhaust and flow through the filter unaided by any additional flow enhancement.

Another prior art device is described in the United States Patent number 2,738,854, granted to B.B. Thrower for EXHAUST FILTER, issued March 20, 1956. Again, a main stated object of the device is to provide apparatus which can be attached to an automobile tailpipe so as to filter the exhaust gases effluent therefrom. The patented device also claims to provide muffling and heat transfer among other advantages. The preferred filter material appears to be charcoal particles of a size such that they are retained in place by a wire mesh structure. A tortuous path is provided so that the exhaust gases are forced to travel through the filtering material before escaping to the outside atmosphere.

Yet another prior art device has been illustrated in the United States Patent number 4,318,720, granted to Donald L. Hoggatt and issued March 9, 1982, for EXHAUST FILTER MUFFLER. The innovation purports to be a combined muffler and engine exhaust filter, again directed to the automobile application, and is mounted in-line between the engine exhaust and the tailpipe. The structure thereof comprises fixed, concentric, perforated tubes with a filtering material filling the space there between. The construction of the contrivance forces the engine exhaust gases to pass through the perforations in one tube and move radially through the filter material and thence through the perforations in the other tube before discharge to the outside air.

United States Patent number 4,419,113, granted to Richard H. Smith for DIESEL EXHAUST PARTICULATE TRAP WITH AXIALLY STACKED FILTERS and issued December 6, 1983, describes another prior art device directed, as the title implies, to the exhaust systems of large diesel trucks. Tandem replaceable filter elements are positioned in spaced apart relationship so as to provide axial gaps there between. As well stated in the Abstract, "The axial gaps are sealed alternately on inner and outer radial ends to define outlet and inlet passages, respectively and to force axial flow through the filter elements...".

Regeneration of the particulate filter by an auxiliary burner device that will burn the collected particulate off of the filter element surfaces so as to reopen clogged exhaust gas flow paths through the filter has been described in detail. The

exhaust inlet of the filter, in addition to receiving the exhaust gases from the engine, provides also for connection to a heater in the form of an atomizing burner, which is used to heat particulates trapped in the filter to their combustion temperatures and burn them off so as to regenerate the filter when it has become clogged by such trapped combustible particulates. At column 3 beginning at line 1, the innovator states: "If desired and as shown in FIG. 1, a small amount of additional air may be supplied to the atomizing burner assembly 22 by means of an air inlet tube 27... connected ... to a suitable source of air...". It appears that the sole function of this additional small amount of air is to enhance the operation of the atomizing burner that is used to burn off trapped combustible particulates that have been collected from the diesel exhaust over time, and thereby to regenerate the filter. It does not appear, however, that such regeneration apparatus or procedure is the subject of any claim.

Patentee Erdmannsdoerfer's United States Patent number 5,042,249, for SOOT FILTER FOR CLEANING THE EXHAUST FROM AN INTERNAL COMBUSTION ENGINE, granted August 27, 1991, is directed primarily to the cleaning of filter elements, in this case tubular elements, by means of electrical energy. Cleaning is accomplished by burning off collected soot from the filter elements by energizing electrical heating elements placed strategically with respect to said filter elements. The burnoff of accumulated soot is enhanced by the supply of a small amount of air as noted at column 2 starting at about line 16. It appears that the sole function of the small amount of air is to promote the burnoff as stated.

These prior art patents, discovered in applicant's pre-examination novelty search, are commendable and show a creative spirit for their times. The inventors and their inventions have contributed remarkably to the technology involved. These prior art structures, however, do not include those combined elements of the instant invention that provide greater facility of use and ingenious arrangement and utilization of components that make the instant invention the high culmination in the art.

Disclosure of Invention

In accordance with the instant invention, there is provided an environmental control system filter purificator filter system having a plurality of filtering sections

and in which contaminated fluids to be filtered are caused to flow from one filtering section into another in the manner to be described. In a favored embodiment, the contaminated fluid to be filtered enters the first section of the environmental control system filter purificator filter system by means of an entry port and the entry port has a turbine positioned and operated such that the contaminated fluid to be filtered is urged along in its entry into said first section thereby. The contaminated fluid to be filtered is caused to enter a first type alternate typical filter section into a foraminous pipe thereof and through whose foramens the contaminated fluid to be filtered is caused to flow radially outwardly into the filtration medium resident in said first section whereby the contaminated fluid undergoes a first level of contaminant removal through the action of the filtration medium. The contaminated, partially filtered fluid then flows into the filtration medium resident in a second type alternate typical filter section through a perforated baffle. A second baffle situated at the distal end of the second type alternate typical filter section and which has no perforations, causes the fluid to reenter the foraminous pipe radially inwardly to continue its journey through the filter system by entering another first type alternate typical filter section, and so on. This cycle of events is repeated for as many pairs of first and second alternate typical filter sections as have been designed into the particular environmental control system filter purificator filter system. The number of pairs of these typical alternate filter sections to be used in any given filter system is at the disposal of the designer of that particular system. Thus the fluid to be filtered is forced to flow alternately through a plurality of first and second filter sections until it flows into the final section and then to exit the system.

Brief Description of Drawings

Further advantages and features of the instant invention will be more fully apparent to those skilled in the art to which the invention pertains from the ensuing detailed description thereof, regarded in conjunction with the accompanying drawings wherein like reference numerals refer to like parts throughout and in which:

Figure 1 is a perspective view of the environmental control system filter purificator filter system of the invention looking through the outer shell thereof so as to illustrate the placement of typical alternate filter sections.

Figure 2 is an enlargement and detail showing the typical alternate filter sections of the environmental control system filter purificator filter system and showing entry of flow-aiding fluid as provided by a turbine.

Figure 3 is a detail view showing details of a first type alternate typical baffle.

Figure 4 is a detail view showing details of a second type alternate typical baffle.

Figure 5 is an enlarged detail taken along the sight circle 5 of Figure 2.

Figure 6 is an illustration showing the invention applied to a furnace but having an exhaust turbine utilized in aiding the flow of fluid.

Figure 7 illustrates the invention applied to a conventional roof-type vent also utilizing an exhaust turbine to aid in the flow of fluid.

Figure 8 is an illustration showing application to a hot water heater vent or the like.

Figure 9 depicts a very large filter system such as may be used in an urban clean-air application to remove contaminants from smog-laden air.

Figure 10 is a detail drawing showing the elements of Figure 9 in greater detail.

Best Mode for Carrying Out the Invention

Referring to the drawing and to Figure 1 with greater particularity, the Environmental Control System Filter Purificator filter system is denoted generally by the numeral 10 and comprises a contaminated fluid entry port 6 entered by

means of contaminated fluid entry pipe 12. An ambient fluid, air, for example, in the case of gaseous filtration of automotive exhaust gases, is supplied under pressure generated by a forced fluid entry turbine 16 through forced fluid entry pipe 14 so as to enhance the flow of the contaminated fluid to be filtered. The example of air, as given above, is not intended to limit application of the invention to air or to any other gaseous fluid and all fluids, including liquids, are contemplated to fall within the purview of the invention. A preferred embodiment of the filter system itself comprises an axially extended outer shell structure 18 having a near end cap 20 and a distal end cap 22 within which structure the filter system elements of section lengths are confined. A first type separately removable alternate typical filter section is denoted by the numeral 24 while a second type separately removable alternate typical filter section, located immediately downstream of said first type filter section within said outer shell, is denoted by the numeral 26. A foraminous inner pipe 32 having foramens 34 runs axially through the length of the filter system 10. Filter section lengths in the space between the outer shell 18 and the pipe 32 are filled with filtering material 36 and are alternately articulated by means of removable first and second type alternate typical baffles 28 and 30 respectively.

First type alternate typical baffle 28, detailed in Figure 3 has an outer periphery 29 and perforations 38 to permit the flow of fluids therethrough. The baffle 28 is employed in the filter system in conjunction with pipe closing partition 40 which forces the flow of fluids through the perforations in baffle 28 rather than allowing flow through the foraminous inner pipe 32. Second type alternate typical baffle 30, detailed in Figure 4 has an outer periphery 31 and has no perforations. The baffle 30 serves to block the passage of the contaminated fluid to be filtered from flowing directly into the downstream contiguous filter section and forces the fluid to flow radially inwardly into the foraminous inner pipe 32 and thence into the following downstream contiguous filter system section. The filtered fluid, having been forced to flow alternately through a plurality of first and second filter sections, respectively 24 and 26, finally flows into the foraminous inner pipe in the final filter section and thence into the exit pipe 8. Thus upon exit from the final filter system section, the filtered fluid leaves the filter system and is expelled into the environment by way of filtered fluid exit pipe 8.

Referring now particularly to Figure 5, the enlargement is intended to emphasize the Teflon coating 42 contemplated by the invention for all interior structural surfaces. The Teflon coating has as its purpose the prevention of buildup of combustible contaminants. In some related prior art devices, these collected combustible contaminants have been known to spontaneously ignite causing a fire hazard. This danger is prevented in the instant invention by the Teflon coating 42 provided for all structural interior surfaces.

In Figure 6 the application contemplated is a furnace 48 and the operation of the filter system differs in that instead of a pushing urge as generated by the turbine 16 of Figure 2, there is generated a pulling urge by means of the exhaust turbine 44. In other respects the filter systems are the same. The weather cap 46 has long been in conventional use and forms no part of the instant invention.

Again in Figure 7, the application contemplated is a vent pipe 50 and may be put into use in a variety of venting applications. The turbine 44 is the same as in Figure 6 and performs the same function. Again, the weather cap 46 is well known and forms no part of this invention.

The application specifically illustrated in Figure 8 is to a hot water heater 52 in which the turbine 44 performs the same function as in Figures 6 and 7 and in which the weather cap 46 is not a part of this invention.

Attention is now invited to Figures 1 through 4 for further explanation of the operation of the filter system as contemplated by the instant invention. With close consideration of Figure 2 in contemplation of the operation of the environmental control system filter purificator, it is expected that contaminated fluid enters the entry port 6 as shown by flow arrow 54 and is supported and aided in such flow by the operation of turbine 16 in providing forward-flow aiding fluid under pressure by way of forced fluid entry pipe 14. Upon entry into foraminous inner pipe 32 the forward axial flow of the fluid is arrested by the pipe closing partition 40. The contaminated fluid to be filtered is thus forced to flow radially outwardly through foramens 34 in foraminous inner pipe 32, into the first type separately removable alternate typical filter section 24 and into the filtering material therein as shown by flow arrows 54. After partial filtration by flowing through the filter material 36 of the first filter section 24, the contaminated, partially filtered fluid then flows

through the perforations 38 in first type alternate typical baffle 28 and into the second type alternate typical filter section 26 and directly into the filtering material 36 thereof. The second type alternate typical baffle 30, having no perforations therein, prevents the further forward axial flow of the partially filtered fluid in the filtering material of the second filter section and forces a radially inward flow into the foraminous inner pipe 32 through its foramens 34. Backward flow is positively prevented by pipe closing partition 40 in addition to the forward urging of the fluid by means of the action of turbine 16. Continuing to follow the fluid flow as illustrated in Figure 2, the fluid being filtered now enters the third filter section by way of foraminous pipe 32 and is stopped in its forward axial flow, in that pipe, as before, by another pipe closing partition 40, being thus forced to flow radially outwardly into the filtering material of the third section of the filter system. This cycle of events is repeated for as many pairs of first and second type alternate filter sections as have been designed into a particular environmental control system filter purificator filter system as contemplated by the invention. The filtered fluid, having been forced to flow alternately through a plurality of first and second filter sections, respectively 24 and 26, finally flows into the foraminous inner pipe 32 in the final filter section and thence into the exit pipe 8.

Referring specifically to Figures 9 and 10, the large embodiment depicted shows an application of the environmental control system filter purificator filter system intended for the removal of smog and other pollutants from contaminated city air. An air purification tower is denoted generally by the numeral 56. The pollutants contemplated may stem from a variety of sources such as, for example, public transportation vehicles using large diesel engines; factory smokestacks; petroleum refineries; jet engine exhaust, barbecue pits, incinerators of both industrial and home types, chemical processing facilities and, in fact, all of the industrial and other air pollutants having their origin in modern technology and any other contaminating sources.

In the operation of the illustrated embodiment it is contemplated that solar panels 58 will generate main power for the operation and control of the large filter system as operated and controlled from the operations building 72. Of course, auxiliary power from other sources may be utilized during periods of low solar activity or for any other reason and at any other times. Contaminated ambient air is taken in by means of the action of solar and auxiliary powered intake turbine 62

through wire mesh protective screen 60, furnished to prevent the entry of large insects and small birds into the system. Solar powered intake turbine 62 is envisioned as usually powered by the solar panels 58 and has a turbine shaft 64 and turbine blades 66. Turbine 62 sucks ambient air through wire mesh screen 60 and forces it into a pressure enhancing intake funnel or throat 68 and thence into foraminous inner pipe 32.

Referring now to Figure 10, and with reference to the smaller versions of the environmental control system filter purificator filter system as illustrated in Figures 1 through 4 and wherein all Figures bear common denotative numerals for like elements, contaminated ambient air is incident into pressure enhancing throat 68 and thence into foraminous inner pipe 32. Flow is blocked by pipe closing partition 40 thus forcing radially outward flow of the contaminated air into the filtering material 36 situated in the first type alternate typical filter section 24. Flow continues through the perforations in first type alternate typical baffle 28 and into the second type alternate typical filter section 26, where, after receiving an additional level of filtration, the fluid is forced radially back into the foraminous pipe 32 since its flow is blocked by second type alternate typical baffle 30. The filtered fluid, having been forced to flow alternately through a plurality of first and second filter sections, respectively 24 and 26, finally flows into the final filter section. After passage through the final filter section, the filtered air is expelled back into the environment through the exit apertures 74. In spite of its much larger contemplated size, the operation of this larger system is essentially the same as for the smaller versions of the environmental control system filter purificator filter system. However, because of that much larger size, it is necessary that service and maintenance elevators 70 be provided and operated for access to the first and second types of separately removable alternate typical filter sections, respectively 24 and 26, and to all other elements of the environmental control system filter purificator filter system, in general, by maintenance personnel for purposes of any necessary maintenance, repair and/or cleaning.

In all Figures, the fluid flow arrows 54 denote the contemplated flow motion of the contaminated fluid to be filtered and of the partially filtered fluid through the filter system.

Industrial Applicability

The instant invention finds abundant application wherever contaminated fluids require removal of the contaminants. In particular, the large urban areas of many cities are not able to control air pollution merely by attempting to control ongoing contamination but must strive to alleviate the effects of already present contamination while at the same time, eliminating as much as possible the continuing defilement being caused by the artifacts of modern civilization's technologies. The instant invention has the potential and the capabilities to begin this very necessary environmental control labor and to continue to maintain a much lower level of air pollution. It is to be emphasized that contaminated ambient air is not the only fluid that may be filtered and thus purified by the methods and apparatus described. The purification of other gaseous and even of liquid fluids is also within the scope and contemplation of the instant invention.

Claims

1. An environmental control system filter purificator comprising:

a contaminated fluid entry pipe communicant with a contaminated fluid entry port for receiving a contaminated fluid to be filtered;

a forced fluid entry turbine communicant with a pressurized fluid entry pipe and with said contaminated fluid entry port by way of said pressurized fluid entry pipe;

an axially extended outer shell structure having a distal end cap and a near end cap and in which said near end cap is connected in fluid communication with said contaminated fluid entry pipe;

a foraminous inner pipe, centrally extending axially through said outer shell structure from the connection of said near end cap to said contaminated fluid entry pipe to a filtered fluid exit pipe connected at said distal end cap;

at least two separately removable alternating typical filter sections located within said outer shell structure and having an initial first type separately removable alternate typical filter section located immediately interiorly following said near end cap and within said outer shell and extending axially along said foraminous inner pipe for a section length, said filter section being filled with a filtering material in the surrounding axial space between said foraminous inner pipe and said outer shell;

a first type alternate typical baffle having perforations and which serves to determine the axial extent of said first type typical filter section;

a pipe closing partition located at the axial extent of said first type filter section and within said foraminous pipe at that location and serving to prevent further axial flow along said foraminous pipe and forcing outwardly radial flow into said filtering material in said first type typical filter section;

a second type separately removable alternate typical filter section immediately following said first type typical filter section and separated therefrom by said first type typical baffle and said pipe closing partition and said filter section being filled with a filtering material and being in fluid communication with said first type filter section by means of said perforations in said first type typical baffle;

a second type alternate typical baffle which serves to limit the axial extent of said second type separately removable alternate typical filter section and to force fluid flow radially inwardly into said foraminous inner pipe; and

whereas after flowing through the filter sections, filtered fluid may exit the system by means of said filtered fluid exit pipe.

2. The environmental control system filter purificator of claim 1 wherein:

interior structural surfaces are coated with a Teflon coating.

3. An environmental control system filter purificator comprising:

a contaminated fluid entry pipe communicant with a contaminated fluid entry port for receiving a contaminated fluid to be filtered;

an axially extended outer shell structure having a distal exhaust end and a near contaminated fluid end and in which said near end is connected in fluid communication with said contaminated fluid entry pipe;

a foraminous inner pipe, centrally extending axially through said outer shell structure from the connection at said near end to said contaminated fluid entry pipe to a filtered fluid exit connected at said distal end ;

at least two separately removable alternating typical filter sections located within said outer shell structure and having an initial first type separately removable alternate typical filter section located immediately interiorly following said near end cap and within said outer shell and extending axially along said foraminous inner pipe for a section length, said filter section being filled with a filtering material in the surrounding axial space between said foraminous inner pipe and said outer shell;

a first type alternate typical baffle having perforations and which serves to determine the axial extent of said first type typical filter section;

a pipe closing partition located at the axial extent of said first type filter section and within said foraminous pipe at that location and serving to prevent further axial flow along said foraminous pipe and forcing outwardly radial flow into said filtering material in said first type typical filter section;

a second type separately removable alternate typical filter section immediately following said first type typical filter section and separated therefrom by said first type typical baffle and said pipe closing partition and said filter section being filled with a filtering material and being in fluid communication with said first type filter section by means of said perforations in said first type typical baffle;

a second type alternate typical baffle which serves to limit the axial extent of said second type separately removable alternate typical filter section and to force fluid flow radially inwardly into said foraminous inner pipe;

an exhaust turbine located at said distal exhaust end for forcibly exhausting the filtered fluid from said filter system; and

whereas after flowing through the filter sections, filtered fluid may positively exit the system by means of said filtered fluid exit .

4. The environmental control system purificator of claim 3 wherein:

interior structural surfaces are coated with a Teflon coating.

5. A large environmental control system filter purificator intended for the removal of smog and other pollutants from contaminated ambient air, comprising:

a pressure enhancing intake throat;

an intake turbine that furnishes contaminated ambient air to said pressure enhancing intake throat;

solar power panels for furnishing power to said intake turbine;

a wire mesh protective screen intended to prevent the entry of insects and birds into said intake throat;

a vertically axially extending outer shell structure having an upper end and a closed lower end having a filtered fluid exit, said upper end being fluidly communicant with said pressure enhancing throat;

at least one elevator operable vertically along said vertically extending outer shell;

a foraminous inner pipe, centrally extending axially through said vertical outer shell structure from said pressure enhancing throat at said upper end to said lower end;

at least two separately removable alternating typical filter sections located within said outer shell structure and having an initial first type separately removable alternate typical filter section located immediately interiorly following

said pressure enhancing throat and within said outer shell and extending axially along said foraminous inner pipe for a section length, said filter section being filled with a filtering material in the surrounding vertical axial space between said foraminous inner pipe and said outer shell;

a first type alternate typical baffle having perforations and which serves to determine the axial extent of said first type typical filter section;

a pipe closing partition located at the axial extent of said first type filter section and within said foraminous pipe at that location and serving to prevent further axial flow along said foraminous pipe thus forcing outwardly radial flow into said filtering material in said first type typical filter section;

a second type separately removable alternate typical filter section immediately following said first type typical filter section and separated therefrom by said first type typical baffle and said pipe closing partition, said second type filter section being filled with a filtering material and being in fluid communication with said first type filter section by means of said perforations in said first type typical baffle;

a second type alternate typical baffle which serves to limit the axial extent of said second type separately removable alternate typical filter section and to force fluid flow radially inwardly into said foraminous inner pipe and; thence into the filter material surrounding said foraminous inner pipe;

An operations and control building supporting said large environmental control system purificator; and

whereas after flowing through the filter sections, filtered air may positively exit the system by means of said filtered fluid exit at said lower end.

6. The large environmental control system purificator of claim 5 wherein:

interior structural surfaces are coated with a Teflon coating.

7. A method of filtering a flowing fluid in an environmental control system filter purificator, comprising the steps of:

introducing a flowing fluid to be filtered into a foraminous inner pipe in said system filter;

injecting another fluid under pressure into the flow path of said fluid to be filtered so as to aid and maintain a positive fluid flow;

forcing said fluid to flow radially outwardly through the foramens in said foraminous inner pipe and thence into filtering material in a first filter section of said system filter purificator;

providing a first type baffle, limiting the extent of said first filter section and having perforations providing fluid communication between said first filter section and a second filter section;

providing a second type baffle, limiting the extent of said second filter section and operative to force fluid flow radially inwardly into said foraminous inner pipe in said second filter section;

repeating the above steps for as many pairs of first and second filter sections as have been provided in the control system filter;

providing exit means for said fluid from a final filter section provided for said control system filter.

8. The method according to claim 7, including the additional step of :

coating the interior structural surfaces of the environmental control system filter purificator with a Teflon coating.

9. A method for removing smog and other contaminants from ambient air, comprising the steps of:

sucking ambient air into a pressure enhancing throat in an environmental control system purificator;

forcing said air to flow alternately through a plurality of first and second filter sections;

expelling said air back into the environment after its passage through a final filter section;

providing means to service, maintain and operate said environmental control system purificator.

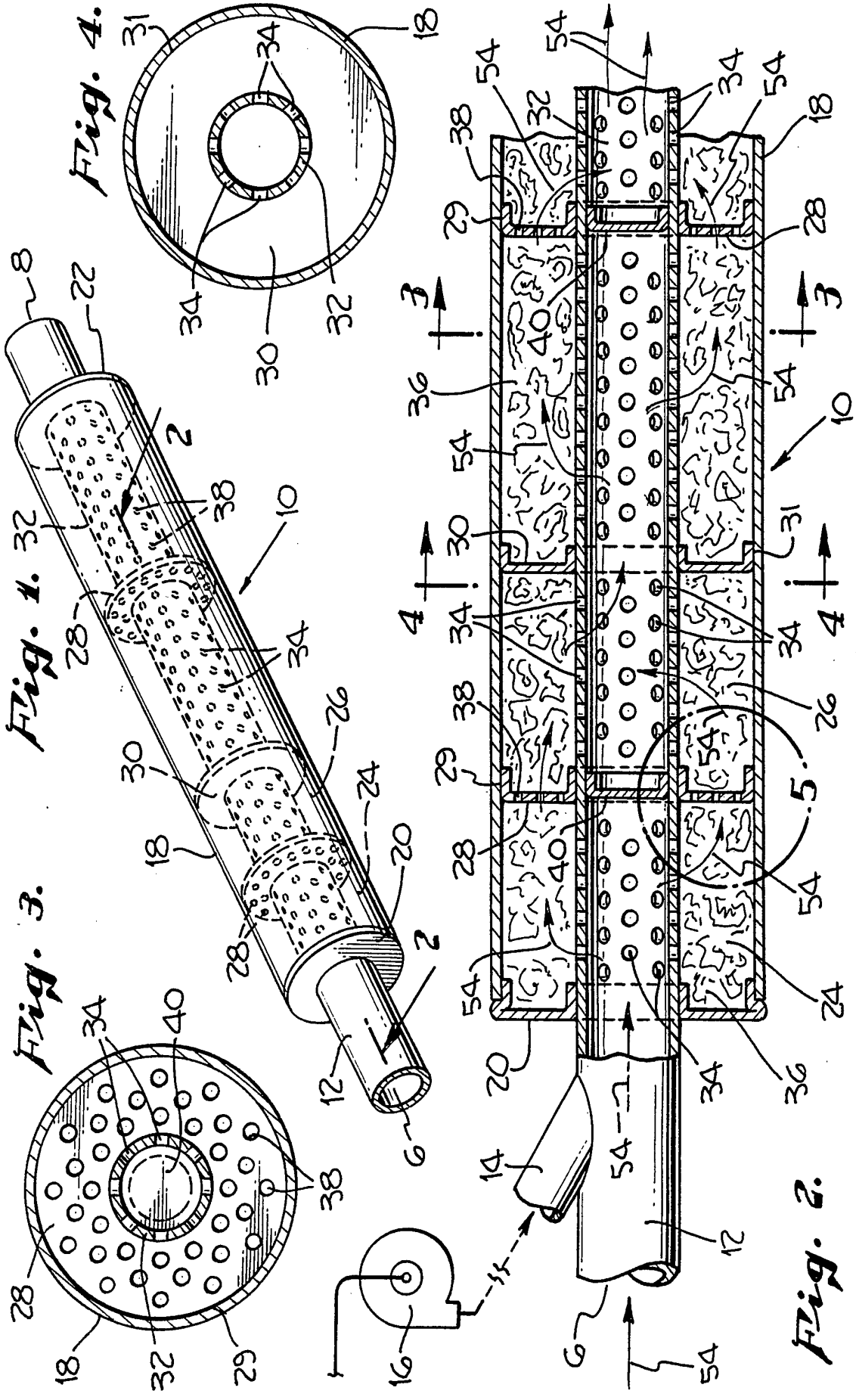
Fig. 4.
Fig. 1.
Fig. 3.
Fig. 2.
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Fig. 5.

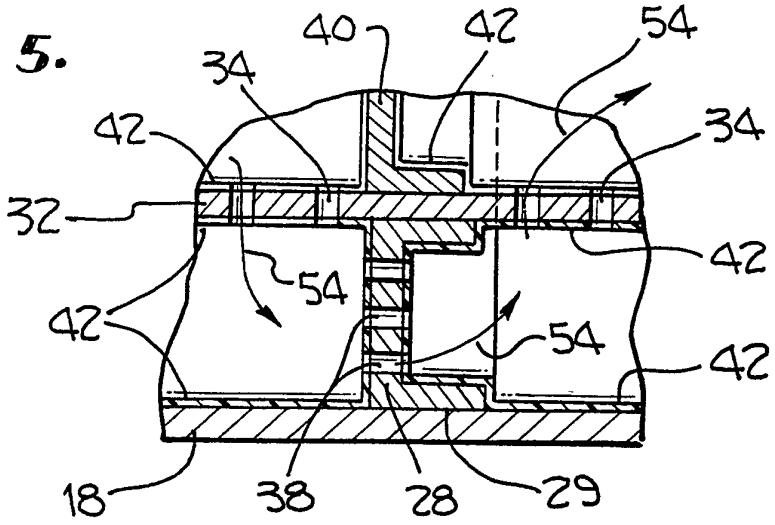

Fig. 6.

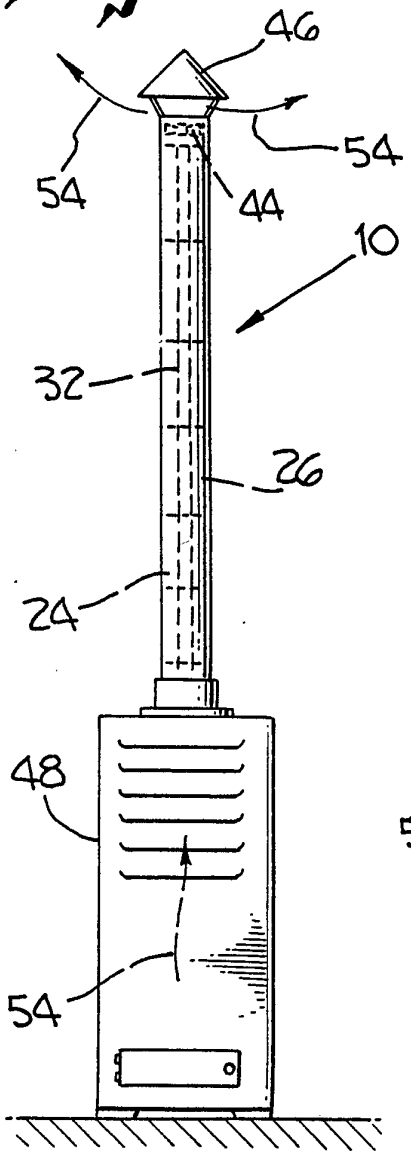

Fig. 7.

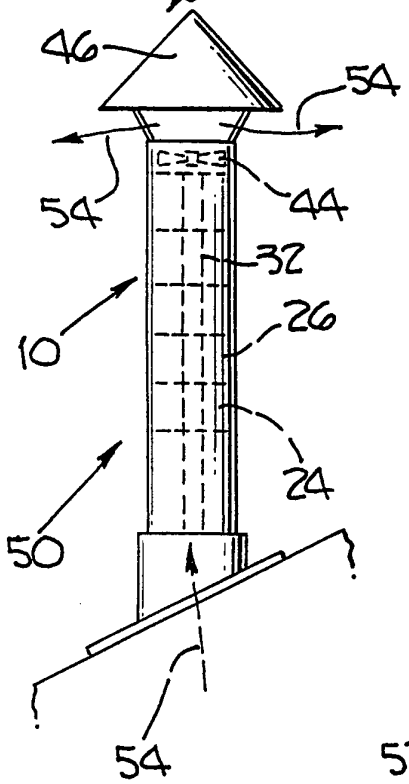

Fig. 8.

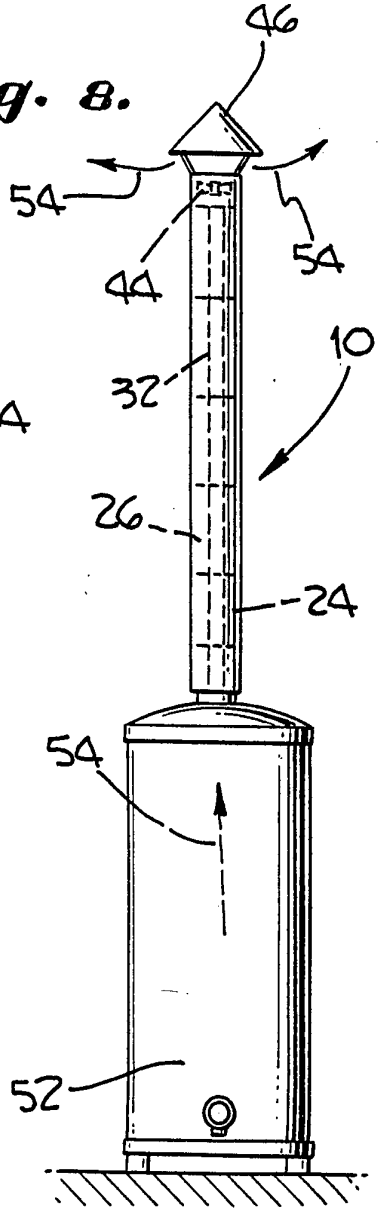

Fig. 9.

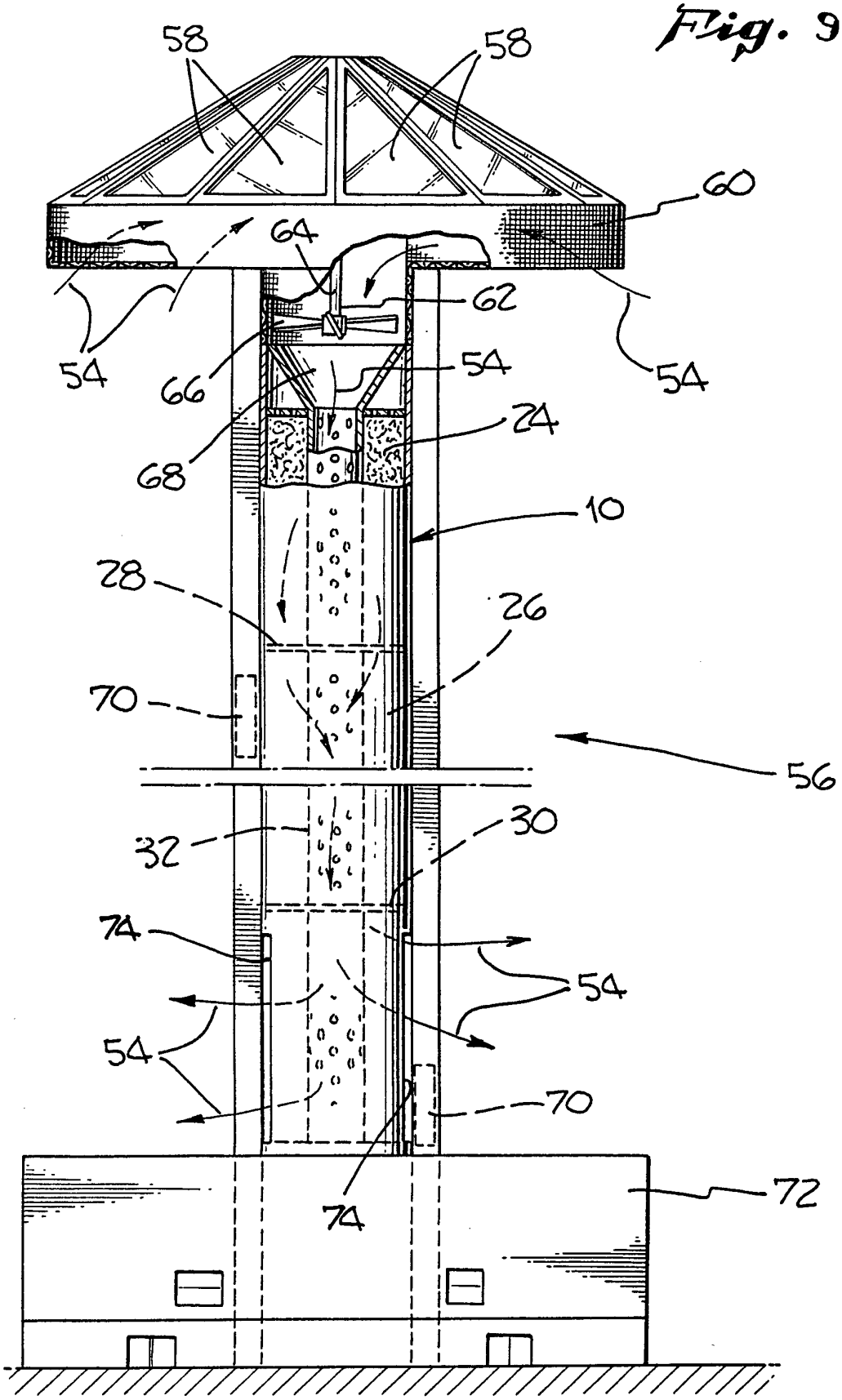
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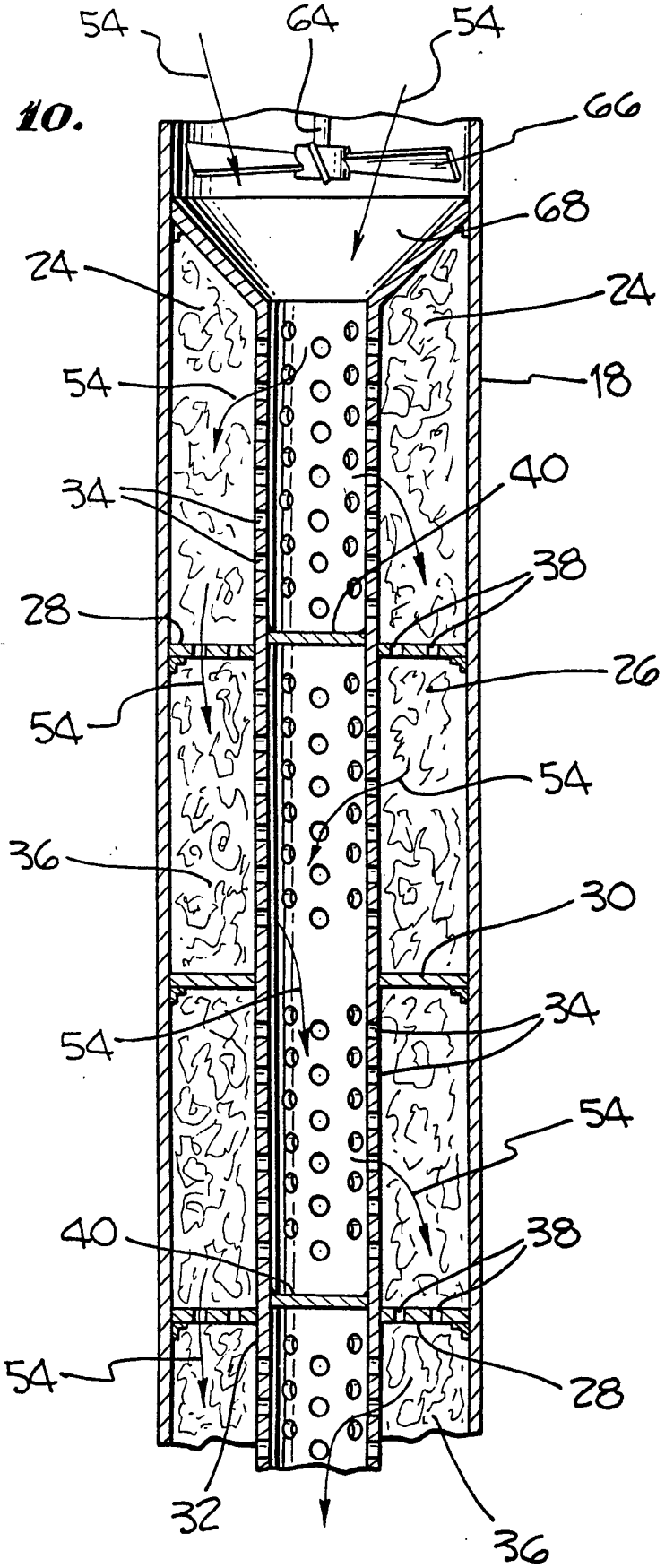
Fig. 10.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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US92/07158

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) :B01D 46/00
US CL :55/97
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 55/97; 482, 473; 60/311; 181/252; 55/DIG. 30, 484

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 1,833,919 (SISSON) 01 DECEMBER 1931 Note Figure 1.	9
Y	US, A, 2,956,865 (WILLIAMS) 18 OCTOBER 1960 Note inlet 36 Figure 1.	9

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"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
"A"	document defining the general state of the art which is not considered to be part of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"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)	"&"	document member of the same patent family
"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		

Date of the actual completion of the international search 13 OCTOBER 1992	Date of mailing of the international search report 10 NOV 1992
Name and mailing address of the ISA/ Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. NOT APPLICABLE	Authorized officer BERNARD NOZICK Telephone No. (703) 308-3792

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