

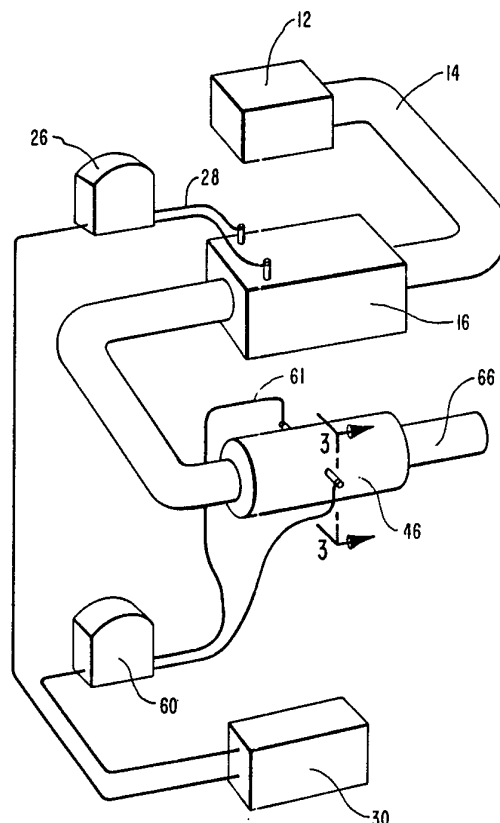


INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁵ : B01J 19/08, 19/10, 19/12 F01N 3/24, 3/26, 3/38	A1	(11) International Publication Number: WO 94/11101 (43) International Publication Date: 26 May 1994 (26.05.94)
(21) International Application Number: PCT/US92/09880 (22) International Filing Date: 18 November 1992 (18.11.92) (71) Applicant: NU ARC SCIENTIFIC, INC. [US/US]; 360 West 6400 South, Salt Lake City, UT 84107 (US). (72) Inventors: TAYLOR, Edward, O. ; TAYLOR, Carole, A. ; 3256 East Germain Circle, Sandy, UT 84093 (US). (74) Agents: SEELEY, David, O., et al.; Workman, Nydegger & Jensen, 1000 Eagle Gate Tower, 60 East South Temple, Salt Lake City, UT 84111 (US).		(81) Designated States: AT, AU, BB, BG, BR, CA, CH, CS, DE, DK, ES, FI, GB, HU, JP, KP, KR, LK, LU, MG, MN, MW, NL, NO, PL, RO, RU, SD, SE, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, SN, TD, TG). Published <i>With international search report.</i>

(54) Title: APPARATUS AND METHOD FOR REDUCING POLLUTANTS IN EFFLUENT GAS FLOW**(57) Abstract**

The present invention relates generally to apparatus and methods used in chemically reducing pollutants in effluent gas flow. More particularly, the present invention relates to ionization of effluent gas from an effluent gas source by passage of the effluent gas through a resonance field (16), and potentialization and purification of the effluent gas by passage of the effluent gas through a continuous electrical arc (46). Preferably, the resonance field (16) and the continuous electrical arc (46) are both generated by an alternating current. The result of using the apparatus and method of the present invention is a release of stabilized air particles without a high consumption of energy, and without producing waste products requiring subsequent collection.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	GB	United Kingdom	MR	Mauritania
AU	Australia	GE	Georgia	MW	Malawi
BB	Barbados	GN	Guinea	NE	Niger
BE	Belgium	GR	Greece	NL	Netherlands
BF	Burkina Faso	HU	Hungary	NO	Norway
BG	Bulgaria	IE	Ireland	NZ	New Zealand
BJ	Benin	IT	Italy	PL	Poland
BR	Brazil	JP	Japan	PT	Portugal
BY	Belarus	KE	Kenya	RO	Romania
CA	Canada	KG	Kyrgyzstan	RU	Russian Federation
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo	KR	Republic of Korea	SE	Sweden
CH	Switzerland	KZ	Kazakhstan	SI	Slovenia
CI	Côte d'Ivoire	LI	Liechtenstein	SK	Slovakia
CM	Cameroon	LK	Sri Lanka	SN	Senegal
CN	China	LU	Luxembourg	TD	Chad
CS	Czechoslovakia	LV	Latvia	TG	Togo
CZ	Czech Republic	MC	Monaco	TJ	Tajikistan
DE	Germany	MD	Republic of Moldova	TT	Trinidad and Tobago
DK	Denmark	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	US	United States of America
FI	Finland	MN	Mongolia	UZ	Uzbekistan
FR	France			VN	Viet Nam
GA	Gabon				

1 APPARATUS AND METHOD FOR REDUCING
POLLUTANTS IN EFFLUENT GAS FLOW

Background

5 Field of the Invention

The present invention relates to apparatus and methods for reducing pollutants in effluent gas flow, particularly exhaust emissions resulting from combustion processes.

10 Background Art

In today's industrial world, the amount of pollution present has reached enormous proportions. Not only do factories, buses, cars, trucks, stationary combustion engines, and commercial and industrial processes provide air pollution but, additionally, migration of releases from
15 dump sites, land fills, sewage treatment lagoons, waste heaps, etc. are sources of air contamination.

In order to understand the structure and theory of the apparatus and system of the present invention, a brief statement on the area of pollution is necessary.
20

As emission and environmental regulations become increasingly more stringent, waste treatment, hazardous chemicals and combustion products, in general, must be handled with innovative methods to reduce their impact upon the environment and upon society. To ultimately be
25 successful, the method employed to resolve the problems must be economical, highly efficient in the reduction of emissions with respect to the equipment it serves, and available for widespread use.

Air pollution chemistry is a complex issue. Many
30 different sources have created emission reaction in quantum proportions. The carbon/oxygen/nitrogen cycles interplay in all aspects of organic and inorganic life and in all chemical reactions. These cycles have photochemical reactions (vibrational reaction due to light absorption),
35 as well as physical vibrational reactions due to the

1 interplay of excited electrons from electrochemical
interactions. It is in these three cycles, as illustrated
by natural processes, that air pollution chemistry finds
its effectiveness and explanations.

5 In the 1960's, it was recognized that the hydroxyl
radical is, with several important exceptions, the key
reactive intermediate in the photo-oxidation of most
inorganic and many organic compounds found in polluted
atmospheres. The NO₃ and the HOHO radicals also play
10 important roles in the atmosphere. The primary air
pollutants are NO, NO₂, SO₂, CO₂, and hydrocarbons.
Devices which reduce the entrance of these compounds into
the atmosphere and which are efficient and inexpensive are
desired.

15 A variety of devices and the methods for removing
pollutants from effluent gas flows are available today.
Such devices and methods focus on the use of mechanical,
electrical, electro-mechanical, and chemical processes.
Typical examples of such prior art methods include filters,
20 aqueous scrubbers, electrostatic precipitators, catalytic
converters.

One type of prior art pollution control device which
utilizes electrical means generally teaches the reduction
of pollutants to a particulate or mist form through
25 precipitation. In these devices, effluent gas may be
passed through an electric current whereby particles become
charged. These charged particles drop out of the gas and
are collected. One problem with these precipitation
devices is the dilemma of subsequent handling of the
30 collected pollutant particles. Once they are collected,
the pollutant particles must still be somehow discarded or
stored.

A number of prior art variations on this technology
deal primarily with methods of electrostatic precipitation
35 to maximize precipitation efficiency or to minimize the

1 number of cleansing cycles required of the electrostatic
precipitator. These variations are aimed towards
minimizing the down time of the electrostatic precipitator.
However, the problem remains of storage or elimination of
5 the collected pollutant particles once they are separated
from the gases.

Such prior art processes and apparatus are typified by
the following patents: U.S. Patent No. 2,382,253, issued
to Penney, et al. on August 14, 1945; U.S. Patent No.
10 3,706,182, issued to Sargent on December 19, 1972; U.S.
Patent No. 3,739,554, issued to Whetten, et al. on June 19,
1973; U.S. Patent No. 3,869,362 issued to Machi, et al. on
March 4, 1975 and U.S. Patent No. 3,907,520 issued to
Huang, et al. on September 23, 1975.

15

BRIEF SUMMARY

The present invention is directed to a system
comprising a series of electrical and non-electrical
components for the purpose of reducing and/or changing the
20 emissions from all types of sources including, but not
limited to, combustion. This system accomplishes its
purpose through the principal of disassociation chemistry
and/or recombination. Generally, the system takes the
exhaust emissions from an engine, or the by-product of a
25 combustion system, and essentially completes the biological
cycles of the nitrogen, carbon, and oxygen in the
emissions, stabilizing them by a form of simple harmonic
resonance. Once stabilized, the disassociated and
recombined emissions can then be released into the
30 atmosphere as stable air products minus the pollutants
which are harmful to humans, plants, and animals. The
system can be applied to any number of different sources of
emissions whether they be industrial, commercial,
residential, or medical.

35

1 In the preferred embodiment within the scope of the
present invention, the method and apparatus for reducing
pollutants in effluent gas flow is an engineered chemical
alteration of the pollutants in the effluent gas. The
5 method comprises the steps of subjecting an effluent gas
flow to ionization in a simple harmonic resonance field
within a special walled chamber and then subjecting the
effluent gas flow to a continuous non-carbon electric arc.
It is believed that what occurs is an electromechanical
10 process that incorporates cycles and precursor
relationships of effluent gas chemical constituents into
specially designed chambers that simulate natural
biological reaction sites.

15 Simple harmonic motion can be defined in the following
way. A particle moving along the X axis is said to exhibit
simple harmonic motion when the displacement from
equilibrium, X, varies in time according to the
relationship:

$$X = A \cos(\omega t + \delta)$$

20 where the parameters A, ω and δ are constants.

In order to give physical significance to those
constants, it is convenient to plot X as a function of
time, as in $(X = A \cos(\omega t + \delta))$, where

25 A = amplitude of motion is the maximum
displacement of the particle in either positive or
negative X direction;

W is called the angular frequency;

30 δ (the constant angle) is called the phase
constant or phase angle and along with A (amplitude) is
determined uniquely by the initial displacement and
velocity of the particle.

It is believed that the method and apparatus of the
present invention can be broken down into interrelated
systems. The first system is ionization within the
35 resonance chamber. The resonance chamber is designed on

1 the principal of simple harmonic resonance, that being a
simple harmonic motion, oscillatory and controllable. The
second system is a plasma field produced by an electric
discharge system within a spherical or cylindrical chamber.
5 The chamber generates a membrane-like barrier through which
the effluent gas constituents pass. The field which is
generated is a multi-charged field and the gases are
potentialized so that when they are released into the
environment, the ultra violet light as well as the entire
10 solar spectrum energizes the gases to inert non-toxic
gases.

In the preferred embodiment within the scope of the
present invention, the simple harmonic resonance field and
the continuous electric arc are created by an alternating
15 current. However, the simple harmonic resonance field may
also be created by other means such as physical vibration,
sound or light, forced oscillation, or any other means for
creating a resonance may be utilized.

In the apparatus of the present invention, it is
20 preferable, although optional, to regulate the temperature,
humidity and velocity of the effluent gas flow before
subjecting the effluent gas to the resonance field and
electric arc. This preconditioning of the effluent gas may
be accomplished in the present invention by transporting
25 the effluent gas through various preconditioning chambers.
The preconditioning chambers have reactive walls that aid
in controlling the bonding energy of the particles as they
pass through the chambers.

Means for temperature regulation of the effluent gas
30 flow comprises at least one heat exchanger located at the
entranceway of the effluent gas flow, in which heat from
the effluent gas is allowed to flow from or to the effluent
gas through the heat exchanger. Means for regulating the
velocity of the effluent gas flow comprises at least one
35 expansion chamber where the gas flow is decompressed.

1 Means for regulating the velocity further comprises a gas
flow regulator. A fan or damper, or any means for
regulating flow of gas may be used as the gas flow
regulator.

5 It is important to note that although, as discussed in
connection with the preferred embodiment, the term
"preconditioning" is used to denote altering the
temperature, speed of gas flow, pressure, etc. of the
effluent gas, it does not mean chemical preconditioning.
10 Chemical catalysts are not required, but may be helpful if
they assist in accomplishing the derived effect.

In the preferred embodiment, the resonance field to
which the gas flow is subjected is an alternating current
electric field. The effluent gas flow is passed through a
15 wire grid vertically placed within a metallic or non-
metallic chamber to which an alternating current is
applied. The effluent gas flow is controlled within the
electromagnetic multi-charged field and with simple
harmonic resonance, becomes ionized. After ionization, the
20 effluent gas is then passed through a cylindrically shaped
chamber within which two electrodes are placed
substantially perpendicular to the flow of the effluent
gas. Between the two electrodes a continuous electric arc
is generated and an electromagnetic plasma field is formed.
25 It is believed that the arc field system is essentially a
semipermeable-like membrane which creates a plasma with
multi-zoned vectoral field. The effluent gas flows through
the continuous electric arc system and is discharged into
the air as stabilized air particles.

30 Alternately, the discharge from the system may also be
passed back into the air intake of the engine or other
effluent gas source from which the effluent gas originated.
When the discharge is passed into the air intake, this
allows for no outside air to enter the engine, and

1 surprisingly, may increase the fuel efficiency of the engine.

The system of the present invention can be broken down into two categories, the principal components and the support components. A first principal component comprises the ionization steps of the system which, it is believed, controls disassociation and recombination of the compounds. The ionization step occurs in a resonance chamber wherein toxic air emissions are disassociated, and then through resonance are stabilized.

A second principal component of the present invention comprises an electric arc. The electric arc is produced for the purpose of providing, it is believed, four very specific requirements of disassociation and recombination. These four requirements are a magnetic field, light of photolization, alternating electrification, and energy of oxidation.

The second category of the present invention, the support components, comprises an inlet fan designed to relieve any back pressure that may result and to regulate the flow of gas, and at least one expansion chamber used for decompression of the effluent gasses.

Each of the components are connected by a piping system. The size of the pipes may regulate resistance to the exhaust gases as the gases are distributed through the system.

BRIEF DESCRIPTION OF THE DRAWING

In order that the manner in which the above-recited and other advantages and objects of the invention are obtained, a more particular description of the invention briefly described above will be rendered by reference to specific embodiments thereof which are illustrated in the appended drawings. Understanding that these drawings depict only typical embodiments of the invention and are

1 therefore not to be considered limiting of its scope, the
invention will be described with additional specificity and
detail through the use of the accompanying drawings in
which:

5 Figure 1 is a perspective schematic of the basic
embodiment within the scope of the present invention.

Figure 2 is a cut-away perspective view illustrating
a resonance chamber of the apparatus of Figure 1.

10 Figure 3 is a cross-sectional view of the electric arc
collar of the apparatus of Figure 1 taken along the line 3-
3.

Figure 4 is a perspective schematic of the preferred
embodiment within the scope of the present invention.

15 Figure 5 is a cross-sectional view of the heat
exchanger of the apparatus of Figure 4 taken along line 5-
5.

Figure 6 is a cut-away perspective view illustrating
an expansion chamber of the embodiment of Figure 4.

20 Figure 7 is a perspective view of an embodiment of the
present invention wherein gasses passing through the
apparatus of the present invention are recycled back to the
effluent gas source.

25 In the drawings, the arrows indicate the general
direction of effluent gas flow. Like parts have been
designated with like numerals throughout.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

30 The following description contains what is presently
believed to be occurring within the method and apparatus of
the present invention. For purposes of discussion, it will
be assumed to be correct. Nevertheless, if new information
is discovered, the presently believed information is not to
be limiting to the present invention.

35 It is believed that the method and apparatus employs
plasma physics. Plasma physics is pertinent to the full

1 use of the mass of a gas because the plasma field breaks
the bonds of each gas in the mass in an orderly and
manageable equilibrium enabling usage of the complete
energy potential in the target gas by recombination methods
5 afforded by plasma technology. Gas effluents, as well, can
be clipped from the gas exhaust of engines, turbines,
boilers, machines, etc., and recombined to make other
products, or destroyed or released as harmless natural
elements to the environment.

10 Plasma physics is that field of physics which relates
to the study of highly ionized gases. A gas which is
composed of a nearly equal number of positive and negative
free charges (positive ions and electrons) is called a
plasma. Because it is composed of charged particles, a
15 plasma exhibits many phenomena not encountered in ordinary
gases.

The charged particles of a plasma are each surrounded
with a Coulomb's field; it is through this field that they
interact with each other. Microscopically, these
20 electrostatic fields give rise to localized attractive or
repulsive forces between the particles as they pass near
each other, resulting in mutual neutralization. The plasma
reacts as a conducting fluid to the total electromagnetic
field in which it is immersed.

25 In Figure 1, a system for reducing pollutants in
effluent gas flow is illustrated. It is believed that the
system of the present invention is not induction plasma,
nor glow discharge plasma. It is not thermionic plasma.
Inert gases, microwaves, radiowaves or high thermal
30 temperatures are not used in the process. Nor are high
ionization temperatures, catalysts or high energy required.
Instead, the system of the present invention operates in
the following manner.

In the preferred embodiment within the scope of the
35 present invention, the system for electrochemical reducing

1 pollutants in effluent gas flow is an engineered chemical
alteration of the pollutants in the effluent gas. The
method comprises the steps of subjecting an effluent gas
flow to ionization in a simple harmonic resonance field
5 within a special walled chamber and then subjecting the
effluent gas flow to a continuous non-carbon electric arc.

Figure 1 illustrates the basic embodiment of the
present invention. In this embodiment, an effluent gas
containing pollutants enters the system from an effluent
10 gas source 12, an example of which effluent gas source 12
may be an internal combustion engine. The effluent gas
passes through a piping system 14 which interconnects the
various chambers of the present invention, to a resonance
chamber 16. It can be appreciated that piping system 14 is
15 designed so that each of the pipes can be easily changed in
order to accommodate not only gases, but also liquid fuels
or even solids. In the preferred embodiment, the piping
system is composed of Polyvinyl Chloride, through which
sulfur material is exchanged.

20 Within the resonance chamber 16, it is believed that
the important ionization step occurs. The resonance
chamber 16 is a combination of many conductive and
thermoconductive materials which are directly responsible
for the process which results in disassociation and
25 recombination.

Referring to the preferred embodiment of the resonance
chamber 16 illustrated in Figure 2, the effluent gas flows
into resonance chamber 16 through a gas inlet 18, through
a wire grid 20 along which an alternating current is
30 passed, and then out gas outlet 22.

As the effluent gas passes through wire grid 20, the
effluent gas is subjected to an electric field being
generated by the passage of the alternating current through
wire grid 20. Wire grid 20 may be designed in all
35 geometric configurations to predict inter-pressure,

1 respiration and turbulence. It can be appreciated that
wire grid 20 functions multi-directionally, as well as with
applied multi-current. The flows and currents are mass
related and function under standard terms of
5 thermodynamics. The geometric configurations possible
correspond to vector angles.

As stated above, the alternating current electric
field through which the effluent gas flows, is created by
energizing wire grid 20 with an alternating current. The
10 strength of the alternating current will vary depending
upon the effluent gas source and the type of effluent gas
being treated. Preferably, the alternating current is in
the range of about 7,500 volts A.C. at 0.1 AMP to about
80,000 Volts A.C. at 0.1 AMP. The alternating current is
15 supplied to wire grid 20 by A.C. power supply 26 through
power lines 28, which may be controlled by control
panel 30, as can be seen in Figure 1. Control panel 30
holds the main circuit breaker switch and the breaker
switches for each electrical component to which it is
20 attached.

Preferably, at least two opposite walls 34 and 36 of
resonance chamber 16 are constructed of a relatively
nonelectrically conductive resonant material, such as wood,
while the other two walls may be constructed of a metallic
25 material.

Within resonance chamber 16, the effluent gas is
ionized by the established physical, electrical, photo or
sound resonance vibrations, and the particulate matter is
cracked. As stated, in the preferred embodiment, the means
30 for establishing resonance comprises an alternating
electric current passing through a wire grid 20 within the
resonance chamber 16.

However, any process which would establish a simple
harmonic resonance field, such as using sound or light, or
35

1 some type of forced oscillation would be within the scope
of the present invention.

It is important to note that using an alternating
current to inhibit formation of particles distinguishes the
5 present invention over prior art. In most prior art
systems, direct current is used in place of alternating
current, and precipitation reactions occur rather than
ionization. In precipitation reactions, the direct current
charges a negative or a positive particle and causes it to
10 drop out as a heavy weighted particle for collection. In
the present invention, the particles are charged with a
multi-field charge, and then a resonance field is
established within an electromagnetic field which further
inhibits particle combination. Particles are not weighted
15 and dropped out for collection. They are stabilized by the
number of resonance forms produced.

The stability of the products caused by resonance is
important to the present invention. A very stable product
decreases the probability of the reversal of the reaction
20 or resynthesis of the reactant, thereby contributing to the
completion of the reaction.

Presently, in the preferred embodiment within the
scope of the present invention, the wire grid 20 of the
resonance chamber being used is one taken from the
25 HONEYWELL brand model F50 which has an operating ambient of
from about 40° F to about 125° F and maximum cell washing
temperature of about 220° F. The maximum power consumption
is about 50 W for 2-cell models, and 30 W for 1-cell
models. Use of voltage of 7500 volts has been found to be
30 preferable with the wire grid of the HONEYWELL device. In
the preferred embodiment the HONEYWELL device is modified
such that there is no honeycomb, and an alternating current
rather than a direct current is used. Presently, the prior
art uses the HONEYWELL model as a precipitator. As earlier
35 stated, the present invention is not a precipitator, and

1 the expansion chamber is used in contrast as a
decompression chamber. It can be appreciated, however,
that although the Honeywell wire grid is used in the
preferred embodiment, any other wire grid may be used.

5 Referring again to Figure 1, the effluent gas passes
from resonance chamber 16 through piping system 14 to an
electric arc collar 46 on which two electrodes 48 are
inserted. Electrodes 48 are preferably of a non-carbon
material. As can be seen in Figure 3, a continuous
10 electric arc 50 is formed between electrodes 48 when
electrical power is applied to the system. The continuous
electric arc 50 may be generated by either alternating or
direct current, but alternating current is preferable.

Electric arc collar 46 is comprised of a cylinder 52
15 through which the effluent gas flows. Cylinder 52 is
preferably made of silicon carbide. However, materials
such as glass and quartz have also been successful.
Electrodes 48 preferably pass through the walls of
cylinder 52 perpendicularly to the longitudinal axis of
20 cylinder 52, but it can be appreciated that electrodes 48
may be inserted into cylinder 52 in any position such that
an electric arc may be formed in between the electrodes.
One end of each electrode is disposed within cylinder 52
and in close enough proximity to the end of the opposite
25 electrode to ensure that a continuous electric arc 50 is
generated when an electric potential is applied across the
electrodes.

Electrodes 48 are insulated from cylinder 52 by the
use of insulators 56. Preferably, electrodes 48 are made
30 of a stainless steel/nickel alloy. Preferably,
insulators 56 are ceramic. Additionally, a number of
different electrode configurations will work in the present
invention. Electrodes 48 are energized by transformed
amplification of a generated current. The current and
35 voltage are received from electric arc power supply 60

1 through power lines 61. Power supply 60 may be controlled
by control panel 30. It is preferable that the alternating
current be in the range of about 12,500 volts A.C. at 0.1
AMP to 138,000 volts A.C. at 0.1 AMP, the size of the plant
5 dictating voltage.

It is important to note that the arc current 50 is
produced for the purpose of providing four very specific
believed requirements of disassociation and recombination:
the magnetic field, light of photolization, alternating
10 electrification, and energy of oxidation. The arc
formulation is as follows: the arc, photolization, the
electrical field, and the thermodynamics energy of
oxidation.

Within the electric arc collar 46, the relative level
15 of electrical and magnetic energy can be established by
analysis of the pressure of the gas passing through
electric arc collar 46 plus the flow rate as specified by
each particular application.

As stated earlier, in the basic embodiment illustrated
20 in Figure 1, the effluent gas is passed through the
continuous electric arc 50 directly from resonance
chamber 16. The effluent gas becomes potentialized by the
electric arc 50 and then exits electric arc collar 46 into
piping system 14. From there, the effluent gas may pass
25 out into the atmosphere as stabilized products through a
discharge tube 66. The apparatus and process results in
significantly reducing NO_x , CO , CO_2 , VOC and SO_x .
Surprisingly, the level of the pollutants is a fraction of
the level previously obtained using currently available
30 technology. An emissions control monitor is currently in
developmental stages. It is believed that the control
monitor will continuously monitor emissions and system
efficiency wherein the range of measurement includes
measurements below 10 parts per million.

1 Although the apparatus of the present invention is
functional in its basic form as illustrated in Figure 1,
for highest efficiency to the system, additional
preconditioning steps may be included within the preferred
5 embodiment.

 Figure 4 illustrates a preferred embodiment within the
scope of the present invention including additional
preconditioning chambers. In this embodiment, an effluent
10 gas containing pollutants enters the system from effluent
gas source 12. Once the effluent gas enters the system,
the effluent gas may pass into means for regulating the
temperature of the effluent gas flow. In the preferred
embodiment, the means for temperature regulation is a heat
15 exchanger 70, wherein the temperature of the effluent gas
is lowered. As seen in Figure 5, heat exchanger 70 of the
preferred embodiment comprises a cylindrical tubing 72
having within tubing 72 a multiple of smaller inner
cylindrical tubings 74. Inner tubings 74 lay
20 longitudinally within tubing 72 in such way that tubing 72
and the multiple of inner tubings 74 are in direct contact
with each other. Tubing 72 and inner tubings 74 are
constructed of a thermally conductive material such as
copper or aluminum. As the conductive material of
25 tubing 72 and inner tubings 74 are in direct contact with
each other, when effluent gas is flowed through heat
exchanger 70, heat from the effluent gas flows from the
effluent gas through inner tubings 74 to the exterior
surface 76 of tubing 72, and dissipates into the ambient
30 atmosphere. The temperature of the remaining effluent gas
is thus lowered. However, any conventional heat exchanger
may be used.

 One important feature of cooling the effluent gas
within gas exchanger 70 is that generally, cooling the
effluent gas reduces the oxides in the effluent gas. As
35 the components of most of the effluent gasses are such as

1 nitrogen, oxygen, carbon monoxide and carbon dioxide,
cooling the effluent gas augments the purification process.

2 In the preferred embodiment of Figure 4, after exiting
heat exchanger 70, the cooled effluent gas then passes
5 through a portion of piping system 14. It is important to
note the relationship between the size of piping system 14
and the horsepower of the engines upon which the system is
being operated. For example, a pipe with four inch
10 diameter was used with an engine with about 150 horsepower.
A six inch diameter corresponds to about 150 to about 200
horsepower. An eight inch diameter corresponds to about
200 to about 5-600 horsepower. Finally, a ten inch
15 diameter corresponds to about 800 to about 1400 horsepower.
Thus, different sized engines require use of differently
sized pipes to obtain preferred results under the present
invention.

After exiting heat exchanger 70, effluent gas passes
through piping system 14 into a first expansion chamber 82.
20 In first expansion chamber 82, the effluent gas is
decompressed. When full expansion is applied, the velocity
of the gas flow is decreased, pressure is lowered, and
temperature is reduced. It is believed that equalization
and segregation of lead gases occurs in the expansion
25 chamber. In the preferred embodiment of the present
invention, the ratio of the velocity of the effluent gas
going into first expansion chamber 82 to the velocity of
the effluent gas going out is approximately 2.5 to 1.

Figure 6 illustrates an expansion chamber 82 within
the scope of the present invention. In expansion
30 chamber 82, the effluent gas flows through at least one
baffle 84. Baffle 84 comprises a plate which is
substantially perpendicular to the flow of the effluent
gas. Effluent gas flows through baffle 84 through a series
of holes 86 cut into baffle 84. Effluent air is directed

1 through holes 86 thereby resulting in the decreased flow of
the effluent gas.

Referring back to Figure 4, it can be seen that from
the first expansion chamber 82, the effluent gas then
5 passes through piping system 14 to a gas flow regulator 90
which regulates the flow of the gas. A fan, or damper, or
any means for regulating flow of gas may be used as gas
regulator 90. Speed of operation of gas regulator 90 may
10 be controlled by a control panel 30 through power lines 92.

The purpose of gas flow regulator 90 is to establish
a continuous gas flow in order to control the resistance in
the system. Controlling the resistance of the system can
be important to obtaining preferred results because certain
15 engines are sensitive to about 6 inches of resistance. Gas
flow regulator 90 assures that as the effluent gas moves
through the piping system 14 and the various chambers of
the system, resistance in the system will never be above 6
inches. In the preferred embodiment within the scope of
the present invention, the system is designed to operated
20 at about 1/2 inch resistance. Therefore, gas flow
regulator 90 maintains resistance above 1/2 inch
resistance, but below 6 inches. It must be noted that the
system may be operated without a gas flow regulator 90, but
the engines on which the system is operated will lose
25 efficiency.

From the gas flow regulator 90, the effluent gas then
enters a resonance chamber 16. After ionization within
resonance chamber 16, the ionized effluent gas may then
flow to a second expansion chamber 96 for further
30 decompression. Second expansion chamber 96 comprises a
similar configuration to first expansion chamber 82 and
provides a similar function. From second expansion chamber
96, the effluent gas passes to electric arc collar 46 where
the gas is passed through continuous electric arc 50 as
35 described earlier for the embodiment of Figure 1. From

1 electric arc collar 46, the gas exits through discharge
tube 66 into the atmosphere as purified air particles.

It is also contemplated within the scope of the
present invention to operate the system in a closed loop
process. Within this process, when the system is attached
to an engine, the discharged effluent gas is passed not to
the atmosphere but to the air intake of the engine. This
allows for no outside air to enter the engine.
Surprisingly, when the discharged effluent gas is passed
directly into the engine's air intake, the engine not only
continues to operate, but may operate at increased fuel
efficiency.

The following examples of the pollution control device
and pollution control method demonstrate the invention with
respect to a particular application and in no way limits
the inventive concepts disclosed herein.

Example I

In this test the apparatus of the present invention
was connected to the exhaust flow of a 150 horse power
naturally aspirated Detroit Diesel engine running at 1200
rpm using diesel fuel. The exhaust flow from the diesel
engine was analyzed for NO_x, CO, CO₂ and O₂ to determine a
base line for the diesel engine without the apparatus of
the present invention attached. The diesel engine exhaust
flow was analyzed for these same components after passing
the exhaust flow through the invention. NO_x was analyzed
using ion chromatography by EPA Method 7A (40 CFR Ch.1, Pt.
60, App. A). CO, CO₂, and O₂ were analyzed using a Teledyne
MAX 5 analyzer.

In the present example, a heat exchanger was used
within the system to cool the temperature of the effluent
gases flowing into the system from the diesel engine. The
temperature of the diesel engine exhaust was in the range
of about 300° to about 350°. Additionally, an expansion

chamber was used in order to decrease the flow of the effluent gas. The ratio of the velocity of the effluent gas as it entered the expansion chamber to the velocity of the effluent gas as it exited the expansion chamber was approximately 2.5 to 1. In this experiment, the resonance chamber used contained a wire grid taken from the HONEYWELL Model F50. The voltage passed through the resonance chamber was 7500 volts. The walls of the chamber were constructed of metal on two sides of metal and two sides of wood.

The electric arc collar used within this example was constructed of silicon carbide, and the electrodes were constructed of stainless steel. The voltage of current sent through the arc collar was 12,500 volts.

The concentration of the tested components in the exhaust flow without application of the present invention were as follows:

	<u>Species</u>	<u>Concentration</u>
20	NO _x	300 ppm
	CO	168 ppm
	CO ₂	4%
	O ₂	18.7%

The concentration of the tested components in the exhaust flow subjected to application of the present invention were as follows:

	<u>Species</u>	<u>Concentration</u>
30	NO _x	5 ppm
	CO	35 ppm
	CO ₂	2%
	O ₂	20.6%

EXAMPLE II

In this test the invention was connected to the exhaust flow of a 1440 horse power turbo charged Superior 1 MW generator using dual fuel (5% diesel and 95% natural gas). During the test, the engine was run at 693 horse power for one hour. The exhaust flow from the engine was analyzed for VOC, NO_x, CO and O₂ to determine a base line for the engine without the apparatus of the present invention attached. The engine exhaust flow was analyzed for these same components after passing the exhaust flow through the apparatus of the present invention. The VOCs were analyzed by EPA Method 25 (40 CFR Ch.1, Pt. 60, App. A). NO_x was analyzed using ion chromatography by EPA Method 7A (40 CFR Ch. 1, Pt. 60, App. A). Co and O₂ were analyzed using a Teledyne MAX 5 analyzer. The strength of the alternating current field was 7500 volts.

In this experiment, the resonance chamber used contained a wire grid taken from the HONEYWELL Model F50. The voltage passed through the resonance chamber was 7500 volts. The walls of the chamber were constructed of metal on two sides of metal and two sides of wood.

The electric arc collar used within this example was constructed of silicon carbide, and the electrodes were constructed of stainless steel. The voltage of current sent through the arc collar was 12,500 volts.

The concentration of the tested components in the exhaust flow without the application of the present invention were as follows:

<u>Species</u>	<u>Concentration</u>
VOC	141 ppm
NO _x	814 ppm
CO	293 ppm
O ₂	16.8%

The concentration of the tested components in the exhaust flow with application of the present invention were as follows:

<u>Species</u>	<u>Concentration</u>
VOC	0 ppm
NO _x	6 ppm
CO	87 ppm
O ₂	18.8%

The exhaust flow temperature across the invention also decreased an average of 575° F (from 700°-800°F to 100°-250°F).

From the foregoing, it will be appreciated that a substantial advantage of the pollutant control system of the present invention is that a single system can be used to control pollution from all noted controlled emissions and, albeit unknown to the applicant, possibly others. Additionally, high temperatures are not necessary, chemical preconditioning is not necessary, and no catalysts are necessary for the system to operate efficiently.

1 The present invention may be embodied in other
specific forms without departing from its spirit or
essential characteristics. The described embodiments are
5 to be considered in all respects only as illustrative and
not restrictive. The scope of the invention is, therefore,
indicated by the appended claims rather than by the
10 foregoing description. All changes which come within the
meaning and range of equivalency of the claims are to be
embraced within their scope.

What is claimed is:

15

20

25

30

35

1

1. A pollution control device comprising:

5

(a) means for subjecting an effluent gas flow to a simple harmonic resonance field such that ionization of the effluent gas occurs; and

10

(b) means for subjecting an effluent gas flow to a continuous electric arc such that the effluent gas is potentialized and purified.

15

2. A pollution control device as defined in claim 1, wherein the continuous electric arc is induced by an alternating current.

20

3. A pollution control device as defined in claim 1, wherein the means for subjecting an effluent gas flow to a simple harmonic resonance field comprises a resonance chamber through which an alternating current is passed, thereby creating a resonance field through which the effluent gas is passed.

25

30

4. A pollution control device as defined in claim 3, wherein the resonance chamber comprises a housing wherein at least two walls of the housing are constructed of a non-electrical conductive resonant material.

35

5. A pollution control device as defined in claim 1, wherein the means for subjecting an effluent gas flow to a simple harmonic resonance field comprises a resonance

1 chamber through which a sound is passed, thereby creating
a resonance field through which the effluent gas is passed.

5 6. A pollution control device as defined in claim 1,
wherein the means for subjecting an effluent gas flow to a
simple harmonic resonance field comprises a resonance
10 chamber through which a light is passed, thereby creating
a resonance field through which the effluent gas is passed.

7. A pollution control device as defined in claim 1,
15 wherein the means for subjecting an effluent gas flow to a
continuous electric arc comprises:

(a) an electric arc collar through which the
effluent gas is passed;

20 (b) a first electrode having an arc end and an
outside end, the first electrode being inserted into
the electric arc collar in such a way that the arc end
is positioned within the electric arc collar, and the
25 outside end is positioned outside the electric arc
collar; and

(c) a second electrode having an arc end and an
outside end, the second electrode being inserted into
30 the electric arc in such way that the arc end is
positioned within the electric arc collar, and the
outside end is positioned outside the electric arc
collar, the arc end of the second electrode being
35 positioned in proximity to the arc end of the first

1 electrode such that a continuous electric arc may be
created when a current is applied across the
electrodes.

5

8. A pollution control device as defined in claim 7,
wherein the electric arc collar comprises silicon carbide.

10

9. A pollution control device as defined in claim 7,
wherein the first and second electrodes comprise stainless
steel.

15

10. A pollution control device as defined in claim 7,
wherein the first and second electrodes comprise a nickel
alloy.

20

11. A pollution control device as defined in claim 1
further comprising means for regulating the velocity of the
effluent gas flow such that the amount of resistance within
25 the device is controlled.

12. A pollution control device as defined in
claim 11, wherein the means for regulating the velocity of
30 the effluent gas flow is a fan.

13. A pollution control device as defined in claim 1,
further comprising means for regulating the temperature of
35 the effluent gas flow.

1 14. A pollution control device as defined in
claim 13, wherein the means for regulating the temperature
of the effluent gas flow is a heat exchanger.

5

15 15. A pollution control device as recited in claim 1,
further comprising means for expanding the effluent gas
such that temperature, pressure, and velocity of the
effluent gas are decreased.

15 16. A pollution control device as recited in
claim 15, wherein the means for expanding the effluent gas
is an expansion chamber comprising:

(a) a housing through which the effluent gas is
passed;

20 (b) at least one baffle located within the
housing at a position substantially perpendicular to
the flow of the effluent gas as the effluent gas is
passed through the housing, the baffle comprising a
25 plate into which a series of holes is cut, the
effluent gas passing through the series of holes in
the baffle, thereby resulting in expansion of the gas.

30 17. A pollution control device as recited in
claim 16, wherein the expansion chamber comprises any
metallic material.

35

18. A pollution control device as recited in claim 16, wherein the expansion chamber comprises any non-metallic material.

19. A pollution control device as recited in claim 1 further comprising a means for continuously monitoring emissions and system efficiency wherein the range of measurement includes measurements below 10 parts per million.

20. A pollution control device comprising:

(a) a resonance chamber for ionizing an effluent gas by subjecting that effluent gas to a simple harmonic resonance field, the effluent gas being transported into the resonance chamber from an effluent gas source;

(b) an electric arc collar for potentializing ionized particles of an effluent gas such that the effluent gas is purified; and

(c) means for distributing the purified effluent gas back to the effluent gas source such that recycling of gas occurs.

21. A pollution control device as defined in claim 20, wherein the simple harmonic resonance field in the resonance chamber is generated by an alternating current.

1 22. A pollution control device as defined in
claim 20, wherein the simple harmonic resonance field in
the resonance chamber is generated by sound.

5

 23. A pollution control device as defined in
claim 20, wherein the simple harmonic resonance field in
the resonance chamber is generated by a light.

10

 24. A pollution control device as defined in
claim 20, wherein the continuous electric arc is created by
an alternating current.

15

 25. A pollution control device as defined in
claim 20, wherein the means for distributing the purified
effluent gas comprises a pipe connecting the discharge from
the electric arc collar to the effluent gas source in such
a way that all air entering the effluent gas source is
passed from the electric arc collar.

25

 26. A pollution control device comprising
 (a) means for subjecting an effluent gas flow to
a resonance field such that ionization of the effluent
gas occurs;

30

 (b) means for subjecting an effluent gas flow to
a continuous electric arc such that the effluent gas
is potentialized and purified;

35

1 (c) means for regulating the velocity of the effluent gas flow such that the amount of resistance within the device is controlled;

5 (d) means for expanding the effluent gas such that temperature, pressure, and velocity of the effluent gas are decreased; and

10 (e) means for regulating the temperature of the effluent gas flow.

27. A pollution control device as defined in
15 claim 26, wherein the means for subjecting an effluent gas flow to a continuous electric arc comprises:

(a) an cylindrical electric arc collar through which the effluent gas is passed;

20 (b) a first electrode having an arc end and an outside end, the first electrode being inserted into the electric arc collar in such a way that the arc end is positioned within the electric arc collar, and the
25 outside end is positioned outside the electric arc collar; and

30 (c) a second electrode having an arc end and an outside end, the second electrode being inserted into the electric arc in such a way that the arc end is positioned within the electric arc collar, and the outside end is positioned outside the electric arc collar, the arc end of the second electrode being
35 positioned in proximity to the arc end of the first

electrode such that a continuous electric arc may be created when a current is applied across the electrodes.

28. A pollution control device as recited in claim 26, wherein the means for expanding the effluent gas is an expansion chamber comprising:

(a) a housing through which the effluent gas is passed;

(b) at least one baffle located within the housing at a position substantially perpendicular to the flow of the effluent gas as the effluent gas is passed through the housing, the baffle comprising a plate into which a series of holes is cut, the effluent gas passing through the series of holes in the baffle, thereby resulting in expansion of the gas.

29. A pollution control device as defined in claim 26, wherein the means for regulating the temperature of the effluent gas flow is a heat exchanger.

30. A pollution control device as recited in claim 26, further comprising a means for continuously monitoring emissions and system efficiency wherein the range of measurement includes measurements below 10 parts per million.

31

1 31. A method for chemically reducing pollutants in an
effluent gas flow comprising the steps of:

5 (a) passing the effluent gas flow through a
resonance field, thereby ionizing the effluent gas;
and

10 (b) passing the effluent gas flow through a
continuous electric arc, thereby potentializing and
purifying the effluent gas such that the remaining
discharge is free of pollutant materials.

15 32. A method for reducing pollutants in an effluent
gas flow as recited in claim 31, wherein the continuous
electric arc is generated by an alternating current.

20 33. A method for reducing pollutants in an effluent
gas flow as recited in claim 31, further comprising the
step of regulating the flow velocity of the effluent gas
flow.

25

30 34. A method for reducing pollutants in an effluent
gas flow as recited in claim 31, further comprising the
step of regulating the temperature of the effluent gas
flow.

35

1/5

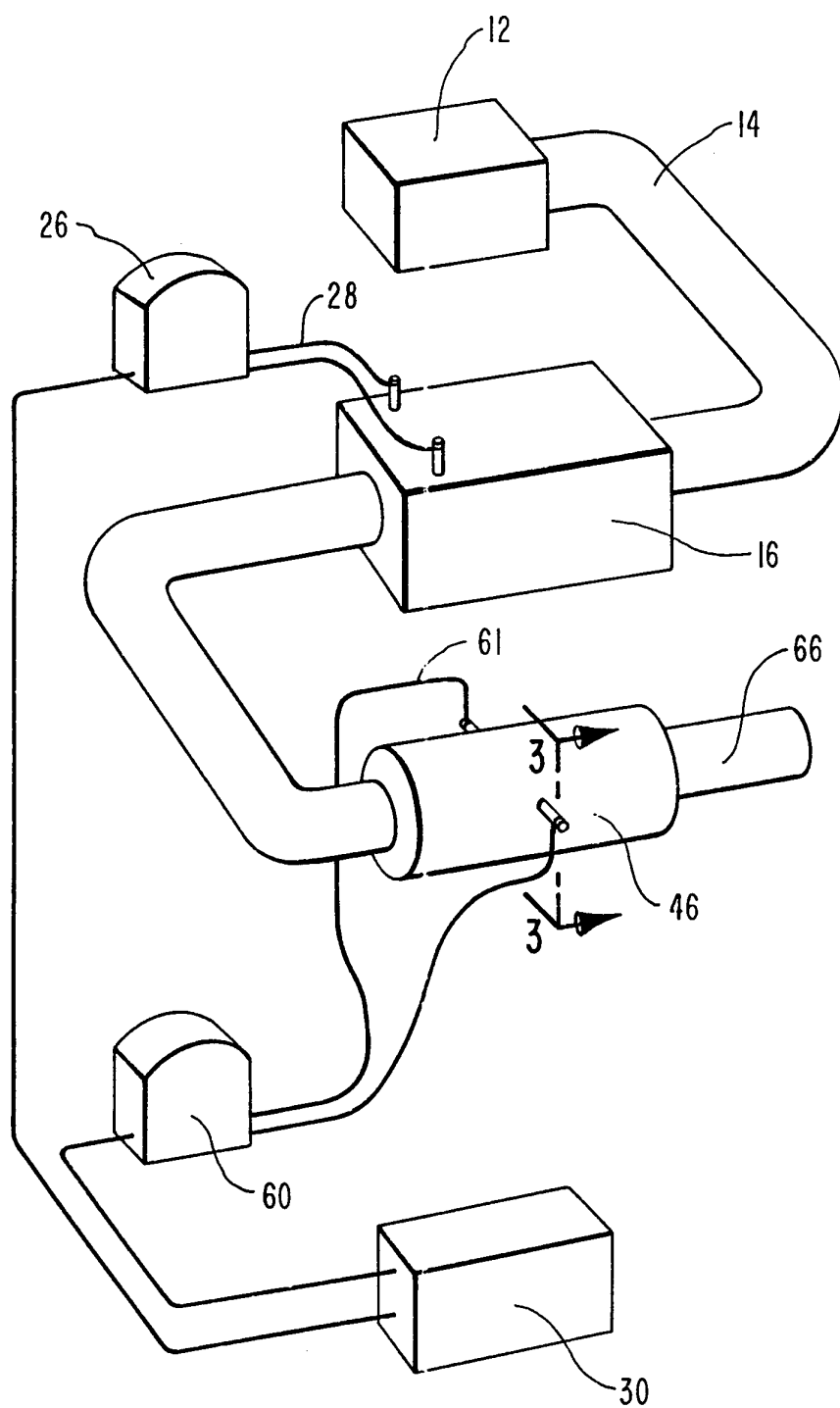


FIG. 1

2/5

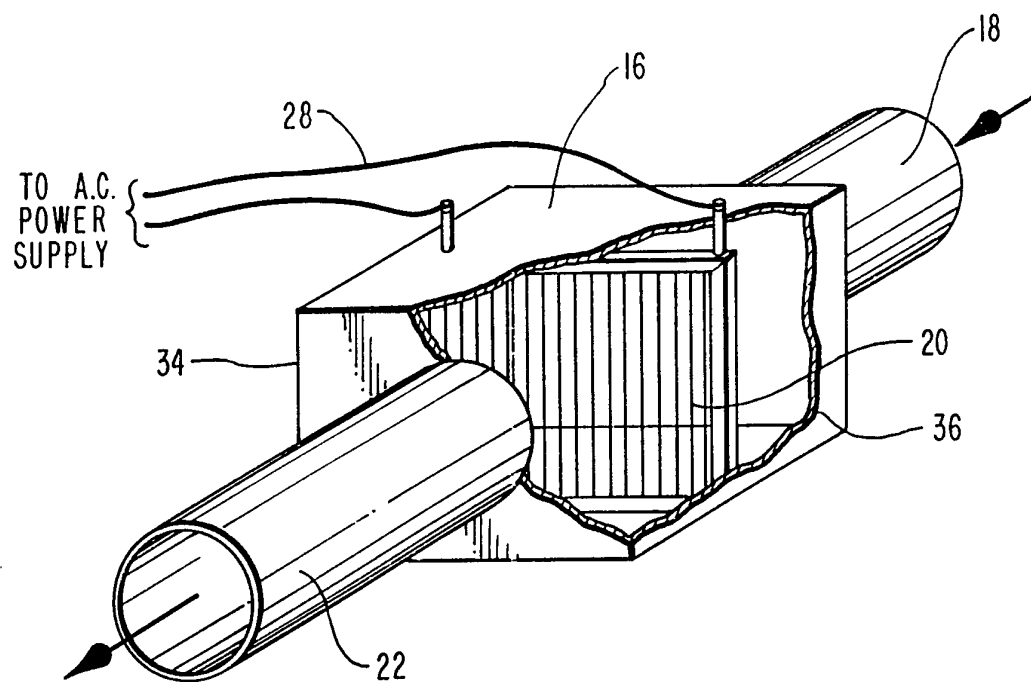


FIG. 2

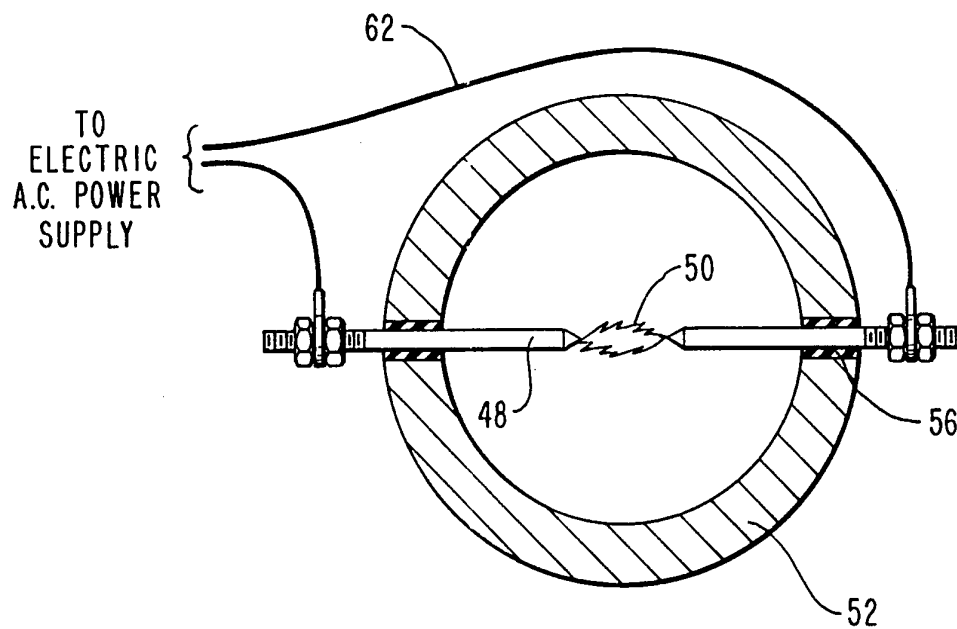


FIG. 3

3/5

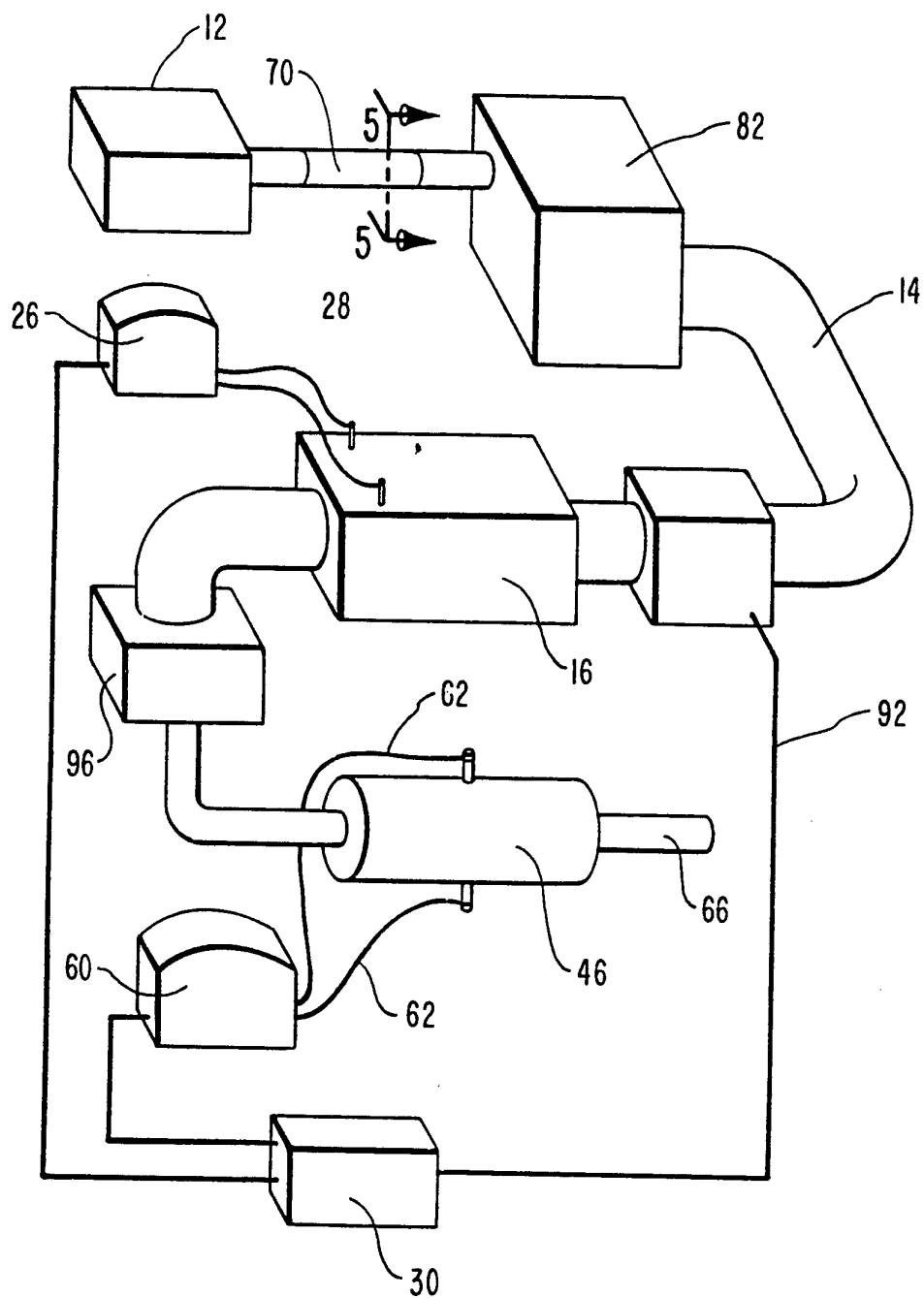


FIG. 4

4/5

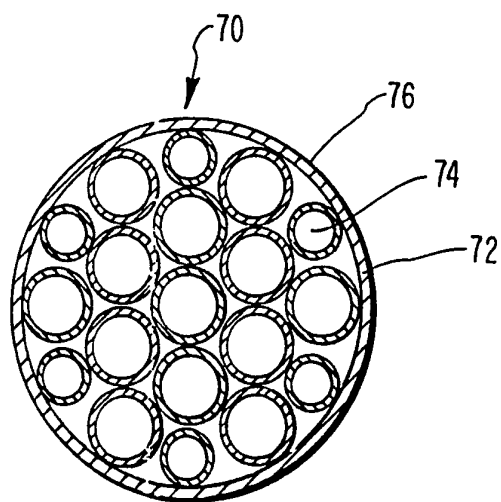


FIG. 5

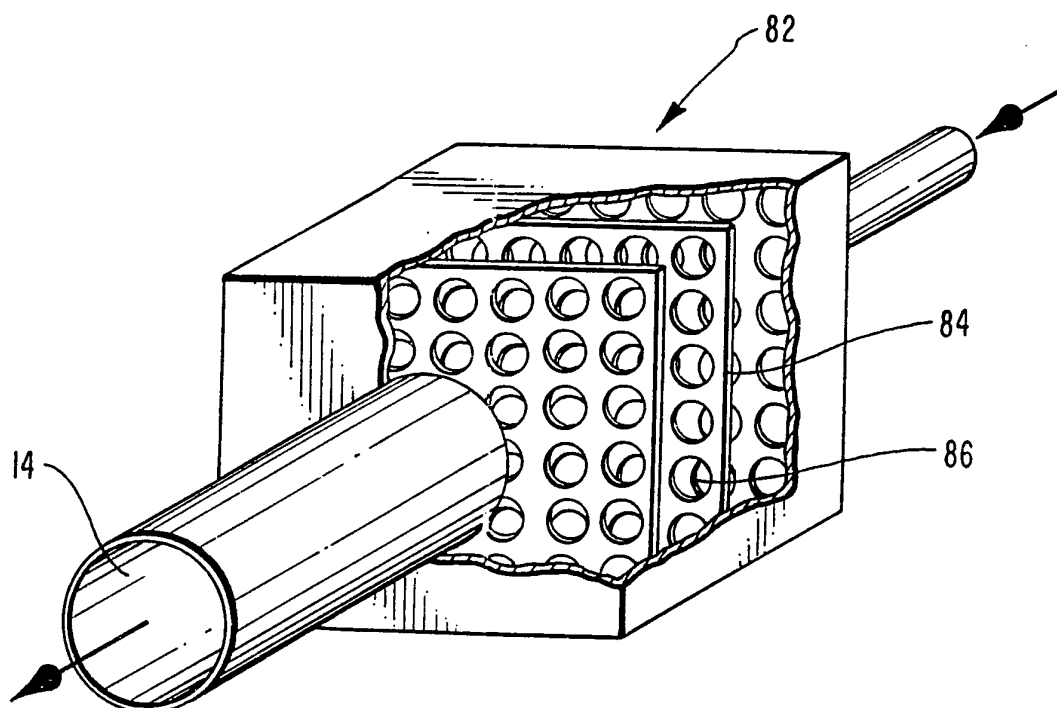


FIG. 6

5/5

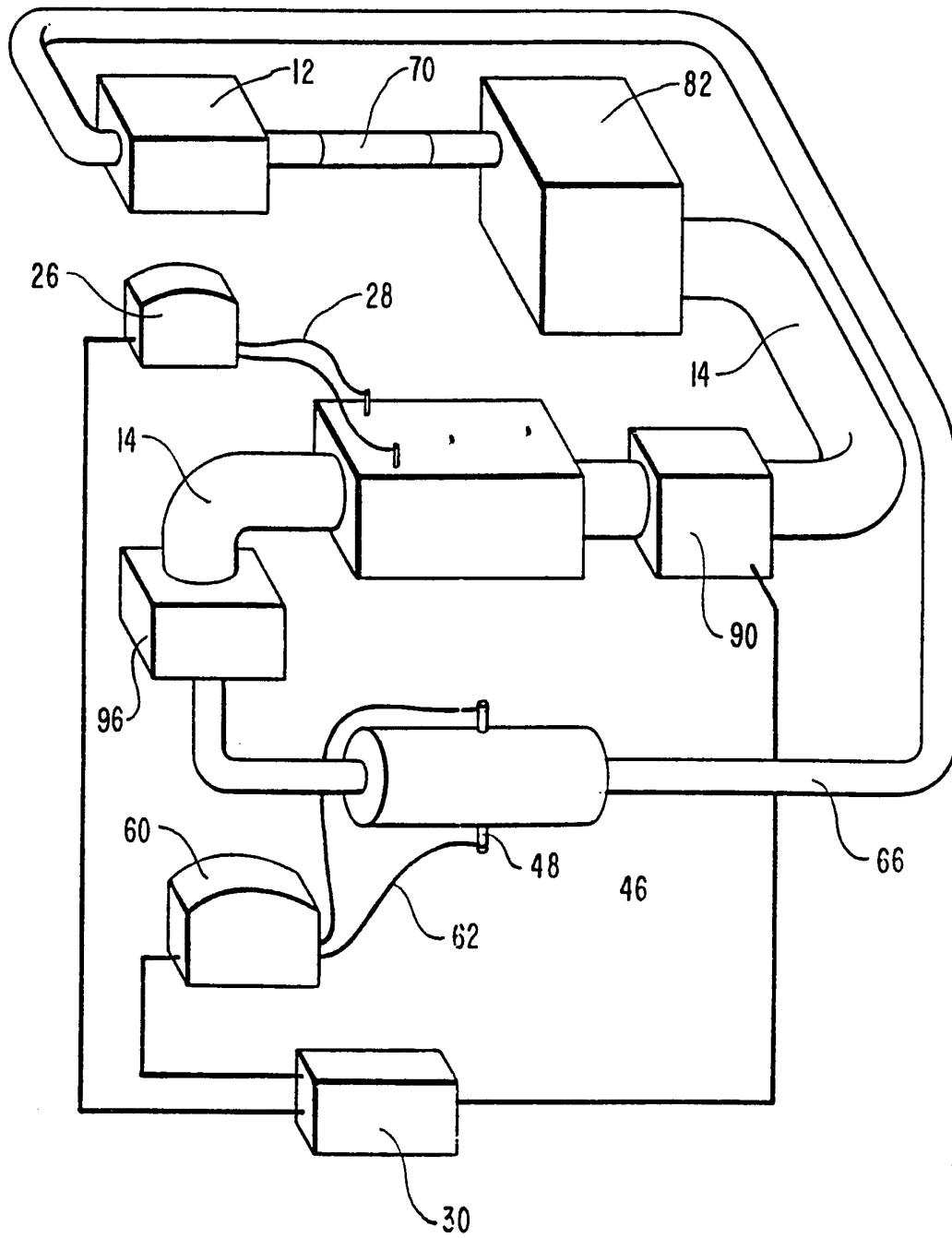


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US92/09880

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) : B01J 19/08,19/10,19/12; F01N 3/24,3/26,3/38

US CL : 422/186.21; 60/275

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. : 422/186,186.01,186.03,186.21,186.23; 60/275,278,282

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.
Y	US, A, 4,376,637 (YANG) 15 March 1983, See abstract; col. 2, lines 14-15,24-25,29-33,64-68; col. 3, lines 61-68; col 4, lines 1-8; col. 5, lines 26-27; col. 6, lines 45-50, lines 65-66; col.7, lines 35-39, 49-54; col. 9, lines 14-26.	1-34
A	US, A, 4,361,423 (NITZ) 30 November 1982, See Abstract, lines 4-9; col. 2, lines 40-44.	1-34
Y	US, A, 4,077,889 (RHOADES) 07 March 1978, See Abstract, col. 1, lines 54-60; col. 2, lines 60-68; col. 3; col. 4.	1-34

☒ 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
E earlier document published on or after the international filing date	*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
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)	*Z* 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	Date of mailing of the international search report
---	--

15 APRIL 1993

22 APR 1993

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Authorized officer

DANIEL JENKINS

Facsimile No. NOT APPLICABLE

Telephone No. (703) 308-0436

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US92/09880

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 3,846,637 (GETTINGER) 05 November 1974, See Abstract, col. 1, lines 35-68; col. 2, lines 1-68.	1-34
Y	US, A, 1,495,563 (RANKIN) 27 May 1924, See lines 9-15, 56-60.	1-34
Y	US, A, 1,332,730 (KOEHLER) 02 March 1920, See page 2, lines 1-11.	1-34
Y	US, A, 1,033,126 (SIEBERT) 23 July 1912, See page 1, lines 18-19.	1-32
A	US, A, 5,078,917 (HENKEL) 14 January 1992, See col. 1, lines 13-19.	1-32
Y	US, A, 3,825,480 (PELOFSKY ET AL.) 23 July 1974, See col. 1, lines 55-58; col. 4, lines 62-75; col. 5, lines 1-75.	1-32
A	US, A, 3,979,193 (SIKICH) 07 September 1976, See Abstract.	1-32
Y	US, A, 4,069,665 (BOLASNY) 24 January 1978, See col. 1, lines 64-69; col. 2, lines 1-14.	1-32
Y	US, A, 4,376,637 (YANG) 15 March 1983, See col. 2, lines 1-66.	1-32
Y	US, A, 4,441,971 (ISHIGURO ET AL.) 10 April 1984, See col. 1, lines 55-68; col. 2, lines 1-35.	1-32
A	US, A, 3,228,755 (LOTTINVILLE) 11 January 1966.	1-32

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US92/09880

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 3,285,709 (ENNARINO ET AL.) 15 November 1966, See col. 3, lines 60-66; col. 4, lines 1-2.	1-32
Y	US, A, 3,587,210 (SHRINER) 28 June 1971, See col. 1, lines 19-50; col. 2, lines 68-75.	1-32
Y	US, A, 3,623,295 (SHRINER) 30 November 1971, See col. 1, lines 32-67; col. 2, lines 50-72.	1-32