629740

FORM 1

REGULATION 9

COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952

APPLICATION FOR A STANDARD PATENT

We, THE BOC GROUP, INC., a corporation organised under the laws of the State of Delaware, United States of America, of 575 Mountain Avenue, Murray Hill, New Providence, New Jersey 07974, United States of America, hereby apply for the grant of a Standard Patent for an invention entitled:-

"ECONOMICAL AIR SEPARATOR"

which is described in the accompanying Complete Specification.

Details of basic application:-

Number: 07/498,078

Country: United States of America

Date: 23rd March 1990

Our address for service is: SHELSTON WATERS
55 Clarence Street
SYDNEY, N.S.W. 2000.

DATED this 15th Day of March, 1991
THE BOC GROUP, INC.

by

Fellow Institute of Patent Attorneys of Australia

To: The Commissioner of Patents
WODEN A.C.T. 2606

File: D.B. B-370

Fee: $241.00

6020576 15/03/91

CONVENTION APPLICATION BY A COMPANY

FORM 8 – REGULATION 12 (2)

AUSTRALIA
PATENTS ACT 1952

DECLARATION IN SUPPORT OF A CONVENTION APPLICATION FOR A PATENT

In support of the Convention Application made by .....

(a) Here Insert (In full) Name of Company.

(a) The BOC Group, Inc.

(hereinafter referred to as "Applicant") for a patent for an invention entitled:

(b) Here Insert Title of Invention.

(b) ECONOMICAL AIR SEPARATOR

(c) and (d) Here Insert Full Name and Address of Company Official authorised to make declaration.

I, (c) Robert I. Pearlman

of (d) The BOC Group, Inc.
575 Mountain Avenue, Murray Hill, New Providence, New Jersey 07974
United States of America

do solemnly and sincerely declare as follows:

1. I am authorised by Applicant to make this declaration on its behalf.

(e) Here Insert Basic Country followed by date of Basic Application.

(f) Here Insert Full Name(s) of Applicant(s) in Basic Country.

2. The basic Application(s) as defined by section 141 of the Act was / were made

in (e) United States on the 23rd day of March 19 90

by (f) Robert C. Gmelin and Alberto I. LaCava

in ..... on the ..... day of 19

by .....

in ..... on the ..... day of 19

by .....

in ..... on the ..... day of 19

by .....

(g) Here Insert (In full) Name and Address of actual Inventor or Inventors.

3. (g) Robert C. Gmelin of 15 Norman Place, Cranford, New Jersey 07016
Alberto I. LaCava of 2201 Orchard Drive, South Plainfield, New Jersey 07080

..... is/are the actual Inventor(s) of the invention and the facts upon which Applicant is entitled to make the Application are as follows: The Applicant is the Assignee of the Actual Inventors by virtue of an Assignment dated March 22, 1990.

See reverse side of this form for guidance in completing this part.

4. The basic Application(s) referred to in paragraph 2 of this Declaration was/were the first Application(s) made in a Convention country in respect of the invention, the subject of the Application.

DECLARED at Murray Hill, New Providence, New Jersey, U.S.A.

this 25th day of February, 1991

By: Robert I. Pearlman, Group Counsel
Patents, Trademarks & Licensing

(h) Personal Signature of Declarant (c) (no seal, witness or legalisation).

(h) .....
(Signature of Declarant)

(12) PATENT ABRIDGMENT (11) Document No. AU-B-73597/91
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 629740

(54) Title
ECONOMICAL AIR SEPARATOR

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(57) Claim

1. A process for pressure swing adsorption in a system having an adsorption column of kinetic zeolite with an inlet and an outlet and adapted to adsorb oxygen from a feed stream of pressurized air passing from the inlet to the outlet to produce a stream of nitrogen at the outlet, said process comprising the steps of:

(a) introducing the feed stream of air into the inlet of the adsorption column at a predetermined pressure to pass the feed stream of air through the adsorption column to leave the adsorption column outlet as essentially pure nitrogen;

(b) providing a two position valve upstream of the inlet of the adsorption column having a first position where the feed stream of air passes through the valve to the inlet of the adsorption column and a second

.../2

position where the feed stream of air is blocked and the inlet of the adsorption column is depressurized;

(c) providing a valve means in the flow of nitrogen leaving the adsorption column outlet to prevent reverse flow of nitrogen back toward the adsorption column outlet;

(d) periodically changing the position of the two position valve at predetermined time intervals between the first and second positions to alternatively produce nitrogen from the adsorption column outlet and vent the adsorption column inlet to atmosphere, wherein the predetermined pressure is at least 20 psig.

9. A pressure swing adsorption system comprising:

(a) an adsorption column containing kinetic zeolite, said adsorption column having an inlet and an outlet and adapted to separate oxygen from a feed stream of air having a predetermined pressure passing through the adsorption column from said inlet to said outlet to produce a stream of nitrogen at the outlet;

(b) reservoir means for receiving the nitrogen leaving said adsorption column outlet;

(c) valve means located in the flow of nitrogen from said adsorption column outlet to prevent the return flow of nitrogen toward said adsorption column outlet;

(d) two position valve means in the flow of feed stream of air upstream of said inlet of said adsorption

column, said two position valve means having a first position where the feed stream of air passes through said two position valve means to said inlet of said adsorption column and a second position wherein said feed stream of air is blocked and said inlet of said adsorption column is vented to atmosphere through said two position valve means;

(e) timer means adapted to move said two position valve means at predetermined time intervals between said first and said second positions to alternatively produce the nitrogen stream from said outlet of said adsorption column and vent the inlet of said adsorption column to atmosphere, wherein the predetermined pressure is at least 20 psig.

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COMMONWEALTH OF AUSTRALIA

FORM 10

PATENTS ACT 1952

COMPLETE SPECIFICATION

FOR OFFICE USE:

Class Int.Class

Application Number:
Lodged:

Complete Specification Lodge
Accept
Publish

Priority:

Related Art:

Name of Applicant: THE BOC GROUP, INC.

Address of Applicant: 575 Mountain Avenue, Murray Hill, New Providence, New Jersey 07974, United States of America

Actual Inventor: Robert C. Gmelin and Alberto I. LaCava

Address for Service: SHELSTON WATERS, 55 Clarence Street, Sydney

Complete Specification for the Invention entitled:

"ECONOMICAL AIR SEPARATOR"

The following statement is a full description of this invention, including the best method of performing it known to us:-

ECONOMICAL AIR SEPARATOR

BACKGROUND OF THE INVENTION

This invention relates to an air separation system that is used to obtain a relatively pure stream of nitrogen from a feed stream of air under pressure in a pressure swing adsorption cycle.

There are, today, many methods and corresponding apparatus for carrying out the process of pressure swing adsorption or PSA. In the use of PSA technology, a stream of gas, normally air, is separated into one of its components by passing that air over a bed of adsorptive material.

Most systems include the use of two or more adsorption beds or columns and which are taken through various steps of pressurization, adsorption, depressurization and regeneration, in many sequences of steps. Such systems can be fairly complex in construction and operation and the associated timing steps, valve operation and sequencing can be considerably costly and difficult to construct. Typical examples of such systems include those shown and described in U.S. Patent 3,086,339 Skarstom showing a three bed system, U.S. 3,891,411 with a two bed system and recently issued U.S. Patent 4,892,566, Bansel et al utilizing a single bed system. Separation of nitrogen from air is also disclosed in the AIChE Journal, April 1987, Vol. 33, No. 4, pages 654-662.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a system and process for pressure swing adsorption which overcomes, or at least ameliorates, the disadvantages of the prior art.

In a first aspect the present invention provides a process for pressure swing adsorption in a system having an adsorption column of kinetic zeolite with an inlet and an outlet and adapted to adsorb oxygen from a feed stream of pressurized air passing from the inlet to the outlet to produce a stream of nitrogen at the outlet, said process comprising the steps of:

(a) introducing the feed stream of air into the inlet of the adsorption column at a predetermined pressure to pass the feed stream of air through the adsorption column to leave the adsorption column outlet as essentially pure nitrogen;

(b) providing a two position valve upstream of the inlet of the adsorption column having a first position where the feed stream of air passes through the valve to the inlet of the adsorption column and a second position where the feed stream of air is blocked and the inlet of the adsorption column is depressurized;

(c) providing a valve means in the flow of nitrogen leaving the adsorption column outlet to prevent reverse flow of nitrogen back toward the adsorption column outlet;

(d) periodically changing the position of the two position valve at predetermined time intervals between the first and second positions to alternatively produce nitrogen from the adsorption column outlet and vent the adsorption column inlet to atmosphere, wherein the predetermined pressure is at least 20 psig.

In a second aspect, the invention provides a pressure swing adsorption system comprising:

(a) an adsorption column containing kinetic zeolite, said adsorption column having an inlet and an outlet and adapted to separate oxygen from a feed stream of air having a predetermined pressure passing through the adsorption column from said inlet to said outlet to produce a stream of nitrogen at the outlet;

(b) reservoir means for receiving the nitrogen leaving said adsorption column outlet;

(c) valve means located in the flow of nitrogen from said adsorption column outlet to prevent the return flow of nitrogen toward said adsorption column outlet;

(d) two position valve means in the flow of feed stream of air upstream of said inlet of said adsorption column, said two position valve means having a first position where the feed stream of air passes through said two position valve means to said inlet of said adsorption column and a second position wherein said feed stream of air is blocked and said inlet of said adsorption column is vented to atmosphere through said two position valve means;

(e) timer means adapted to move said two position valve means at predetermined time intervals between said first and said second positions to alternatively produce the nitrogen stream from said outlet of said adsorption column and vent the inlet of said adsorption column to atmosphere, wherein the predetermined pressure is at least 20 psig.

The system includes a single adsorption column containing a kinetic zeolite sieve material. In the context of this disclosure, a kinetic zeolite is one that performs a separation by discriminating between components due to the difference of adsorption rates of each component. The intrinsic mechanism of such discrimination could be pore diffusivity, surface diffusivity, crystalite diffusivity, or surface adsorption kinetics. The zeolite covered in this disclosure adsorbs N_2 with a half time in the order of ten (10) seconds. Oxygen is adsorbed at a much faster rate.

In preferred embodiments, the single adsorption column is charged with the air at a pressure in excess of 20 psig through a three way solenoid valve. The valve itself is a readily commercially available valve from a number of sources. A simple solid state electronic timer controls the valve position between a first position where the feed stream is delivered through the valve to the inlet of a adsorption column and a second position where the feed stream is blocked and the valve vents the

inlet side of the adsorption column to atmosphere. A check valve is also provided in the outlet line from the adsorption column.

By the use of the molecular sieve material, an extremely short duty cycle can be employed to alternatively deliver a nitrogen product stream from pressurized air passing through the adsorption column and to back flow the column to depressurize the same through its inlet.

All of the components of the present air separation system including the zeolite sieve material can be readily purchased from various commercial sources. Accordingly, a relatively compact air separator can be assembled and operated as a low cost, simple operation.

These and other advantages and features of the present invention will be more readily understood from the detailed description of the preferred embodiment set forth below taken in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG 1 is a schematic view of the overall process and equipment used in carrying out the subject invention; and

FIG 1A is a schematic view of a portion of the FIG 1 equipment with its solenoid valve in the alternate position.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG 1, there is shown a schematic of the process and apparatus for carrying out air separation by means of the present invention.

As shown in FIG 1, an inlet 10 is provided to an inlet conduit 12 which receives the feed stream air. The air is under a predetermined pressure of between about 20 psig to about 100 psig and preferably at a pressure of about 60 psig. Due to the range of pressures, conduit 12 may be of relatively inexpensive polyvinyl chloride (PVC) pipe having a rupture pressure rating of at least 220 psig.

A three way solenoid valve 14 is provided at the downstream end of conduit 12 and has a through passage 16 and a radial passage 18 normal to the through passage 16. Solenoid valve 14 is electrically operated between two positions, the first of which is depicted in FIG 1 and the second of which is depicted in FIG 1A, the purpose of which will be later explained.

Various, if not many, commercially available three way solenoid valves may be used, however, one typical valve is the Humphrey 125E1 solenoid valve operating on 240 volts AC and, for purposes of this description, its ports will be referred to as inlet port 20, outlet port 22 and vent port 24. As may be seen, the inlet conduit 12 is connected

to inlet port 20 of solenoid valve 14 while vent port 24 is connected to a vent conduit 26 that is open at its end. The third port, outlet port 22 is connected to a further conduit 28 that joins that port to the adsorption column 30 by means of a column inlet 32.

An electronic timer 33 is used to control the position and sequence timing between the two positions of solenoid valve 14. The electronic timer 34 again, can be one of many commercially available timers, one that has been found suitable is a NCC Q6F-00060-321 timer available from National Controls Company.

Depending upon the source of pressurized feed air, a further tank may be employed upstream of the solenoid valve 14 to act as a reservoir to smooth out pressure fluctuations in the feed air supply and to stabilize the pressure of the feed stream. That tank is not shown, however, a conventional commercially available reservoir tank may be used.

The adsorption column 30 is a standard column and, as will be shown in the example, a compact air separation system can use an adsorption column 30 having a capacity of about one liter. Within the adsorption column 30 is provided the sieve material 34.

The sieve material is a kinetic zeolite product, one of which being designated RS-10 commercially available from The Union Carbide Company. Other kinetic zeolites may be used, however, and one other zeolite which is very effective is zeolite 4A available also from the Union Carbide Company after being crushed to 10-40 mesh size and thermally treated at 350°C.

In the preferred embodiment, the adsorption column 30 is divided into two sections with about 90% containing the kinetic zeolite 34 with about 10% containing alumina 36 directly adjacent the column inlet 32. The alumina 36 is utilized to dry the incoming feed air in order to prevent moisture from contaminating the kinetic zeolite 34. A felt layer 38, in the order of .025 inches can be used to separate the kinetic zeolite 34 from the alumina 36. Alternatively, a wire screen or other separation may be used to isolate the alumina from the zeolite while

allowing the flow of gas.

Obviously, while for compactness, it is preferred to include the alumina 36 within the adsorption column 30, its function is merely to dry the feed air and therefore other means of drying the air may be used, such as a separate dryer further upstream of the adsorption column 30 or there may be locations or supplies of pressurized air that is already sufficiently dry so as to not affect the zeolite.

A column outlet 40 is provided in adsorption column 30 and connects to outlet conduit 42 to a buffer or product reservoir 44 and again, the use of the product reservoir 44 is merely to smooth out surges of flow and/or pressure fluctuations to provide a product stream of relatively constant flow and pressure.

A check valve 46 is provided in outlet conduit 42 downstream from column outlet 40 and prevents the flow of gas in a reverse direction, that is, toward the column outlet 40.

As a further component, a pressure regulator or valve 48 is used downstream of the product reservoir 44 to provide a gas to the end user at the desired conditions.

The operation of the compact air separation unit is thus as follows. The adsorption column 30 is pressurized by the feed air entering inlet conduit 12 via inlet 10. The electronic timer 34 has positioned the solenoid valve 14 in its position shown in FIG 1 such that the feed air passes directly through solenoid valve 14 by through passage 16 and enters and passes through the adsorption column 30 via its column inlet 32 and column outlet 40 respectively. The pressure of the air feed may be within the range of from about 20 psig to about 100 psig with a preferred pressure of about 60 psig.

During passage through adsorption column 30, the oxygen is, of course, separated from the air stream and the product entering outlet conduit 42 is almost entirely nitrogen. That product nitrogen thereupon passes through the check valve 46 and accumulates within product reservoir 44 before being transported to its end use through regulator 48.

After a predetermined extremely short cycle of the feed air passing through adsorption column 30, the electronic timer 34 signals solenoid valve 14 thereby changing its position to that shown in FIG 1A. In the FIG 1A position of the solenoid valve 14, the feed stream is cut off since the inlet conduit dead ends at inlet 20 of solenoid valve 14. Meanwhile, the residual pressure and feed air within adsorption column 30 is vented to atmosphere since the outlet 22 of solenoid valve 14 is open to the vent conduit 26 through passage 16 and a section of through passage 16. Since check valve 46 prevents product nitrogen contained within product reservoir 44 from flowing in a reverse direction back into the adsorption column 30, that adsorption column 30 undergoes depressurization and a reverse flow of feed air remaining therein progresses toward and out of vent conduit 26, thus returning adsorption column 30 to atmosphere pressure.

At the end of a second predetermined time period, electronic timer 34 signals solenoid valve 14 and solenoid valve 14 returns to its position depicted in FIG 1 to again commence the introduction of feed air into the adsorption column to produce nitrogen product stream.

The timing cycle is relatively critical in operation of the present air separation system in that the product cycle, that is where the solenoid valve 14 is in the FIG 1 position, and the vent cycle, where the solenoid valve 14 is in the FIG 1A position, must be relatively rapid.

Preferably the product cycle time is from about 4 seconds to 15 seconds, since the continued product cycle for time in excess of about 15 seconds results in oxygen leaving the adsorption column into the outlet conduit 42. The preferred time for the product cycle is about 10 seconds. The vent cycle is also relatively rapid and preferably is from 4 seconds to 15 seconds, however, it is obviously less critical than the product cycle since its function is to vent the adsorption column 30 and create a reverse flow of air and partially separated air out the vent conduit 26.

It is preferred, however, for cycle efficiency that the vent

cycle be about the same time as the product cycle time, that is from 4 to 15 seconds and preferably about 10 seconds.

The simplicity and compactness of the separation system is exemplified by the lack of a need for a separate pressurization cycle or purge cycle, typically used in various PSA systems.

The product cycle time is so rapid that the pressure builds up almost immediately merely by the pressure of the feed air and depressurization is also rapidly accomplished.

EXAMPLES

EXAMPLE 1

This example illustrates the cycle times and inlet pressures used in Applicants economical air separator. Inexpensive PVC piping was used throughout. The absorption column was a one liter size and filled with about 585 grams of RS-10 kinetic zeolite or approximately .85 liters and the remaining volume filled with alumina.

The runs obtained the data in the following table.

TABLE 1

Inlet Press (PSIG)	Product Flow (liters/min)	Cycle Time Product/Vent (seconds)	O_2 in Product (%)
75	1.1 l/m	10/10	0.55%
60	0.9	10/10	.5%
50	0.8	10/10	.46%
45	0.7	10/10	.44%
40	0.5	10/10	.44%
35	0.4	10/10	.46%
30	0.3	10/10	.52%
30	0.3	8/8	.46%
35	0.4	7/7	.4%
40	0.5	7/7	.4%
50	0.8	7/7	.44%
60	0.9	7/7	.47%
60	0.9	5/5	.60%
80	1.1	8/8	.64%
60	0.5	12/12	.84%

The preferred results were obtained with cycle times of seven seconds product cycle and seven seconds vent cycle and an inlet pressure of about 60 psig and product flow of 0.9 liters per minute. The product included .47% of oxygen.

EXAMPLE 2

Equipment as in example 1. The one liter bed was filled with 0.85 liters of Union Carbide 4A Molecular Sieve. The remaining volume was filled with Alumina.

The results of the runs are given below in Table 2.

TABLE 2

Inlet Pressure (PSIG)	Product Flow (liters/min)	Cycle Time Product/Vent (seconds)	O_2 in Product (%)
70	1.75	10/10	0.95
70	1.80	10/10	1.0
70	2.00	10/10	1.3
70	2.13	10/10	1.5
70	2.40	10/10	1.65

EXAMPLE 3

Equipment as in example 1. The bed is filled with 0.85 liters of a zeolite prepared by crushing 4A molecular sieve pellets to 20-40 mesh and by regenerating at 350° C overnight under N_2 stream. The remaining volume of the bed is filled with alumina. The results of the runs are given below in Table 3.

TABLE 3

Inlet Pressure (PSIG)	Product Flow (liters/min)	Cycle Time Product/Vent (seconds)	O_2 in Product (%)
70	2.75	10/10	1.2
70	2.43	10/10	1.0
70	1.8	10/10	0.5
70	1.05	10/10	0.2
70	0.68	10/10	0.1

The preferred range of results included cycle times from five seconds product/vent cycles to twelve seconds product/vent cycles and inlet pressures between about 30 psig to about 80 psig.

Thus, the present air separation unit provides a relatively low cost, simple construction, yet obtains a useful nitrogen product stream of sufficient purity for various end uses. The unit is compact in size and can even be wall mounted on site, is relatively trouble free with few components and minimum maintenance.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. A process for pressure swing adsorption in a system having an adsorption column of kinetic zeolite with an inlet and an outlet and adapted to adsorb oxygen from a feed stream of pressurized air passing from the inlet to the outlet to produce a stream of nitrogen at the outlet, said process comprising the steps of:

(a) introducing the feed stream of air into tne inlet of the adsorption column at a predetermined pressure to pass the feed stream of air through the adsorption column to leave the adsorption column outlet as essentially pure nitrogen;

(b) providing a two position valve upstream of the inlet of the adsorption column having a first position where the feed stream of air passes through the valve to the inlet of the adsorption column and a second position where the feed stream of air is blocked and the inlet of the adsorption column is depressurized;

(c) providing a valve means in the flow of nitrogen leaving the adsorption column outlet to prevent reverse flow of nitrogen back toward the adsorption column outlet;

(d) periodically changing the position of the two position valve at predetermined time intervals between the first and second positions to alternatively produce nitrogen from the adsorption column outlet and vent the adsorption column inlet to atmosphere, wherein the predetermined pressure is at least 20 psig.

2. The process of claim 1 wherein the predetermined pressure of the feed stream is from 30 psig to 80 psig.

3. The process of claim 1 wherein the predetermined pressure of the feed stream is 60 psig.

4. The process of claim 1 wherein the step of periodically changing the position of the two position valve comprises allowing said two position valve means to be in its first position for a period of between 4 and 15 seconds and in its second position for a period of between 4 and 15 seconds.

5. The process of claim 4 wherein said step of periodically changing the position of the two position valve comprises allowing said two position valve to be in its first and second positions for about the same time period.

6. The process of claim 5 wherein said time period is ten seconds.

7. The process of claim 1 wherein said adsorption column additionally contains a water absorbent material at or near its inlet.

8. The process of claim 1 wherein said step of periodically changing the position of the two position valve comprises said position every seven seconds and said predetermined pressure of the feed stream is 60 psig.

9. A pressure swing adsorption system comprising:

(a) an adsorption column containing kinetic zeolite, said adsorption column having an inlet and an outlet and adapted to separate oxygen from a feed stream

of air having a predetermined pressure passing through the adsorption column from said inlet to said outlet to produce a stream of nitrogen at the outlet;

(b) reservoir means for receiving the nitrogen leaving said adsorption column outlet;

(c) valve means located in the flow of nitrogen from said adsorption column outlet to prevent the return flow of nitrogen toward said adsorption column outlet;

(d) two position valve means in the flow of feed stream of air upstream of said inlet of said adsorption column, said two position valve means having a first position where the feed stream of air passes through said two position valve means to said inlet of said adsorption column and a second position wherein said feed stream of air is blocked and said inlet of said adsorption column is vented to atmosphere through said two position valve means;

(e) timer means adapted to move said two position valve means at predetermined time intervals between said first and said second positions to alternatively produce the nitrogen stream from said outlet of said adsorption column and vent the inlet of said adsorption column to atmosphere, wherein the predetermined pressure is at least 20 psig.

10. A pressure swing adsorption system as defined in claim 9 wherein said predetermined pressure of said feed stream of air is from 30 psig to 80 psig.

11. A pressure swing adsorption system as defined in

claim 10 wherein said predetermined pressure of said feed stream of air is 60 psig.

12. A pressure swing adsorption system as defined in claim 9 wherein said timer means retains said two position valve means in its first position for 4 to 15 seconds and in its second position for 4 to 15 seconds.

13. A pressure swing adsorption system as defined in claim 12 wherein said timer means retains said two position valve means in its first and second positions for a period of ten seconds.

14. A pressure swing adsorption system as defined in claim 1 wherein said two position valve means comprises a solenoid valve and said valve means in the flow of nitrogen from said adsorption column outlet comprises a check valve.

15. A pressure swing adsorption system as defined in claim 1 wherein said adsorption column also contains a water adsorbent material at or near its inlet.

16. A pressure swing adsorption system as defined in claim 15 where said water adsorbent material is alumina and is separated from the kinetic zeolite by a mesh screening material.

17. A pressure swing adsorption system as defined in claim 1 wherein said predetermined pressure of the feed stream of air is 60 psig and said timer means moves said two position valve between its first and second positions alternatively at ten second intervals.

18. A pressure swing adsorption system substantially as herein described with reference to Figures 1 and 1A of the accompanying drawings.

DATED this 11th day of August, 1992

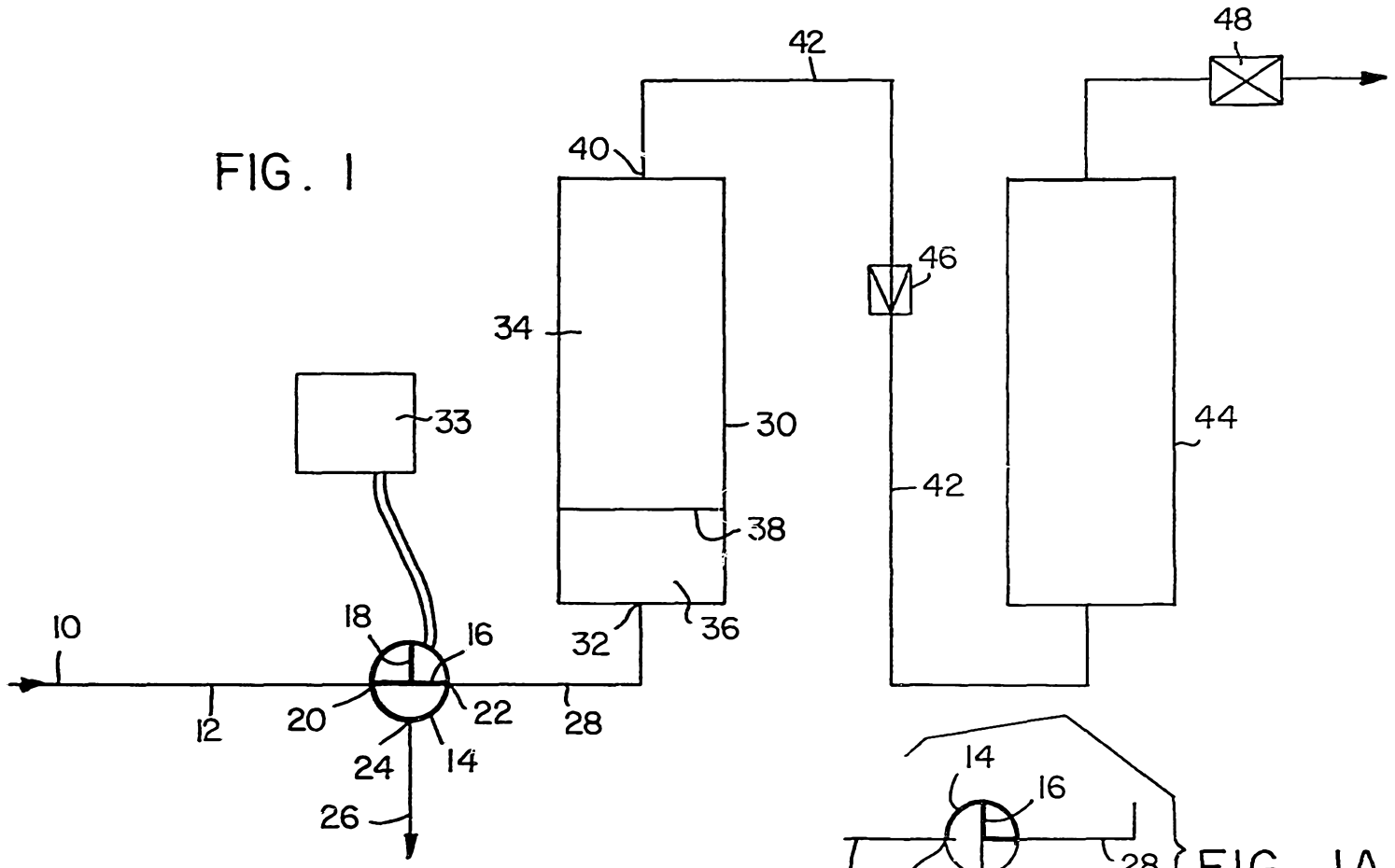
THE BOC GROUP, INC.

Attorney: LEON K. ALLEN

Fellow Institute of Patent Attorneys of Australia

of SHELSTON WATERS

FIG. 1


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FIG. 1A