(12) PATENT
(19) AUSTRALIAN PATENT OFFICE

(11) Application No. AU 199965004 B2
(10) Patent No. 755440

(54) Title

Flow modifier for submerged intake screen

(51)[6] International Patent Classification(s)
E02B 005/08 B01D 029/33

(21) Application No: 199965004

(22) Application Date: 1999.09.24

(87) WIPO No: WO00/19022

(30) Priority Data

(31) Number	(32) Date	(33) Country
09/164238	1998.09.30	US

(43) Publication Date : 2000.04.17
(43) Publication Journal Date : 2000.06.08
(44) Accepted Journal Date : 2002.12.12

(71) Applicant(s)

United States Filter Corporation

(72) Inventor(s)

Richard C Maxson

(74) Agent/Attorney

SPRUSON and FERGUSON,GPO Box 3898,SYDNEY NSW 2001

(56) Related Art

US 2249020
US 4822486
US 4337008

65004/99

PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : E02B 5/08, B01D 29/33 — A1

(11) International Publication Number: **WO 00/19022**

(43) International Publication Date: 6 April 2000 (06.04.00)

(21) International Application Number: PCT/US99/22204

(22) International Filing Date: 24 September 1999 (24.09.99)

(30) Priority Data:
09/164,238 30 September 1998 (30.09.98) US

(71) Applicant *(for all designated States except US)*: UNITED STATES FILTER CORPORATION [US/US]; 40–004 Cook Street, Palm Desert, CA 92211 (US).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: MAXSON, Richard, C. [US/US]; 8110 Walnut Grove Lane North, Maple Grove, MN 55311 (US).

(74) Agent: GANZI, Gary, C.; United States Filter Corporation, 10 Technology Drive, Lowell, MA 01851 (US).

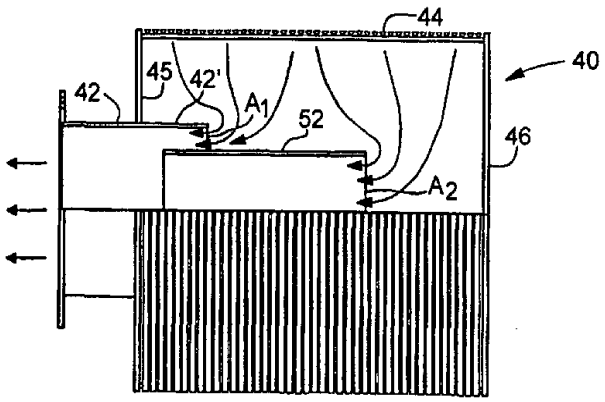
(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) **Title:** FLOW MODIFIER FOR SUBMERGED INTAKE SCREEN

(57) **Abstract**

Improved flow modifier assembly (40, 60) for a water intake system having a cylindrical intake screen (44, 64) prevents damage to fish and other aquatic organisms by providing a controlled velocity profile which causes the average flow velocity (58) to closely approach the peak flow velocity. By extending two or more concentric tubular flow modifiers (42', 52) or (62', 67, 68, 69) into one end of the screen, it is possible to achieve flow uniformities of more than 90 %, as compared to a maximum of about 72 % for a prior art configuration utilizing a single tube flow modifier (22). In addition, the size, weight and cost of screen required can be greatly reduced for a given peak flow velocity as compared to prior art devices.



INTAKE SCREEN CYLINDER
w/ DOUBLE PIPE FLOW MODIFIER

FLOW MODIFIER FOR SUBMERGED INTAKE SCREEN

TECHNICAL FIELD

The invention relates to submerged intake screens, and particularly to internal flow modifiers for such screens which help to ensure that the maximum flow velocity into the screen will be controlled well enough to prevent harm to fish while preventing buildup of debris.

BACKGROUND ART

Major manufacturing plants, large cities, irrigation systems and power generation facilities require large quantities of water for their successful operation. For reasons of economy and to facilitate inspection, it is desirable that the length of the collection pipe which must be laced in a body of water such as a lake or a river be minimized. It is also desirable that the screen assembly which filters the water entering the collection pipe be of as small a size as possible. Still more important, however, is the necessity of protecting fish and other aquatic organisms from harm and preventing buildup of debris along the length of the screen by ensuring that the maximum peak flow velocity through any of the slots of the intake screen is kept at 15.5cm per second or below. One prior art flow modifier is typically 50% of the diameter of the screen cylinder and about 33% of its length. This prior art arrangement is able to increase the flow uniformity, which is the ratio of the average to peak flows, to about 72% as compared to just 32% for a cylinder without a flow modifier.

US-A-2 249 020 describes an inlet screen assembly according to the preamble of claim 1.

DISCLOSURE OF INVENTION

It is among the objects of the present invention to provide a flow modifier structure for a cylindrical intake screen assembly which will provide a degree of protection to aquatic life and prevention of debris buildup. It is an additional object to provide such protection with a structure which permits the use of a smaller diameter screen assembly than previously required. A still further object is to provide an average flow uniformity through the screen surface which is very close to the allowable peak flow velocity. These and other objects are attained by the flow modifier and intake

AUSTRALIAN PATENT OFFICE

screen assembly of the present invention. The screen is preferably cylindrical and of a length equal to about 85-140% of its outer diameter. However, it is most preferable that the length and diameter of the cylinder be equal so as to achieve the most desirable flow distribution and to minimize the amount of material in the screen member. Such a shape would most closely approach the ideal screen shape which would be spherical, but which would be extremely difficult and expensive to fabricate from wire wound screen having a constant slot width. The intake screen assembly preferably includes two or more internal flow modifier tubes projecting concentrically into one end of the axial length of the cylindrical screen. Proceeding radially inwardly from the cylindrical screen surface, each successive tube is somewhat smaller in diameter than the previous one and extends a greater distance into the screen cylinder. The flow modifier tubes each have a diameter, the largest of which is about 60% or less of the diameter of the screen. They also preferably have cross-sectional inlet flow areas which are approximately equal. The design results in the maximum or peak velocity of flow into the screen at any point along its length being very close to the design average velocity. The design average velocity is determined by the volume of water being drawn by the system's pump into the flow modifier tubes divided by the open area of the screen. For the most commonly acceptable peak slot velocity of 15.5 cm per second, the improved design can provide an average slot velocity of at least 14 cm per second as compared to an average slot velocity of about 11 cm per second for a single tube flow modifier or only about 4.9 cm per second for a system where there is no flow modifier tube.

The slots of the screen comprise the space between the wraps of profiled wire which form the cylindrical screen surface. The shape of the screen wire is important since it has been found that the smooth surface created by a construction with the base of a trapezoidal wire facing outward enhances the sliding of debris over the screen surface. The slots could also be formed in the wall of a solid pipe member. In the wrapped wire embodiment, the slots can be either transverse or parallel to the axis of the screen. In the latter arrangement, the wrapped screen would have to be cut along its length, flattened, rolled into a cylinder and welded. For larger sizes, the expense of performing these additional fabricating steps can often be offset by reduction in the amount of reinforcement material required to provide the strength necessary to resist collapse since

the screen bars to which the wires are welded will be oriented circumferentially where they provide substantial hoop strength. Where the flow modifier structure comprises two tubes or pipes, it is preferred that the larger diameter one be about 50% of the screen diameter and about 16% of the length of the screen, while the smaller diameter pipe, which is nested within the outer pipe, has a diameter about 70% that of the outer pipe and a length which extends about 67% of the length of the screen cylinder. Such an arrangement has been found to yield a flow uniformity of over 90%. While the flow modifiers have been referred to as pipes, this term is intended to include hollow shapes fabricated from rolled sheets.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a side view illustrating a prior art intake screen which has no flow modifier.

Fig. 1-A is graph which plots slot velocity against distance from the outlet end and illustrates the screen velocity profile for the prior art intake screen of Fig. 1.

Fig. 2 is a side view, partially broken away, illustrating a prior art intake screen having a single tubular flow modifier.

Fig. 2-A, is graph which plots slot velocity against distance from the outlet end and illustrates the screen velocity profile for the prior art intake screen of Fig. 2.

Fig. 3 is a side view, similar to Fig. 2, but illustrating a prior art configuration wherein a pair of screens, each having a single tubular flow modifier are attached to a single connector member.

Fig. 4 is a side view, partially broken away, illustrating a preferred embodiment of the improved flow modifier which has two flow modifying pipes projecting into the screen cylinder.

Fig. 4-A is graph which plots slot velocity against distance from the outlet end and illustrates the screen velocity profile for the intake screen of Fig. 4.

Fig. 5 is a side view, partially broken away, illustrating an embodiment which has four flow modifier pipes to cause the flow uniformity to be even further enhanced as compared to the dual pipe arrangement shown in Fig. 4.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring to Fig. 1, a prior art intake screen assembly is indicated generally at 10 and includes an outlet pipe portion 12 and a length of screen 14 integrally attached to the outlet pipe portion 12 by an inner end cap in the form of an annular flange portion 15. The screen 14 is closed at its outer end by an outer end cap or plate 16. The flow enters through the surface of the screen, as shown by the arrows 17, and exits through the outlet pipe 12. As can be seen in the velocity distribution curve V_{p1} in Fig. 1A, the flow is highest at the points on the screen which are near to the point of withdrawal from the screen. Thus, the actual flow at the left end of the screen 14 is about 6 times as much as the flow at the right end. If the screen is sized to cause the flow at the left end to be at the peak allowable velocity of 15.5 cm per second, the flow at the right end will be well below 3 cm per second and the average flow velocity, indicated by the dotted line 18, will only be about 4.9 cm per second.

Referring to Fig. 2, a prior art intake screen assembly indicated generally at 20 is shown as including an outlet pipe portion 22 and a length of screen 24 integrally attached to the outlet pipe portion 22 by an inner end cap member 25 and closed at its outer end by an outer end cap member 26. The flow enters through the surface of the screen, as shown by the arrows 27, and exits through the outlet pipe 22. As can be seen in the velocity distribution curve V_{p2} in Fig. 2A, when the actual flow rate of the flow entering the screen 24 is at the maximum permissible flow rate of 15.5 cm per second, the flow rate near the right end will be less than 9.2 cm per second and the average flow rate indicated by dotted line 28 will be 11 cm per second.

Fig. 3 shows another prior art assembly 30 which illustrates that a pair of intake screen assemblies 34 can be joined together in a tee configuration which allows the screen diameters to be reduced as compared to the single screen configuration shown in Figs. 1 and 2.

Fig. 4 shows a preferred embodiment of the present invention in which an intake screen assembly indicated generally at 40 includes an outlet pipe portion 42 and a length of screen 44 integrally attached thereto by means of the inner end cap member 45. The right end of the screen 44 is closed by the outer end cap member 46. Preferably, the primary flow modifier portion 42' of the outlet pipe 42 has a length to the right of end

cap member 45 which is about 16% of the length of the screen surface 44 between end cap member 45 and end cap member 46, while its diameter is about 50% of the diameter of the screen 44. The right end of the secondary flow modifier portion 52 extends to about 67% of the length of the screen surface 44 between end cap member 45 and end cap member 46. The diameter of secondary flow modifier portion 52 is preferably about 70% of the diameter of primary flow modifier portion 42' so as to cause the annular flow area A_1 between flow modifier portions 42' and 52 to be equal to the flow area A_2 defined by the open right end of flow modifier portion 52. The secondary flow modifier portion 52 may be mounted within the primary flow modifier portion 42' by any suitable means, such as a plurality of radially extending and circumferentially spaced rib members (not shown).

Fig. 4-A shows the velocity distribution curve V_{p4} which illustrates the actual flow velocity at various points along the length of the screen 44 in Fig. 4. The average flow velocity indicated by dotted line 58 is 14 cm per second, and is very close to the maximum allowable slot velocity of 15.5 cm per second. Thus, the flow uniformity is 92% with the improved two pipe flow modifier shown, as compared to 72% for the one pipe prior art design shown in Fig. 2-A and just 32% for the prior art design shown in Fig. 1-A that has no flow modifier.

Fig. 5 shows an alternative screen assembly 60 which is similar to Fig. 4 in that it includes elements 62, 64, 65 and 66 which correspond to elements 42, 44, 45 and 46. However, the design includes four flow modifier portions 62', 67, 68 and 69 whose diameters are sized so as provide equal flow areas B_1, B_2, B_3 and B_4. Each of the four flow modifier portions are preferably of a length such that its right end will be positioned at the same distance from the previous flow modifier or, in the case of the first flow modifier 62', from the end cap member 65. The largest flow modifier pipe 62' is preferably spaced from the outlet end of screen 64, as defined by end cap member 65, by a distance equal to 1/(2(N+1)) times the screen length, where N is the number of flow modifier pipes. Thus, in the four pipe system shown in Fig. 5, the pipes 62', 67, 68 and 69 would extend 1/10, 7/20, 3/5 and 17/20 times the screen length. Similarly, in a three pipe system, the pipes would extend 1/8, 11/24 and 19/24 times the screen length away from the outlet end of the screen.

Table 1 shows several parameters for various water intake systems based on the number of flow modifiers associated with them. Assuming a typical flow rate of 7,570 liters per minute, a screen with a slot width opening of 2 mm would need to have a length and diameter of 137 cm for the prior art construction shown in Fig. 1 which includes no flow modifier. The use of a single flow modifier pipe in the prior art construction shown in Fig. 2 would allow the screen size to be reduced to 91 cm long and 91 cm in diameter. By providing two flow modifier pipes 42' and 52, as shown in Fig. 4, the screen size can be reduced to just 76 cm long and 76 cm in diameter. The Fig. 4 design produces a flow uniformity of 92% as compared to 32% and 72% for the prior art embodiments shown in Figs. 1 and 2, respectively. Although the use of more and more flow modifier pipes, such as the four shown in Fig. 5, could produce slightly higher flow uniformities, their use would also produce higher pressure drops and higher costs for pumping and materials.

TABLE 1

Number of Flow Modifiers	**None** **Fig. 1**	**One** **Fig. 2**	**Two** **Fig. 4**
Intake Flow (liters per minute)	7,570	7,570	7,570
Slot Opening (mm)	2	2	2
Slot Velocity-Peak (cm per second)	15.5	15.5	15.5
Slot Velocity-Average (cm per second)	4.9	11	14
Flow Uniformity	32%	72%	92%
Required Screen Diameter (cm)	137	91	76
Required Screen Length (cm)	137	91	76
Screen Open Area (sq cm)	31,737	14,104	9,794
Inner Flow Modifier Dimensions- Dia. (cm.)	—	—	27
Length (cm)	—	—	51
Area (sq cm)	—	—	222
Outer Flow Modifier Dimensions- Dia. (cm.)	—	46	38
Length (cm)	—	30.5	12.7
Area (sq cm)	—	1,639	1,136
Annulus Area (sq cm)	—	—	568

While the invention has been particularly shown and described with reference to the preferred embodiments thereof, it will be understood by those skilled in the art that various alterations in form and detail may be made therein without departing from the spirit and scope of the invention.

CLAIMS

1) An inlet screen assembly (40, 60) for a water intake system comprising a screen member (44, 64) having a cylindrical screen surface, said screen member being closed at its outer end by an outer end cap member (46, 66), said screen member being partially closed at its inner end by an inner end cap member (45, 65), said inner end cap member having an outlet pipe member (42) attached thereto for carrying away water which has passed through said screen surface, said outlet pipe member having a diameter which is substantially smaller than the diameter of the screen surface, and flow modifier means (42', 52, 62', 67, 68, 69) positioned inside said cylindrical screen surface for directing water to said outlet pipe member and comprising a cylindrical pipe member portion which communicates with the outlet pipe member and extends from the inner cap member, characterized in that said flow modifier means causes the flow entering the screen surface along the entire length thereof to have a flow uniformity in excess of 75% where the flow uniformity is defined as the average flow velocity through the screen surface divided by the peak velocity at any point along its length; said flow modifier means comprising at least two cylindrical pipe member portions (42', 52, 62', 67, 68, 69) extending axially along a portion of the axial length of said screen member (44, 64), each of said at least two cylindrical pipe member portions being radially spaced from each other and the innermost (52, 69) of said at least two cylindrical pipe member portions extending axially further into the screen member (44, 64) in the direction away from the inner cap member (45, 65) than the pipe member portion (42', 68) which is radially adjacent to it.

2) An inlet screen assembly for a water intake system according to claim 1 wherein the diameter of the innermost pipe member portion (52) is such that its internal cross-sectional area (A_2) is about 50% of the cross-sectional area (A_1) of the pipe member portion (42') radially adjacent to it.

3) An inlet screen assembly for a water intake system according to claim 2 wherein the innermost pipe member portion (52) extends about 2/3 of the length of the screen cylinder (44) and the outermost pipe member portion (42') extends about 1/6 of the length of the screen cylinder.

AUSTRALIAN PATENT OFFICE

4) An inlet screen assembly for a water intake system according to claim 1 consisting of multiple pipes (62', 67, 68, 69) wherein the diameters of the pipes are such that the internal cross-sectional area (B_4) of the smallest pipe (69) and the cross-sectional area (B_3, B_2, B1) between radially adjacent pipes (68, 67, 62') are essentially equal to each other.

5) An inlet screen assembly for a water intake system according to claim 4 wherein the ends of the successive pipes (62', 67, 68, 69) are evenly spaced between each other and the largest pipe (62') is spaced a distance equal to 1/(2(N+1)) x the screen length away from the outlet end (65), where N is the total number of pipes.

AUSTRALIAN PATENT OFFICE

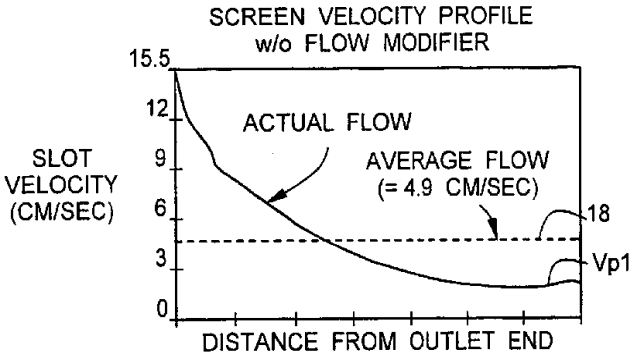
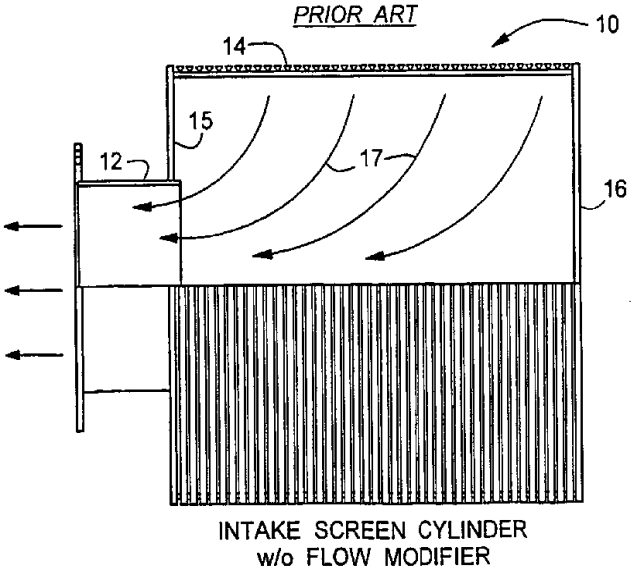


FIG. 1A
PRIOR ART

FIG. 1
PRIOR ART



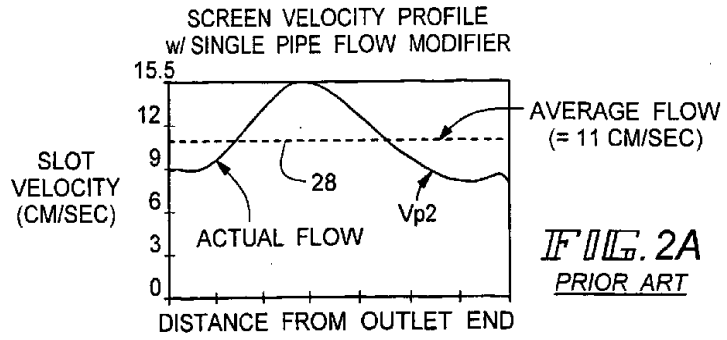
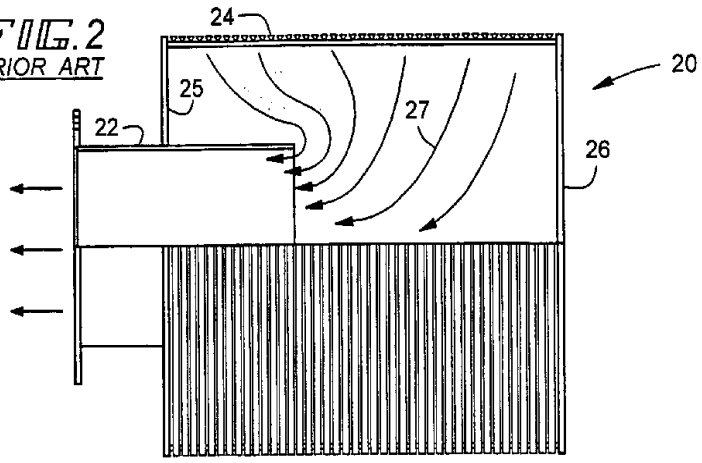


FIG. 2A
PRIOR ART

FIG. 2
PRIOR ART



INTAKE SCREEN CYLINDER
w/ SINGLE PIPE FLOW MODIFIER

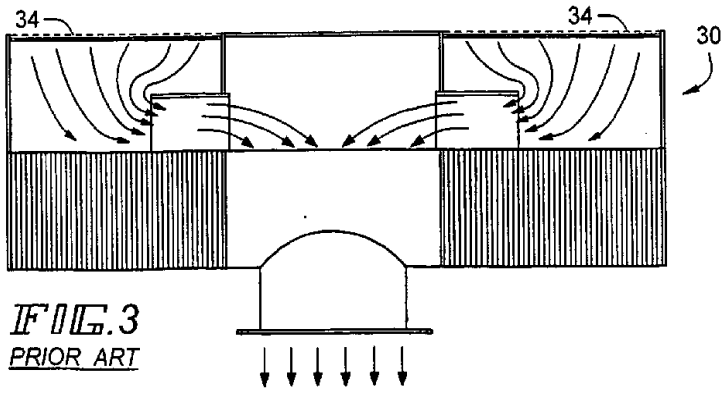


FIG. 3
PRIOR ART

INTAKE SCREEN TEE ASEMBLY
w/ SINGLE PIPE FLOW MODIFIER

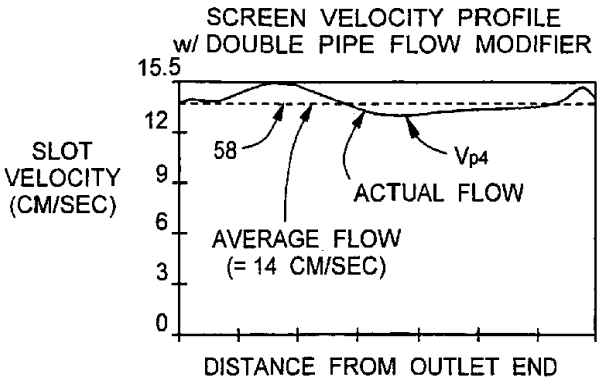


FIG. 4A

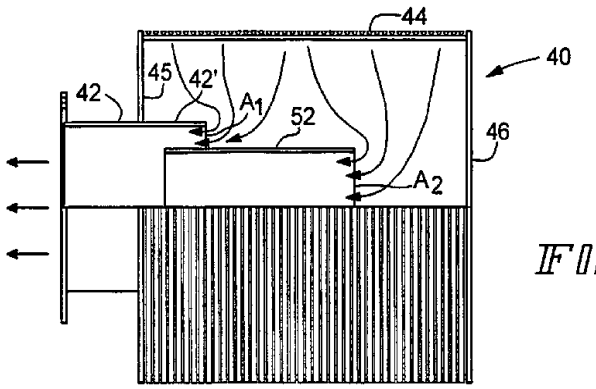


FIG. 4

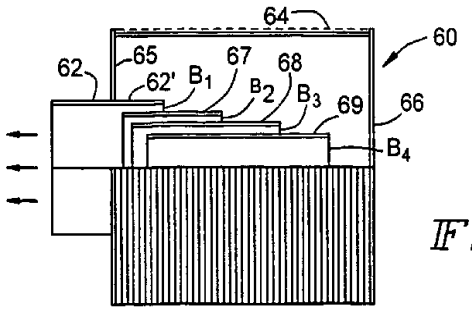


FIG. 5