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P. LEDER ETAL

3,319,792

MULTIPLE FILTRATION APPARATUS

Filed Oct. 19, 1964

2 Sheets-Sheet 1

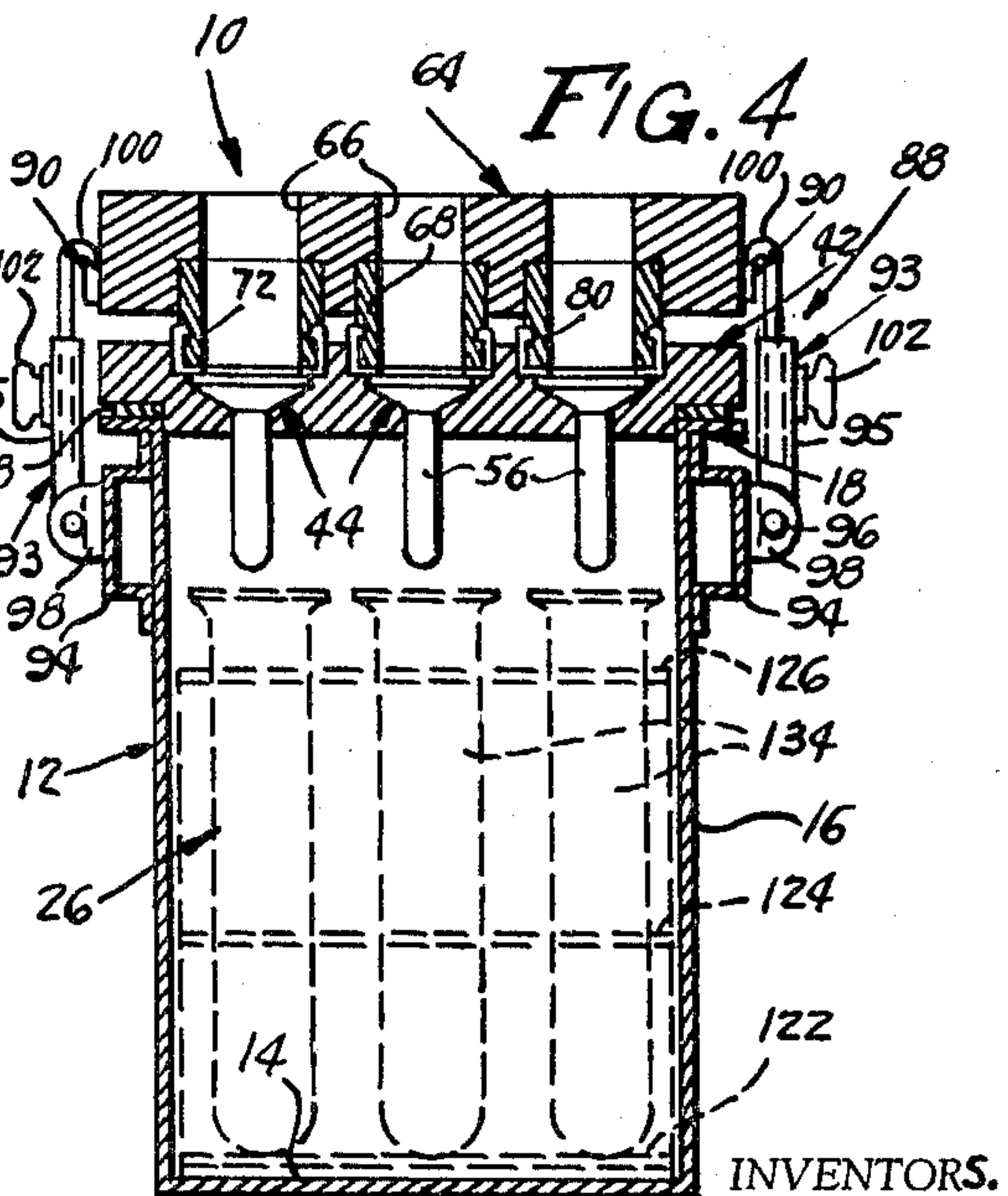
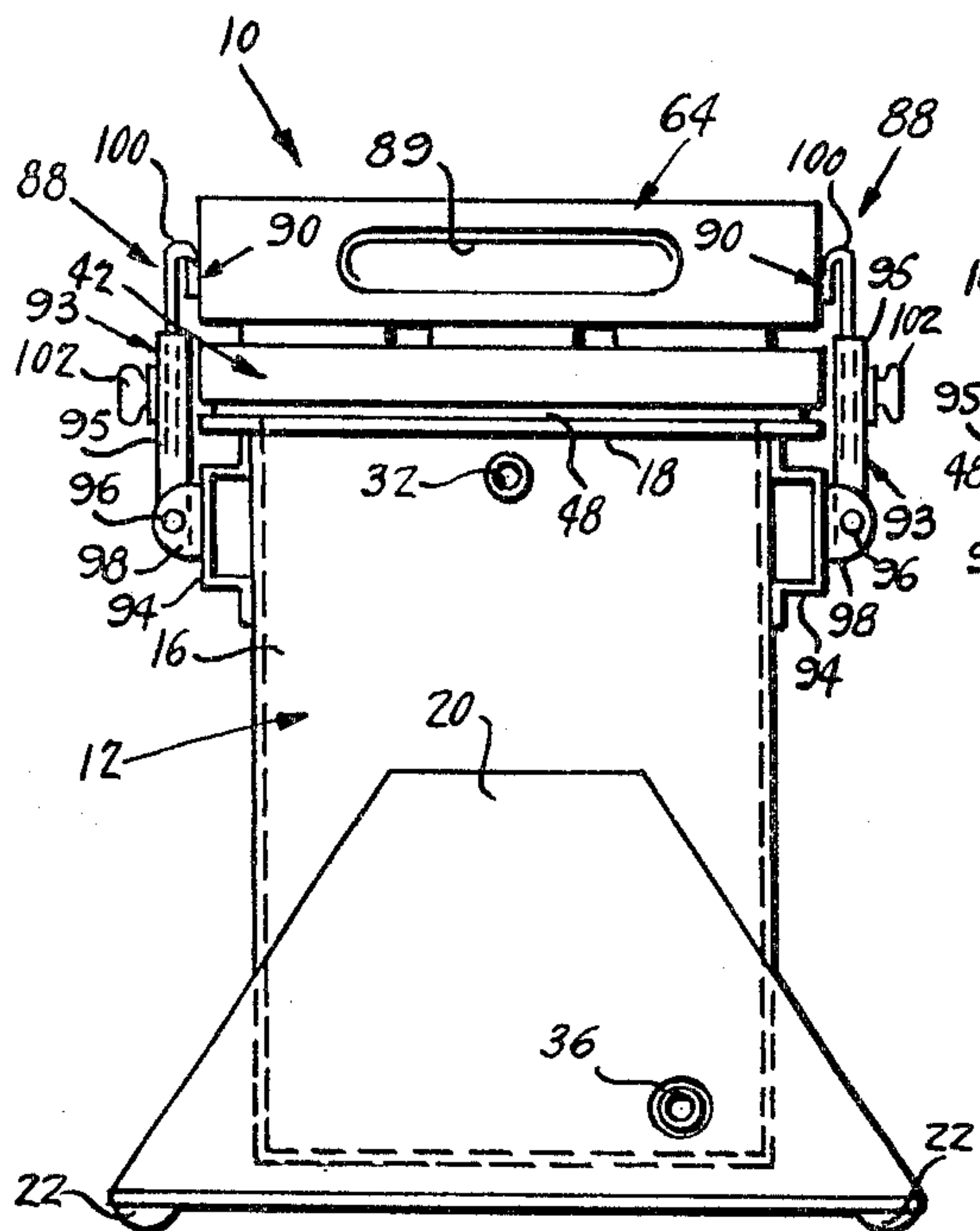
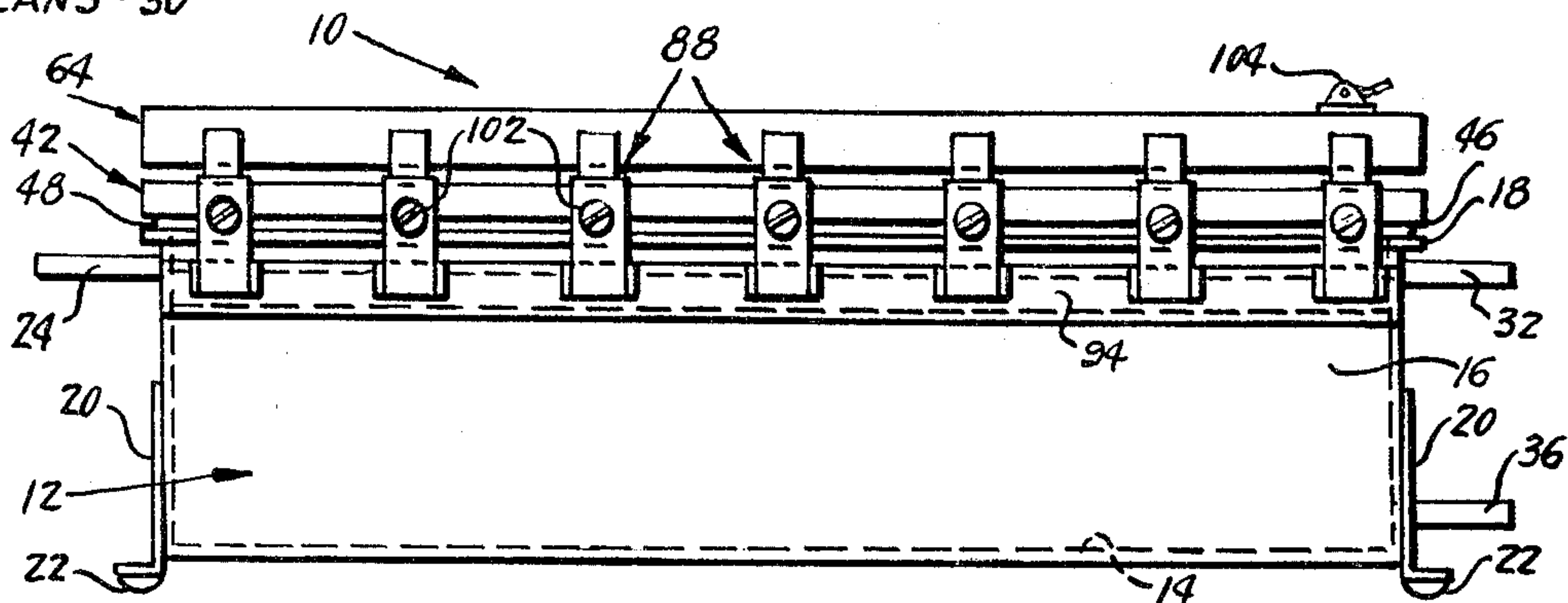
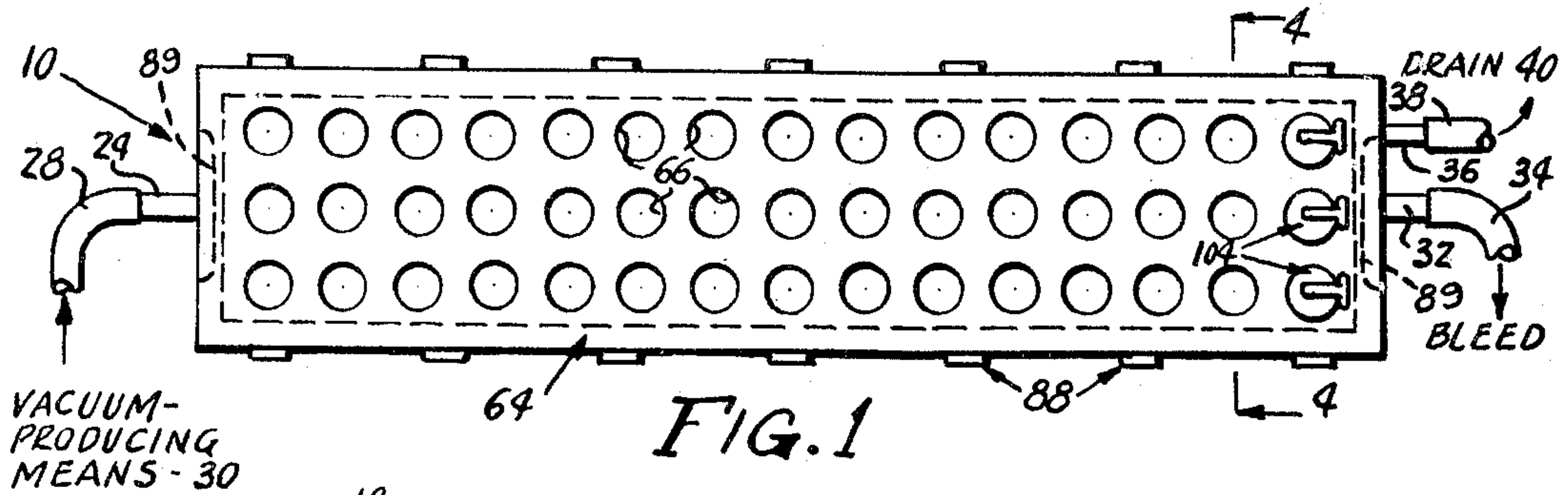


FIG. 3

FIG. 4

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2 Sheets-Sheet 2

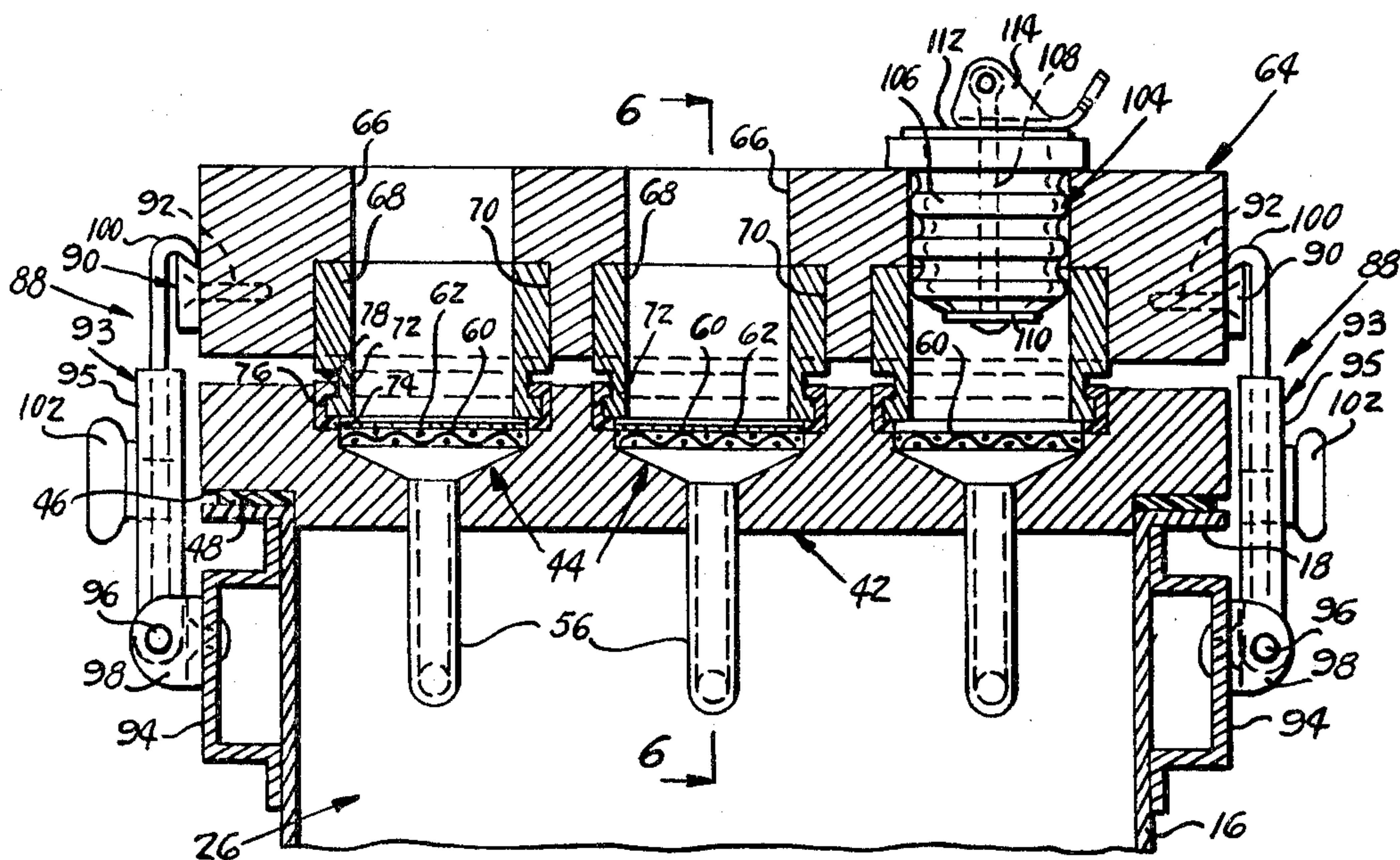


FIG. 5

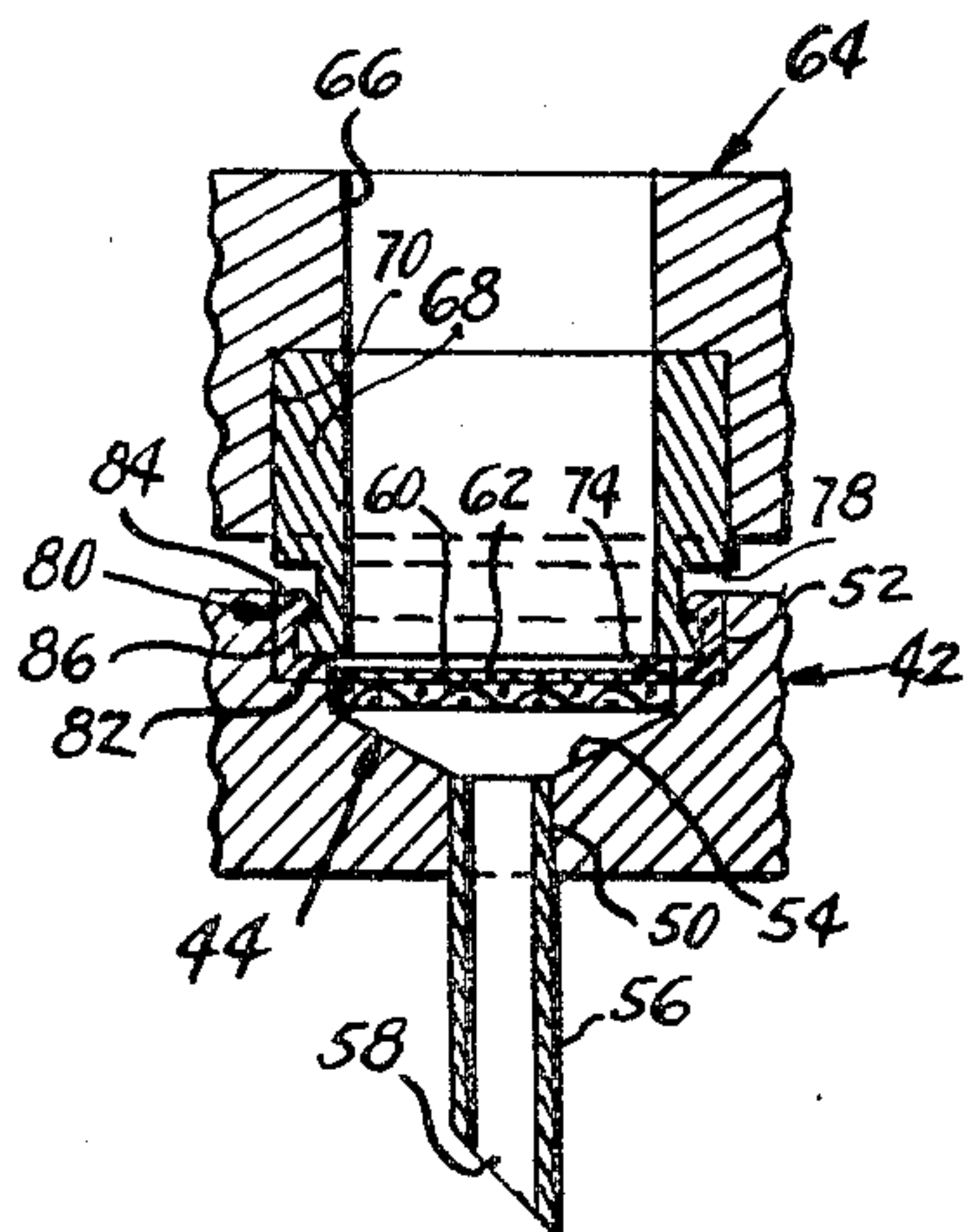


FIG. 6

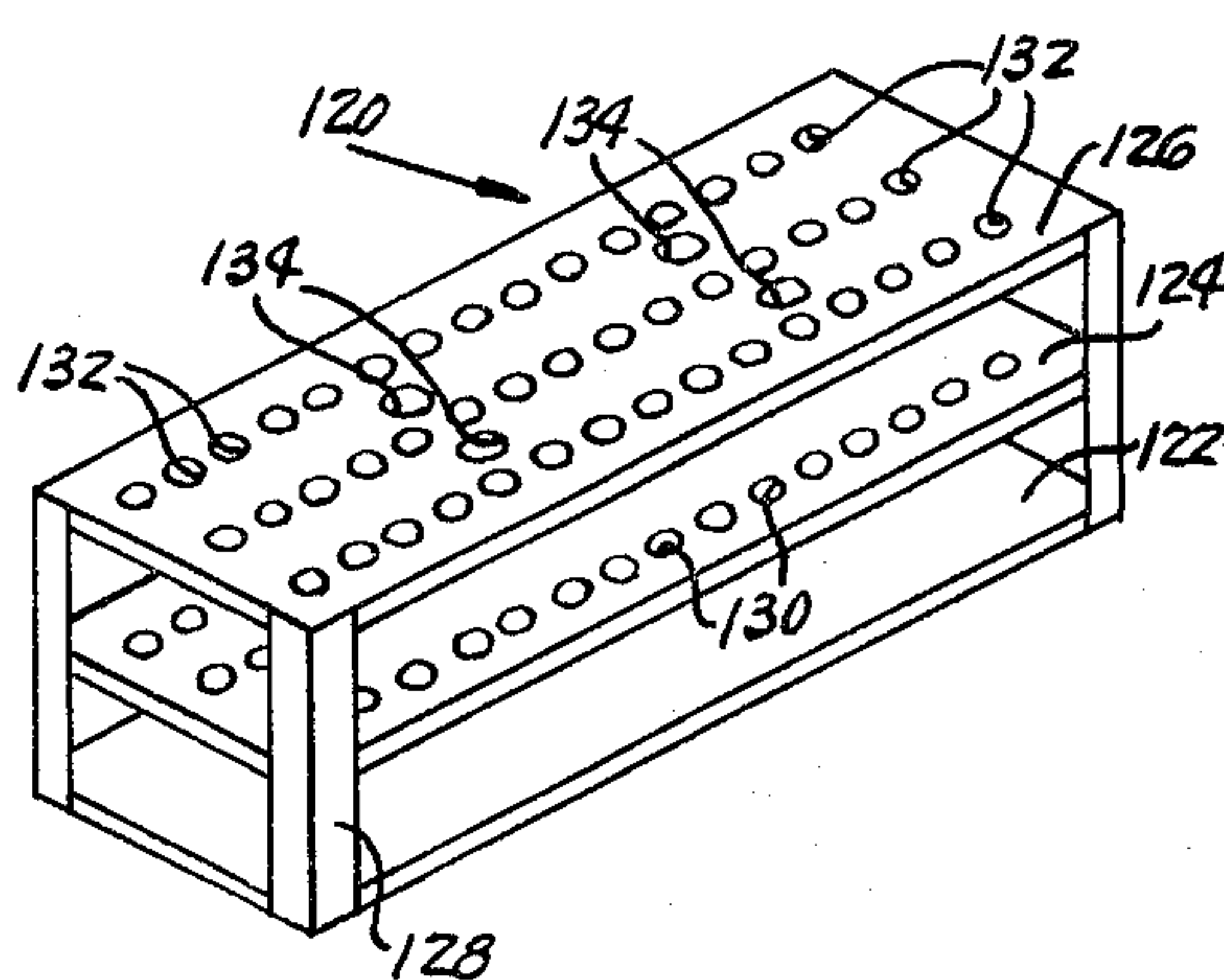


FIG. 7

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## MULTIPLE FILTRATION APPARATUS

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10 Claims. (Cl. 210—238)

The invention described herein may be manufactured and used by the Government of the United States of America for governmental purposes without the payment to applicants of any royalty thereon.

This invention relates to a multiple filtration apparatus and relates more particularly to a device for filtration of one or more samples of materials wherein a precipitate or sediment is to be separated from a liquid carrier under the influence of vacuum.

Single filtration units have been suggested heretofore for processing materials wherein a filtrate is to be removed from a suspension of substantially solid particles. Such individual filtering devices are removably carried by conventional laboratory vacuum bottles and permit relatively efficient handling of extremely small numbers of test solutions on the order of one or two. However, the manipulative steps involved in the filtration of numerous reaction mixtures by such single filtration systems presents a time-consuming and relatively inefficient procedure. Further, repeated use of the same filtrative cell requires undesirable cleaning steps to insure that successive samples are not contaminated by precipitate or the like from previous test runs. While a plurality of individual filtration cells may be set up, it can readily be seen that such a procedure would be cumbersome and inefficient.

Although multiple filtration apparatuses are not new per se, prior art devices have suffered from numerous disadvantages. For example, previously known multiple filtration units have been little more than a combination of the individual cells, possibly utilizing a single source of vacuum. Such devices have been difficult to use in that their size is frequently unduly large and their filtration efficiency is frequently relatively small. In many such devices it is necessary to use all of the cells at one time or pressure will be lost through idle units. Moreover, such prior art apparatuses have been difficult to disassemble for cleaning and also for removing the collected samples of both precipitate and filtrate. Further, previously known filtration devices, whether single or multiple cell, have either held only a small quantity of the sample material requiring constant attention by a laboratory worker to process a large test run or have rendered it relatively inconvenient to remove the precipitated sample by collecting the same at the bottom of a fairly large chamber.

A primary object of this invention is the provision of a multiple filtration apparatus free from the foregoing, and other disadvantages.

With this intention in mind, the instant invention is directed to the production of a multiple filtration apparatus which is sturdy and durable in construction, reliable and efficient in operation, and relatively simple and inexpensive to manufacture, assemble, utilize and maintain.

Another object of this invention is the provision of a multiple filtration apparatus wherein one or any desired number of filtering cells may be utilized without substantially decreasing the vacuum pulled on each sample.

A further objective of this invention is the provision of a device of the type described wherein each filtering cell is comprised of two readily separable portions, the lower portion including the filtering means and presenting the precipitated samples in a readily accessible position, and the upper portion defining a pressure plate and including

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an extension of each of the filtering cells whereby relatively large samples may be poured into each cell without making it difficult to later remove the precipitate.

A still further object of the instant invention is to provide a multiple filtration apparatus which includes means for individually collecting both the precipitate and the filtrate from each filtering cell for further testing, if desired, while with slight modifications, the filtrate from all filtering cells may be readily collected together for disposal precluding the use, and accompanying cleaning, of individual test tubes or the like if such separate filtrate collection means are not necessary.

Yet another object of the instant invention is the provision of a multiple filtration device which is quickly and easily assembled and disassembled and in which the individual parts are readily cleaned and available for reuse or replacement.

Other and further objects reside in the combination of elements, arrangement of parts and features of construction.

Still other objects will in part be obvious and in part be pointed out as the description of the invention proceeds and as shown in the accompanying drawings wherein:

FIGURE 1 is a top plan view of a multiple filtration apparatus in accordance with the instant inventive concept;

FIGURE 2 is a side elevational view thereof;

FIGURE 3 is an enlarged end elevational view of the multiple filtration apparatus;

FIGURE 4 is an enlarged transverse cross-sectional view taken substantially on line 4—4 of FIGURE 1 and showing, in dotted lines, means for collecting individual filtrate samples within the vacuum chamber;

FIGURE 5 is a still further enlarged fragmentary transverse cross-sectional view illustrating certain details of the apparatus;

FIGURE 6 is a fragmentary cross-sectional view taken substantially on line 6—6 of FIGURE 5; and

FIGURE 7 is an orthographic view to a reduced scale of a rack means suitable for use with the multiple filtration apparatus of the instant invention.

Like reference characters refer to like parts throughout the several views of the drawings.

Referring now to the drawings, one embodiment of a multiple filtration apparatus in accordance with the instant inventive concept is designated generally by the reference numeral 10 and includes a chamber means 12 shown substantially rectangular in form, although any desirable shape may be utilized. The chamber means 12 is preferably formed of stainless steel or the like to facilitate cleaning and other maintenance, but it will be readily seen that other suitable materials may be substituted. As shown in the drawings, the chamber means 12 has a bottom element 14 and upstanding peripheral side walls 16, the side walls 16 having upper terminal portions defining an outstanding annular flange 18 surrounding an open top. Any conventional leg elements 20 may be secured to the chamber means 12 with feet members 22 in the form of rubber pads or the like to support the chamber means on a lab table (not shown) or the like.

A tubular member 24 communicates with the interior 26 of the chamber means 12 and is operatively connected in any suitable manner as by a flexible conduit 28 to a vacuum-producing means 30 which may take any conventional form, such as a separate vacuum pump or an ordinary laboratory vacuum supply line (not shown).

Another tubular member 32 is carried by the chamber means 12 communicating with the interior 26 thereof, and may have a flexible conduit 34 of the like secured thereto with any conventional clamp means (not shown) to close the conduit 34 and selectively open the same to form a vacuum bleeding means.



A third tubular member 36 also communicates with the interior 26 of the chamber means 12 at least in juxtaposition to the bottom element 14 and may carry a flexible conduit 38 or the like for carrying filtrate or cleaning solution to a drain 40, the conduit 38 being selectively closed in any desired manner.

If desired, a single flexible conduit may interconnect tubular members 32 and 36 thereby functioning as a quick vacuum bleeding means by removal from the former tubular member, while simultaneously being utilizable as a draining means.

A filter plate means 42 is provided in spanning relationship to the open top of the chamber means 12 and having portions defining a plurality of spaced filtering cells 44. Although forty-five such cells are shown in the drawings as illustrative, it will be readily understood that any desired number of cells could obviously be included. The filter plate means 42 is preferably defined by a filter plate member formed of methyl methacrylate such as Plexiglas, or other suitable materials, including portions defining a peripheral recess 46 on its underside, the recess carrying a gasket means 48 which rests on the annular flange 18 of the container means 12 to form a substantially pressure-tight seal.

Each filtering cell 44 is defined by an opening including a relatively small portion 50 communicating with the underside of the filter plate member, a relatively large portion 52 communicating with the upper side of the filter plate member, and a frustoconical funnel portion 54 interconnecting the relatively small and relatively large portions. An elongated tubular element 56, preferably of stainless steel or the like, is press fit or otherwise secured in the relatively small portion 50 of each opening and has an angular terminal tip 58 extending in spaced relationship to the underside of the filter plate member for directing fluid material passing through the filtering cell. A filtering means is included in each of the openings and comprises a screen element 60 carried substantially at the junction between the relatively large portion 52 and the frustoconical funnel portion 54 with a filter disk 62 supported on the screen element 60. The filter disk 62 may be a well-known Millipore membrane utilized in filtration techniques involving the precipitation and subsequent counting of washed, radioactively labelled, acid-insoluble proteins and polynucleotides for which the apparatus of the instant invention was originally designed and with which it is found to be particularly useful. However, in the broader sense of the instant inventive concept, the filter disk 62 may be merely a piece of conventional filter paper. Further, it is contemplated that other well-known filtering means may be substituted for the screen member 60 and the filter disk 62 without departing from the instant invention.

Superimposed over the filter plate means 42 is a pressure plate means 64 which includes a pressure plate member formed of Plexiglas or the like and having portions defining substantially elongated spaced bores 66 aligned with each of the filtering cells 44 in the assembled relationship of the multiple filtration apparatus 10. Inserts 68 are secured by any conventional cement or the like in counterbores 70 in the pressure plate member, each insert defining an annular protuberance 72 extending from the underside of the pressure plate member and surrounding each of the bores 66. The protuberances 72 are dimensioned to be received in the relatively large portions 52 of their associated filtering cells 44 with a slight tolerance to facilitate assembly of the apparatus as will be explained in more detail hereinafter.

Each protuberance 72 preferably includes an inner wall portion defining an extension of the bore 68, an end portion 74 for engaging the junction between the relatively large portion 52 and the frustoconical funnel portion 54 of its associated filtering cell 44, and an outer wall portion 76 juxtaposed to the large portion 52 of its associated filtering cell 44 in the assembled relationship. An annu-

lar groove 78 is defined in the outer wall portion 76 of each protuberance 72 in spaced relationship to its end portion 74.

An annular compressible gasket member 80, substantially U-shaped in transverse cross-section, is removably carried by each of the protuberances 72 to allow for a good pressure-tight seal of each filtering cell 44 while permitting the inserts 68 to be made of a relatively rigid and wear-resistant material such as the Plexiglas mentioned hereinbefore. Each of the gasket members 80 includes a lower flange 82 covering the end portion 74 of the protuberance 72, a flexible lip 84 spaced from the flange 82 and removably received in the annular groove 78, and a connecting portion 86 extending between the flange 82 and the lip 84 and covering the part of the outer wall portion 76 of protuberance 72 between the end portions 74 and the annular groove 78. Thus, it will be seen that these removable gasket means, which may be readily replaced when worn and which are preferably formed of a silicone rubber or the like, provide a substantial contact area for sealing between the pressure plate means 64 and the filter plate means 42.

Handholds 89 are formed in the ends of the pressure plate means 64 to facilitate removing and replacing this member. Similar means (not shown) may be provided in the filter plate means 42, if desired.

Any conventional securing means 88 is provided for removably engaging the chamber means 12 with the filter plate means 42 and the pressure plate means 64 in a substantially pressure tight assembled relationship. While the specific form of this securing means 88 is not a part of the instant invention, an illustrative embodiment is shown in the drawings comprising a plurality of individual locking means including striker members 90 fixed in any conventional manner, such as by screws 92 or the like, in peripherally spaced relationship to the pressure plate means 64. Latch members 93 are associated with each of the striker members 90 and are fixed to a hat-shaped peripheral bead 94 secured in any conventional manner to the side walls 16 of the chamber means 12 beneath the annular flange 18. Each latch member 93 includes a guide member 95 pivotally secured at 96 to a pair of outstanding ears 98 carried by the bead 94. Hooked members 100 are slidingly carried by the guide members 95 and are adapted to be engaged over the striker members 90 and tightened in any conventional manner by a cam means 102 or the like.

In accordance with the instant invention, any desired number of the filtering cells 44 may be utilized at a particular time. The unused cells are preferably closed by plug means of any commercial form, one well known soda bottle stopper being illustrated in the drawings at 104. Such a device includes either a smooth or corrugated compressible plug 106 of rubber or the like interposed on a shank 108 between a pair of pressure plates 110 and 112, the pressure plates being moved together by a cam operated locking member 114 in a well known manner to longitudinally compress the plug and spread the same radially outwardly into pressure tight engagement with the wall defining the bore 66. It will be readily understood that any conventional plug means, even including a simple cork, could be substituted for the embodiment shown in the drawings although this particular form of plug has been found to be quite efficient and useful in cooperation with the apparatus of this invention.

In the event the filtrate need not be saved it can merely be permitted to flow through the tubular elements 56 into the interior 26 of the chamber means 12 from which it may subsequently be discharged to the drain 40. However, if it is desirable to collect the individual quantities of filtrate and maintain them separate from each other, a rack means 120 shown particularly in FIGURES 4 and 7 may be removably supported within the chamber means 12. The rack means 120 is preferably dimensioned to



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substantially conform to the interior 26 of the chamber means 12 whereby it will be quickly and easily accurately positioned therewithin for use. This means, which may be formed of stainless steel or the like, preferably includes a base plate 122 and a pair of support plates 124, 126 maintained in spaced relationship above the base plate 122 by angular corner elements 128. The support plates 124, 126 include portions defining a plurality of vertically aligned openings 130, 132 for receiving and supporting in vertical relationship beneath each of the filtering cells 44, collecting elements such as the test tubes 134 shown in dotted lines in FIGURE 4. Enlarged finger-engaging openings 134 may be provided in the upper support plate 126 to facilitate inserting the rack means 120 into the chamber means 12 and removing the same therefrom.

The use and operation of the apparatus of the instant invention will now be apparent. If the filtrate is to be collected, the rack means 120 with suitably positioned collecting elements 134 is inserted into the interior of the chamber means 12. The filter plate means 42 is then placed over the chamber means 12 with the gasket means 48 engaging the annular flange 18, the terminal tips 58 of the tubular elements 56 of the filtering cells 44 overlying the collecting elements 134 carried by the rack means 120. Suitable filter disks 62 are then placed over the screen elements 60 of filtering cells 44 to be utilized. The pressure plate means 64, having gasket means 80 snapingly engaged with each of the protuberances 72, is then superimposed over the filter plate means 42, alignment of the two plates being facilitated by the protuberances 72 being received within the large portions 52 of the opening of the filtering cells 44. The individual elements of securing means 88 are then quickly and easily engaged to provide a pressure tight assembly. Plug means 104 are inserted into bores 66 aligned with filtering cells 44 which are not to be utilized. The tubular conduits 34 and 38 are closed and the tubular conduit 28 is connected to the vacuum producing means 30 to draw a vacuum through the interior 26 of the chamber means 12. Test samples are poured into individual filtering cells 44 which may be numbered if desired for identification, the relatively elongated bores 66 of the pressure plate means 64 defining means to confine and receive a substantial quantity of test solution in each filtering cell.

After all of the samples have been filtered, the device is readily disassembled, the filter disks 62 being quite accessible for any further processing after the pressure plate means 104 has been removed to expose filter plate means 42. The entire filter plate means 42 and pressure plate means 64 may then be sterilized, if necessary, for reuse.

It will now be seen that there is hereinafter provided an improved multiple filtration apparatus which satisfies all of the objectives of the instant invention, and others, including many advantages of great practical utility and commercial importance.

Since many embodiments may be made of the instant inventive concept and since many modifications may be made of the embodiments hereinbefore shown and described, it is to be understood that all matter herein is to be interpreted merely as illustrative and not in a limiting sense.

What is claimed is:

1. A multiple filtration apparatus comprising chamber means, vacuum-producing means operatively connected to said chamber means, filter plate means removably carried in overlying relation to said chamber means, portions of said filter plate means defining a plurality of spaced filtering cells in communication with said chamber means, filtering means associated with each of said cells for collecting precipitate from samples passing through said cells, pressure plate means removably carried in overlying relation to said filter plate means, portions of said pressure plate means defining elongated spaced bores aligned

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with each of said cells and communicating with said chamber means through said cells, and securing means removably engaging said chamber means, said filter plate means and said pressure plate means in substantially pressure-tight assembled relationship, said chamber means including a chamber member having a bottom element and upstanding peripheral side walls carried by said bottom element, said side walls having upper terminal portions defining an open top, said filter plate means spanning said open top and resting on said upper terminal portions of said side walls, said filter plate means including a filter plate member having portions defining a plurality of openings therethrough, one for each of said filtering cells, each of said openings including a relatively small portion communicating with the underside of said filter plate member, a relatively large portion communicating with the upper side of said filter plate member, and a frustoconical funnel portion interconnecting said relatively small and relatively large portions, said filtering means being carried between said relatively large portion and said frusto-conical funnel portion, said pressure plate means including a pressure plate member, an annular protuberance extending from the underside of said pressure plate member surrounding each of said bores and dimensioned to be received in said relatively large portion of its associated filtering cell, and gasket means interposed between each of said protuberances and said portions of said filter plate member defining the relatively large portion of its associated filtering cell.

2. A multiple filtration apparatus in accordance with claim 1, further including, in combination, rack means removably supported within said chamber means and substantially conforming to the interior of said chamber means, said rack means including portions defining a plurality of spaced carrying means for removably supporting individual collecting elements aligned with, and positioned below, each of said cells to collect filtrate from samples passing through said cells.

3. A multiple filtration apparatus in accordance with claim 1 further including, in combination, vacuum bleeding means operatively carried by said chamber means.

4. A multiple filtration apparatus in accordance with claim 1 further including, in combination, plug means removably carried in pressure-tight relationship by bores in said pressure plate means associated with unused filtering cells.

5. A multiple filtration apparatus in accordance with claim 1 wherein said securing means includes a plurality of striker members fixed in peripherally spaced relationship to said pressure plate means, and latch members associated with each of said striker members and fixed to said chamber means, said latch members including tightening means to draw said pressure plate means toward said chamber means for forming a pressure-tight assembly.

6. A multiple filtration apparatus in accordance with claim 1 further including, in combination, an elongated tubular element secured in said relatively small portion of each opening and having a terminal tip extending in spaced relation to the underside of said filter plate member.

7. A multiple filtration apparatus in accordance with claim 1 wherein said filtering means includes a screen element carried in each of said openings substantially at the junction between said relatively large portion and said frustoconical funnel portion, and a filter disk supported on said screen element.

8. A multiple filtration apparatus in accordance with claim 1 wherein said gasket means are removably carried by said protuberances.

9. A multiple filtration apparatus comprising chamber means, vacuum-producing means operatively connected to said chamber means, filter plate means removably carried in overlying relation to said chamber means, portions of said filter plate means defining a plurality of spaced filtering cells in communication with said chamber means,



filtering means associated with each of said cells for collecting precipitate from samples passing through said cells, pressure plate means removably carried in overlying relation to said filter plate means, portions of said pressure plate means defining elongated spaced bores aligned with each of said cells and communicating with said chamber means through said cells, and securing means removably engaging said chamber means, said filter plate means and said pressure plate means in substantially pressure-tight assembled relationship, said filter plate means including a filter plate member having portions defining a plurality of openings therethrough, one for each of said filtering cells, each of said openings including a relatively small portion communicating with the underside of said filter plate member, a relatively large portion communicating with the upper side of said filter plate member, and a frustoconical funnel portion interconnecting said relatively small and relatively large portions, said pressure plate means including a pressure plate member, an annular protuberance extending from the underside of said pressure plate member surrounding each of said bores and dimensioned to be received in said relatively large portion of its associated filtering cell, and gasket means interposed between each of said protuberances and said portions of said filter plate member defining the relatively large portion of its associated filtering cell, said gasket means being removably carried by said protuberances, each of said protuberances including an inner wall portion defining an extension of said bore, an end portion for engaging the junction between the relatively large portion and the frustoconical funnel portion of its associated filtering cell, and an outer wall portion juxtaposed to the large portion

of its associated filtering cell in assembled relationship said gasket means including a compressible member covering said end portion and at least a part of said outer wall portion juxtaposed to the large portion of its associated filtering cell.

10. A multiple filtration apparatus in accordance with claim 9 wherein an annular groove is defined in said outer wall portion of each protuberance in spaced relationship to its end portion, said gasket means including an annular compressible member, substantially U-shaped in transverse cross-section, and including a flange covering said end portion of said protuberance, a flexible lip spaced from said flange and removably received in said annular groove, and a connecting portion extending between said flange and said lip and covering the part of said outer wall portion of said protuberance between said end portion and said annular groove.

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