April 23, 1968 E. W. VERES ET AL 3,378,993

AIR LINE FILTER

Filed July 3, 1963 3 Sheets-Sheet 1

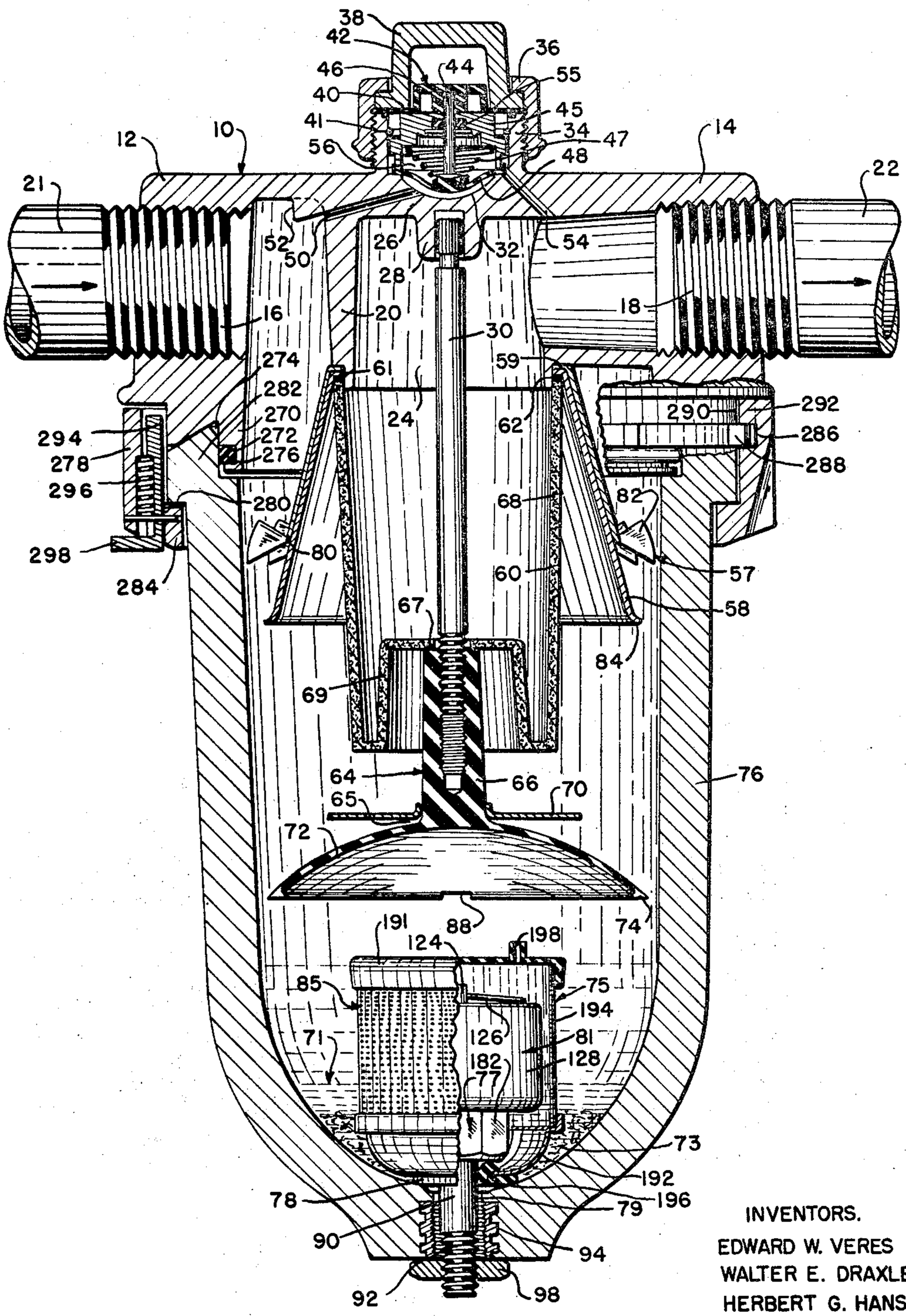

FIG. 1

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AIR LINE FILTER

Filed July 3, 1963 3 Sheets-Sheet 2

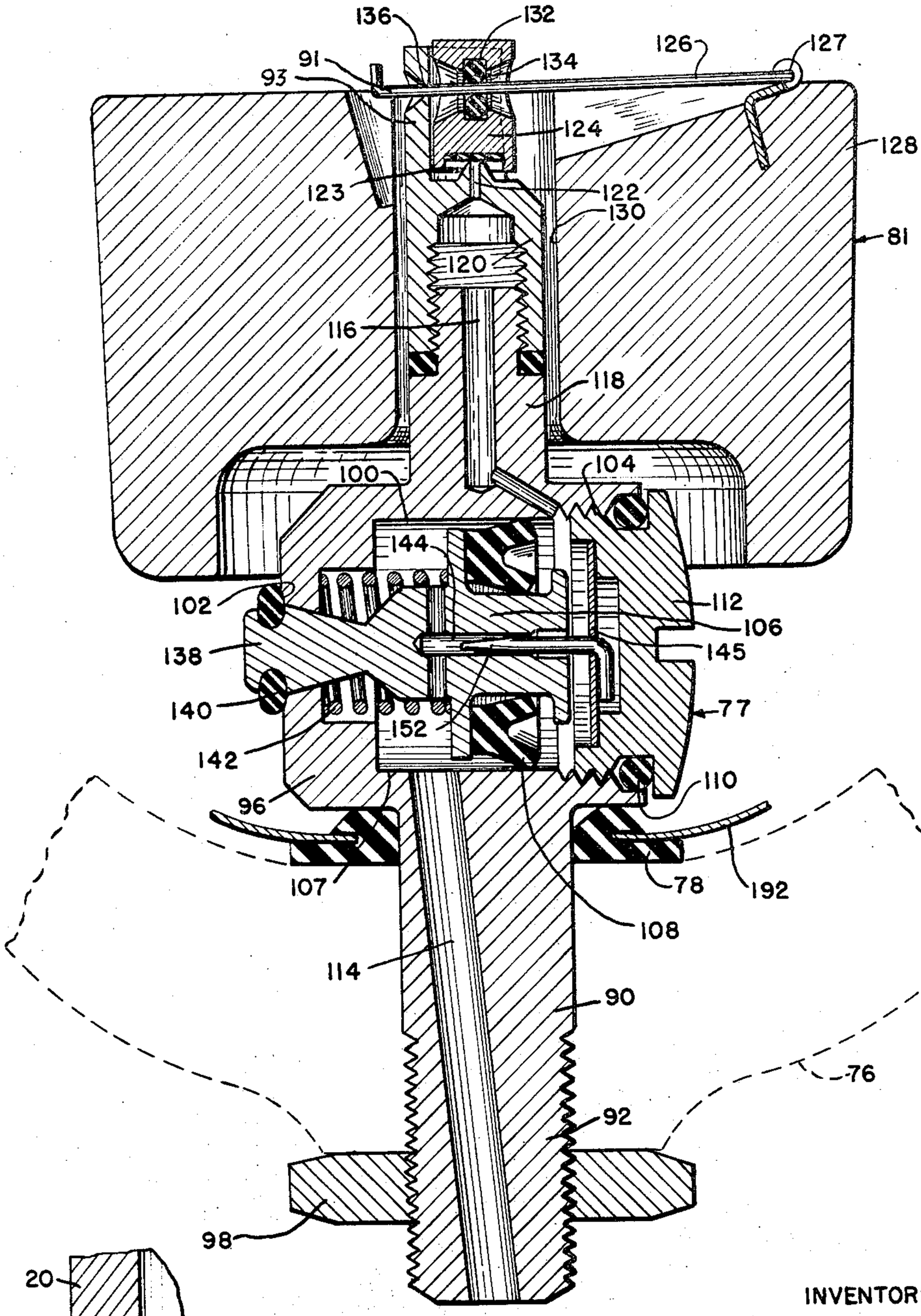

FIG. 2

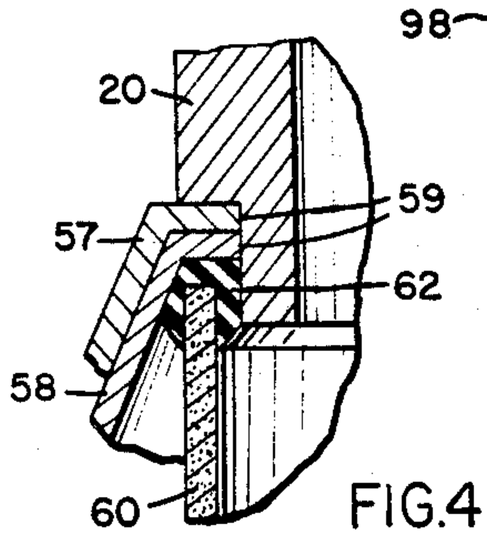

FIG. 4

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AIR LINE FILTER

Filed July 3, 1963 3 Sheets-Sheet 3

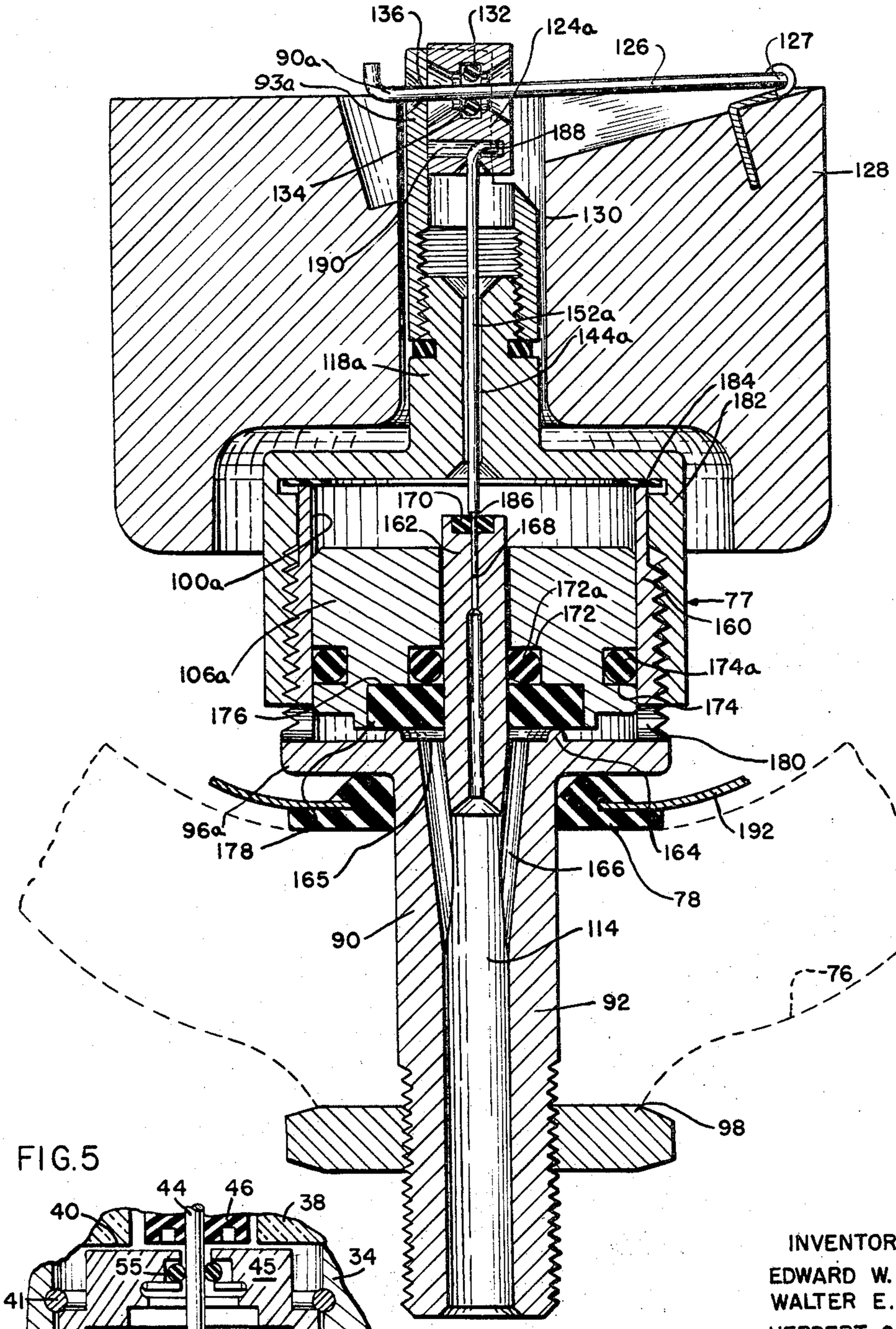

FIG. 5

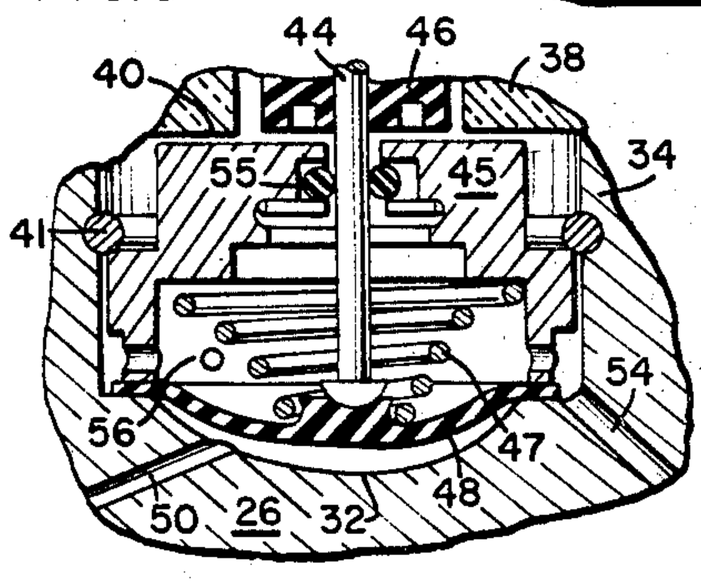

FIG. 3

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3,378,993
AIR LINE FILTER

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Filed July 3, 1963, Ser. No. 292,597

8 Claims. (Cl. 55—219)

The present invention relates to a compressed air line filter and drain and particularly to one which automatically separates, collects and drains from an air line undesirable materials such as condensation, dust and rust and indicates when its efficiency becomes materially impaired, so that devices powered by compressed air will not be damaged thereby and will be powered at their top efficiency with minimum servicing of the air line.

The industry has somewhat standardized on the filter heights and diameters including the bowl size for each "pipe size" of an air line, and, in those conventional installations where filters attain a required efficiency, there is little room left in the bowl for a drain device. Accordingly, either the filter is reduced in size and efficiency or the overall height of the filter is increased with special bodies or bowls being supplied to accommodate an adequate drain device in the bowl.

In the present invention a standard size filter device is supplied with an improved full efficiency filter system with or without an improved automatic drain and the automatic drain with or without a screen cage for bowls as small as those having a two inch inside diameter. Moreover, a full view device is provided indicating when the filter efficiency falls below a predetermined efficiency as when dust collected begins to retard air flow volume.

A principal object of the invention is to provide a full rated capacity filtration device and a compact, highly efficient and inexpensive automatic drain, both protectively disposed in a quickly removable bowl of a standard size otherwise interchangeable with bowls on other air line equipment.

Moreover, when such is indicated to be desirable, the bowl can be quickly removed and flushed clean and the filter also can be quickly removed, cleaned or replaced and returned to operation in seconds, instead of minutes, thereby greatly reducing air line shut down times.

A further object of the invention is to provide an improved filter device and pilot valve arrangement operated with minimal air flow and buoyancy forces to control positive discharge of accumulated condensation and debris under air pressures ranging from 10 to 200 p.s.i., with or without the air flowing.

A further object of the invention is to provide an improved filter device of the type described which is relatively simple and inexpensive to manufacture, operate and service.

Further objects and advantages of the present invention will be apparent from the following description and a drawing relating thereto in which:

FIG. 1 is a vertical sectional view taken along the center line of a device embodying the invention,

FIG. 2 is a vertical section taken through the automatic drain device embodying a preferred form of the invention where pressure is applied to actuate the drain valve, and

FIG. 3 is a view similar to FIG. 2 showing a modification of the invention in which applied pressure is released to actuate the drain valve.

FIG. 4 is an enlarged fragmentary section showing the electrical insulation mounting of the baffles and filter element.

FIG. 5 is an enlarged fragmentary section showing the

operating parts of the signal device for a fouled filter element.

In the present invention all of the compressed air passing through an air line is subjected to a purification involving passage through a filter element of sintered bronze to accomplish multiple actions. An improved centrifugal action is imparted to the air for separation of heavier particles and the accumulation of undesirable liquids, and an improved sintered bronze conical filter element with its working length reversely doubled upon itself catches all dust that is too light to centrifugate. In event the filter element becomes undesirably obstructed with dust, the need for cleaning it is visually indicated automatically without any loss of compressed air and without any danger of the indicator being reset without the filter element being serviced. Accumulated water and foreign particles are automatically jettisoned from the accumulating bowl. A screen cage prevents fouling of the float and ejection valve with large particles. The filter device is protected against tampering while under pressure but can be readily cleaned in event debris large enough to clog small passages is collected. Moreover, only a predetermined limited amount of compressed air is lost in the operation of the automatic discharge.

Referring now to the drawing in further detail, a body **10** is provided at its top with aligned bosses **12** and **14** having threaded inlet and outlet openings **16** and **18**, respectively, receiving an inlet nipple **21** and an outlet nipple **22** of a compressed air line. A downwardly extending cylindrical flange **20** is centrally located on the bottom side of the body to baffle the incoming air downwardly along the outside of its walls and in turn the flange permits outgoing air to pass to the outlet opening **18** through its open lower end **24**. The cylindrical flange **20** is closed at its upper end by a wall **26** having a depending boss **28** thereon that is centrally cored out to receive a mounting stud **30**.

The upper face of the wall **26** is depressed to form a cavity **32** which is bordered by an upstanding flange **34** externally threaded to receive a flanged retaining ring **36** that releasably holds a transparent dome member **38** in place. The dome member **38** in turn marginally engages the top of the circular flange **34** in sealed relationship and extends inwardly at **40** to provide a shoulder which along with a C-ring clamp **41** the indicator assembly **42** is held in place within the flange **34**. The indicator assembly includes an inverted cup **45** that slidably supports a pin **44** which carries an indicator head **46** for viewing inside the dome. The indicator head **46** is preferably provided with a luminous color for commanding color detection. In its resting position the indicating head **46** is out of sight below the dome ring **36** but when the pin **44** is forced upwardly it carries the indicating head **46** to the upper part of the dome where it is quickly visible from all directions.

The lower end of the inverted cup **45** engages and holds in sealed relationship the margins of a snap-acting neoprene diaphragm **48** which is molded to normally assume a spherical shape so that in its resting position it resides in the cavity **32** with the head **46** out of horizontal sight in the dome. When the diaphragm **48** is moved upwardly, compressing the spring **47**, it carries the pin **44** with it through an O-ring **55** that serves to frictionally support the pin and head **46** in the raised visible position and also dampens the movement of the pin **44** against responding to momentary differentials of pressure as where the use of air from the outlet is shut down and suddenly resumed. If the air pressure is removed from the air line to clean the filter the spring will return the diaphragm downwardly, and although the spring could engage the head of the pin to reset the indicator at the same time, it is preferred to let the pin and head remain in the up

position without the pin and head being connected to the diaphragm so that the head remains up until reset manually when the filter is cleaned.

For purposes of actuating the diaphragm a conduit **50** interconnects the inlet **16** and the cavity **32** below the diaphragm **48** while a deflecting ear **52** in the inlet protects the mouth of the conduit **50** against the direct force of incoming air under pressure. A second conduit **54** interconnects the space **56** above the diaphragm **48** through the wall of the cup **45** with the outlet **22** so that when a predetermined differential is reached between the air inlet and the outlet pressures, the higher pressure in the cavity **32** will force the diaphragm **48** upwardly to carry the indicator **46** up where it can be seen to indicate that there is an undesirable drop of the pressure on the air passing through the filter.

Thus, in event the filter becomes clogged with dust to such an extent that its efficiency is materially reduced, a pressure drop develops in the outlet side which is effective through the passage **54** to actuate the diaphragm **48** to raise the indicator **46** to indicate such conditions, and, this indication cannot be successfully reset until the filter is cleaned. Whereupon as will be explained later, the filter can be quickly removed and purged and the dome **38** removed by removal of the dome ring **36** so that the indicator may be manually reset to its original position for resumption of clean operation.

The lower end of the circular boss **20** is externally reduced marginally at **61** to provide a shoulder and receive in assembled relation thereagainst, first a vane baffle **57**, a deflector baffle **58** and a porous filter element **60** in stacked array. Both baffles have the same wall inclination. Suitable nesting flanges **59** upon the baffles are provided at their upper edges to receive the upper edge of the filter element **60** which is coated with a dipped rubber seal **62** bonded thereon to maintain the filter element **60** out of electrical contact with any metal. Such provides not only a seal against the passage of dust therepast but also prevents any galvanic action that could otherwise deteriorate the filter.

The assembly of baffles and filter is held in place by a dielectric filter shield assembly **64** having a boss **66** threaded to the lower end of the stud **30** and engaging at **67** the filter element in a direction of movement urging it into clamped relationship with the circular boss **20**.

It is to be noted that the filter element has an elongated conical frustum outside wall surface **68** like an umbrella and an upwardly tapering conical frustum inside wall **69** which can be made with any further length desired if corrections in the length of the stud **30** and boss **66** are made to accommodate same. This arrangement increases the flow area through the filter quite materially over that which would be present with a single wall extending the same distance downwardly.

The lower end of the filter shield comprises a radial flange element **70** centrally flanged and press fitted on the boss **66**. Below the flange **70** a baffle element **72** is integrally provided defining a segment of a sphere with downwardly inclined edges **74** terminating in close proximity to the wall of an accumulator bowl **76**. The flange and baffle elements **70** and **72**, respectively, compositely provide a diverging wall arrangement defining an annular space **65** whose minor diameter at its narrow portion is substantially less than the outer diameter of the filter above it and whose major diameter at its wider portion is at least as great or greater than the diameter of the filter portion **60** directly above it. Castellations **88** in the edge **74** of the baffle **72** permit centrifugated particles to drop into the bottom of the bowl and, when the bowl is removed, the baffle element **72** provides a hand grip by which the filter element **60** can be quickly removed and replaced with a clean one within the comprehension of unskilled labor.

Referring again to the baffles **57** and **58** a radial flange **80** at the lower marginal edge of baffle **57** is provided

with inclined propeller-type vanes **82** which swirl substantially all of the air passing through the filter downwardly and around the inside wall of the bowl **76**. This swirling action is accelerated by the externally flared flange end **84** at the bottom of the baffle **58** which confines the air to the wall of the bowl like an annular jet port. Any particles present in the swirling air are thereby heavily centrifugated helically against the wall in a downwardly direction with sufficient force that their inertia carries them to the edge **74** of the baffle **72** where they drop into the lower part of the bowl through the castellations **78**.

Thus, it will be seen from the disclosure that before the compressed air is passed through the electrically isolated sintered bronze filter **60**, it is passed downwardly through peripheral vane blades contiguous to a circular wall which centrifugates the air with a violent rotary motion along the wall past a conical deflector at a level well down on the filter. Moreover, the baffles not only shroud the major length of the filter element, but their lowest marginal edge is flared outwardly in closely spaced relationship with the circular wall to assure that the centrifugated air reaches the spherical slope of the domed element **72** near the circular wall before contacting the filter. From there the centrifugated particles and liquids pass through the castellations to permit foreign debris to be collected in the bottom of the bowl before the air can begin to approach the filter. Debris that might not reach the castellations immediately move inwardly over the dome element and are trapped by the annular space **65** where under the flow of air into and out of the annular space the air and any debris carried thereby are caused to recirculate back over the sides of the bowl. Otherwise the filter is as wide open in its exposed area as possible and substantially free of any sharp current of flowing air reaching it until after the debris laden portions have encountered two acute angle corners into which any remaining debris is driven by inertia when the air is redirected in its flow pattern. Moreover, below the spherical segment **72** with the flow pattern described the air is rather quiescent and it will be observed from the description which follows that with water **71** present to a moderate depth, the debris **73** becomes wet and sinks along the walls to collect at the bottom with minimal disturbing turbulence for co-operation with the rest of the structure which will now be described.

Shielded below the baffle **72** from any disturbing flow of air is located an automatic float actuated liquid drain device **85** which includes a screen assembly **75**, a float arrangement **81**, a valve ararngement **77** and an assembly grommet **78** which serves as a common seal at the bottom of the bowl **76** around an opening **79** through the bottom thereof.

More particularly, the drain device **85** comprises an elongated element **90** externally threaded at its lower end **92** which extends through the opening **79** defined by a metal collar **94** embedded in the bottom of the bowl **76**. The lower end **92** is firmly secured in erect relationship and the sealed relationship just described in connection with grommet **78** is maintained by a nut **98**. Above the gasket **78** the member **90** is enlarged to provide a body portion **96** having a horizontal cylindrical cross bore **100** therethrough terminating at one end in a small opening defining an external valve seat **102** opening into the interior of the bowl **76** and a large threaded opening **104** at the other end which is closed by a bonnet plug **112** as sealed therewith by an O-ring **110**. A piston **106** is slidably mounted in a large cylindrical portion **107** of the cross bore **100** for movement towards and away from the valve seat **102** in sealed relationship therewith by a V-ring seal **108** carried by the piston. The valve side of the piston is vented to the atmosphere through a conduit **114** extending through the lower end **92** and opening downwardly outside of the bowl. The opposite side of the piston **106** is in communication with

a passage **116** formed in a boss **118** on the upper side of the body **96.**

The piston **106** has a tapered valve element **138** of a diameter much smaller than the diameter of the piston and is grooved to receive an O-ring valve seal element **140** that is normally held closed against the valve seat **102** as urged by a compression spring **142** bearing against the piston. Thus, whenever the piston **106** is driven to the left as viewed in FIG. 2 as driven by air pressure, it carries the O-ring **140** away from the valve seat **102** to permit liquid **71** and foreign particles **73** in the bowl **76** to be ejected through the passage **114** by the air pressure in the bowl.

The piston is moved to open the valve **138** by air under pressure being supplied from the bowl through a passage **122** in a valve body **120** that is threaded to the upper end of the boss **118.** At its upper end the passage **122** terminates in a valve seat **123** that is closed by a valve head element **124** actuated by a float driven lever **126** whenever the liquids in the bowl reach a predetermined level. In providing this actuation one end of the lever **126** is pivoted at **127** to a float **128** and for purposes of multiplying the work effort of the float, said lever **126** is preferably arranged to be a No. 2 type lever system with a 7 to 1 mechanical advantage. The lever extends through an aperture at **132** having an O-ring **134** at a work point beyond which there is a minimal length arm **91** fulcrumed to the body **120** on an ear **93** as supported in a bore **136.**

The float is provided with a central bore as at **130** so that it moves freely under buoyancy in a vertical guided relationship upon the boss **118** and valve body **120.** The bore **130** being centrally located and of a diameter substantially less than its length, maximum buoyancy in minimum space is obtained without any cocking or binding of the float in its operation. Thus, as the float rises with an increasing level of accumulated liquid **71** in the bottom of the bowl **76,** it moves the lever **126** upwardly with maximum leverage ratio against the O-ring **134** but since the passage **116** is at atmospheric pressure when the valve **124** is closed, as will be explained shortly, the air pressure in the bowl tends to hold the valve closed until the float has moved far enough upwardly to compress the O-ring **134** resiliently with enough force to lift the valve **124** to an open position whereupon both the float and the release of compression on the O-ring **134** causes the valve **124** to open a sufficient distance for sufficient length of time for a substantial discharge of liquid **71** from the bowl.

To accomplish this discharge of liquid, the valve **124,** when opened, admits bowl pressure through passage **116** to the piston **106** thus forcing it towards the left as viewed in FIG. 2 to open the valve seat **102** as already described. Then when the level of the liquid **71** falls a predetermined distance, the valve **124** is again closed whereupon air pressure is cut off from the passage **116** and the spring **142** urges the valve stem **138** to carry the O-ring **140** into valve closing engagement with the valve seat **102.**

To assist the spring **142** in closing and keeping the valve **140** closed in its resting position, a bleed passageway **144** is provided through the piston **106** to vent the pressure in conduit **116** to atmosphere through the conduit **114.** Although this bleed passageway could be through a fixed wall portion of the body **96,** it is preferred to locate it centrally in the piston where a self-cleaning pin **152** can be supported on a disc **145** for relative movement in the passage **144** as the piston **106** makes each excursion to open and close the valve **138.** Not only does the pin **152** provide a moving element that keeps the bleed passage **144** free of foreign particles, but its use enables a large bore to be provided which is easily drilled and a large diameter pin which provides a restricted bleed passageway therebetween of a limited capacity difficult to drill as a small open bore.

Thus, the valve **124** supplied with "flea power" provided by a small compact float **128** pivots the positive opening and closing of a drain valve **138** under and with the high air pressure differentials involved. Also the valve is self-cleaning in its action where disposed at the bottom of the bowl in direct contact with accumulated debris without the added protection of the screen assembly because the taper on the valve **138** makes sure that if a particle such as rust gets past the seat **102,** it will clear all the way through. Furthermore, the fluid flow around the taper tends to center the valve element **138** in its operation.

Referring now to FIG. 3, another construction is shown but in this arrangement, where like numerals refer to like parts, the piston chamber **100***a* is symmetrically arranged for ease of tooling. Moreover, it is disposed vertically and under resting conditions the bowl pressure is applied to both sides of the piston **106***a* with the pressure on top thereof vented to atmosphere by the float **128** so that the pressure on the lower side lifts the piston and opens a valve controlled thereby to jettison liquid **71** from the bowl.

Structurally the housing **77** is an assembly of three parts, the lower one **96***a* comprises an externally threaded cylindrical flange **160** having an upright boss **162** centrally therein provided with a bleed passage **168** therethrough having a resilient valve ring seat **170** at the top thereof. At its base the boss is surrounded by a valve seat land **164** and openings **165** are provided within the confines of the land for passages **166** which along with passage **168** lead to the atmosphere through passage **114.**

The piston **106***a* slides in guided relation upon the boss **162** and preferably has internal and external annular grooves **172** and **174** in which O-rings **172***a* and **174***a* are disposed to engage the walls of said boss **162** and chamber **100***a,* respectively, in slidable sealing relationship. O-rings are preferred but can be dispensed with if desired.

Below the O-ring **172***a* and in a cavity **176** provided for the purpose is pressed a valve disk **178** which engages the valve land **164,** and apertures **180** are provided around the bottom of the flange **160** through which liquid and debris can flow from the bowl **76** into the chamber **100***a* and be ejected therefrom through passages **166** when the piston **106***a* is raised.

An inverted cup **182** is internally threaded and received on the flange **160** and secured in sealed relationship therewith by a circular gasket **184.** Extending upwardly from the top of the cup is a guide boss **118***a* for the float having a bleed passage **144***a* therethrough in which a self-cleaning pin **152***a* is received to make of the passage **144***a* a restricted bleed passage. The pin also carries on its lower end a valve element at **186** which closes against the valve seat **170** when the float **128** is in its lower position. The upper end of the pin is crooked as at **188** to be loosely received in a support slot **190** on the bottom of the head element **124***a.* The relative bleed areas of the passages **144***a* and **168** in relationship to the area of the piston exterior of the valve land is such that as long as the valve **186** is open, air will bleed from the chamber **100***a* much faster than air entering through the bleed passage **144***a.* Thus, sufficient pressure drop is quickly attained above the piston for it to be raised by the bowl pressure below it and when the float again closes the valve **186** there will be some overrun on liquid ejection due to a slight delay in the closing of the piston against the valve. The overrun, however, is terminated rapidly. The aspiration of liquid and the pressure drop within the land area assist the pressure that is increased above the piston when the valve **186** is closed.

In both embodiments, it will be observed that the drain traps **85** are preferably protectively enclosed in a screen assembly **75** which comprises upper and lower facing cup members **191** and **192,** respectively, axially flanged marginally to receive in snugly supported relationship a cylindrical screen member **194.** The lower cup member **192** is apertured at **196** to be received in a circumferential groove on the resilient grommet **78** while the upper cup has an

upright apertured nipple **198** thereon for assured equilization of pressure inside and outside of the screen assembly with little chance of particles of debris entering therethrough.

The embodiments can be readily assembled and disassembled for servicing. The cup **191** is removed and the drain trap is slipped into the position shown through the grommet **78**. The cup **191** is returned to position and the lower end **92** is slipped through the opening **79** in the bottom of the bowl **76**. The nut **98** is then applied and tightened into place.

The bowl is then readily slipped into place against its supporting shoulder and readily secured by the ring and bayonet attachment structure which includes interdigitating flange segments locked in their closed position by a latch on one element engaging between the flange segments on the other portion more fully described in the copending application Ser. No. 272,991, now Patent No. 3,214,054 which is hereby incorporated by reference.

Briefly, it is preferred to remove the bowl by actuation of a quickly manipulated retainer ring for a ready flush out when the collection of debris in the bottom warrants it during an airline shut down time and return it immediately to place with the ring snapped again into place. This is accomplished with a joint of axially telescoping wall members sealed by a radially acting seal and a quick disconnect releasably maintaining the joint between the bowl **76** and the body **10**. The joint comprises a downwardly extending annular flange **270** having an external O-ring groove **272** therein as provided upon the bottom of the body **10**. The upper end of the bowl **76** is offset outwardly to provide a cylindrical surface **274** which telescopes over flange **270** with sufficient clearance that it can be readily attached and removed. An O-ring **276** in the groove **272** seals the joint against escape of air under pressure.

The quick disconnect comprises a quickly attached and detached ring **278** having an inwardly extending flange **284** which engages below and supports a peripheral flange **280** provided on a shoulder **282** bordering the rim of the bowl when locked in a position to do so by a locking arrangement in which an internal groove at **286** on the ring mates with annular male flange segments **288** upon the body **10** and a groove **290** on the body **10** mates with annular female segments **292** located adjacent to the upper edge of the ring **278**. The flange segments **286** and **292** serve in the nature of bayonet joint elements since the segments in one member slip between the segments in the other member so that they come to rest in the co-operating grooves as described whereupon a slight turning of the ring brings the segments into axial abutting relationship to support the bowl **76** against downward movement.

For purposes of ready engagement and disengagement, the tolerances are quite large and the segments can be engaged or disengaged by relative rotation in either direction. However, to lock the segments against rotation out of said abutting relationship, an axially movable latch **294** carried by the ring **278** in a space between two of the segments **292** on the ring is urged by spring **296** to intersect the groove **286** in the ring **278** between two of the segments **288** on the body. The lower end of the latch has a radial lip **298** thereon serving as a manual means for operating the latch.

Assuming the bowl **76** has been cleaned, the ring **278** is slipped into place over the bottom of the bowl and the bowl is raised to its telescoping sealed relationship with flange **270** on the body **10**. After this the ring is moved upwardly and rotated slightly until the flange segments interdigitate whereupon one of the flange segments **288** comes into engagement with the upper end of the latch **294**. Further upward movement of the ring depressed the latch to locate the flange segments in their respective mating grooves whereupon the ring is turned until the latch snaps upwardly between two of the flange segments **288** on the body **10**. This disposes the segments in abutting relationship for supporting the bowl **76** against removal. While

pressure is present in the bowl, the engaged flange segments are heavily loaded frictionally to prevent inadvertent rotation and disengagement. Moreover, it will be observed that the latch can be received between any two adjacent segments **288** which permits orientation for accessibility of the latch a full 360° around the lubricator. When removing the bowl with the air pressure "off," the latch **294** is pulled downwardly by its radial lip **298** to clear the body segments **288** and a slight twist of the ring interdigitates the segments so that the ring **278** can be lowered and the bowl **76** with it. During engagement or disengagement thereof the ring and latch can be managed with one hand.

Having described the preferred embodiments of the invention, their operation and the improved results attained thereby it will be readily apparent to those skilled in the art that various and further changes can be made therein within the objects and results set forth and described herein without departing from the spirit of the invention, the scope of which is commensurate with the appended claims.

What is claimed is:

1. An air line filtering device comprising a die cast body made of an electrically conductive material which includes aluminum and having an inlet conduit, an outlet conduit and a chamber, a pressure differential responsive diaphragm urged inwardly and dividing said chamber into two compartments the inner one of which is in communication with the inlet conduit and the outer one of which is in communication with the outlet conduit, signal means actuated by said diaphragm when the pressure in said one compartment exceeds that in the other compartment by a predetermined differential including an element propelled upwardly by said diaphragm, a transparent dome closing said outer compartment receiving said signal means and being removable for manually resetting same, means on the body defining a pair of concentric shoulders and a central boss, an accumulator bowl of a plastic dielectric material axially engaging the outer one of said shoulders to define a reservoir for the collection of liquid under pressure in the bottom thereof, a ring member on said body detachably supporting said bowl in said engagement, a porous filter element of an electrically conductive sintered metal which includes copper supported on the other of said concentric shoulders, dielectric means below said body for supporting said filter including readily releasable dielectric elements interengaging the filter element and body, including a resilient dielectric element around the upper edge of the filter element constituting the sole engagement between said other shoulder and the filter, said filter defining a frustum of a cone depending below said body, a dielectric member carried by said central boss and engaging the lower end of the filter constituting the sole engagement between the body and filter element at the lower end thereof, filter shrouding means carried by said other shoulder including vane means marginally terminating in a plurality of fan blades and a downwardly and outwardly curved lower edge for swirling air downwardly along the side of the bowl before the air contacts the filter, a baffle carried by said dielectric member having a substantially semi-spherical contoured surface curved downwardly toward the bottom of said bowl and terminating in a castellated edge in close contiguous relationship with the side wall of the bowl defining a quiescent zone at the bottom of the bowl, a radially extending baffle disposed above said arcuate baffle and immediately below but spaced from said porous member, a housing supported in said bowl below said baffle and protected thereby including a vertical tubular means having a conduit communicating with said reservoir and with the atmosphere, a float responsive to the level of liquid in the bottom of the bowl and having a central portion adapted to slide vertically on said tubular means, a link attached at one end to the float for movement thereby and at the other end extending inward across said central portion and sup-

ported on said housing, an expulsion conduit through said housing including a cylinder in said housing below said liquid level, a piston reciprocable in said cylinder, a valve actuated by movement of the piston for placing the interior of said bowl in communication with said expulsion conduit through said cylinder, conduit means for venting the cylinder to atmosphere on the valve side of said piston, and valve means actuated by said link intermediate its ends for selectively applying different pressures to the cylinder on the other side of the piston for actuating same to open and close said piston actuated valve, and bleed conduit means through said piston for venting said other side of the piston to atmosphere including a self cleaning pin in said bleed conduit means for determining the flow capacity of said bleeding means, said pin and conduit means being axially movable with respect to each other in association with movement of said piston actuating valve and said piston.

2. In an air line filter body made of an electrically conductive material and having an inlet conduit and an outlet conduit, a porous filter element of an electrically conductive but different material closing the entrance of said outlet conduit, dielectric means for supporting said filter element including readily releasable dielectric elements interengaging the filter element impregnating the edge of the filter body and bonded thereto and body comprising a resilient dielectric element around the upper edge of the filter element constituting the sole engagement with metal parts on the body, a stud element extending down through said filter element and a dielectric element interengaging through the lower end of the filter element and constituting the sole engagement between the body and filter element at the lower end thereof.

3. An air line filter comprising a body, an elongated accumulator bowl removably secured thereto and depending therefrom and having a rounded bottom wall, said body having an air inlet conduit through the wall of the body communicating with said interior of said bowl, said body also having an outlet conduit through the wall of the body communicating with the interior of said receptacle through an opening disposed at a point spaced from said inlet conduit whereby a flow path is defined from said inlet conduit to said opening through said bowl, a stud mounted in said opening extending therefrom into said bowl, an elongated porous filter having a round cross-section and received over said stud engaging said body at one end to cover said opening and extending therefrom into said bowl, a filter shield means mounted within said bowl upon said stud to secure the porous filter to said body including a radial flange element extending transversely across the bowl adjacent the lower end of said porous filter, said flange at all points being spaced from the filter for shielding the bottom of the filter and an outwardly and downwardly inclined baffle element spaced therebelow extending transversely across the bowl below the lower end of said porous filter having a marginally castellated downwardly curved edge terminating in close proximity to the circular sides of the bowl, baffle means mounted at its upper end at said opening in sealed relationship with the top of the filter including a vane baffle within said bowl having blades below the level of the top of the porous filter in close proximity to the side walls of the bowl directing air flowing therethrough to swirl around the side walls of the bowl in a downward direction, and outwardly and downwardly inclined deflector baffle extending below said vane baffle into close proximity to the wall of the bowl below said blades to confine and accelerate the swirling air movement downwardly along the circular side of the bowl towards said castellated edge, said radial flange element defining a downwardly facing wall of a diameter at least as great as the diameter of the porous filter below the lower end thereof and defining with said deflector baffle an annular space whose outer diameter is substantially the same as that of the flange and whose inner diameter is substantially less than said filter to trap particles moving inwardly and upwardly along the top of said deflector baffle and redirect their flow back towards the sides of the bowl.

4. An automatically emptied air line filter comprising an accumulator bowl in communication with the inlet and outlet of an intermediate section of an air line filter means in said bowl interconnecting said inlet and outlet, a baffle within and spaced apart from the bowl and defining a quiescent zone with said bowl at the bottom of the bowl, vertical tubular means below said baffle extending through the bottom of said bowl having a conduit communicating with said quiescent zone and having a bore and opening diametrically opposed to each other through its wall at the top thereof, a float having a central portion adapted to slide vertically on said tubular means, a lever link pivotally attached at one end to the float for movement thereby and at the other end extending inwardly through said opening across the tubular means and terminally received pivotally in said bore, a valve element defining a valve seat closing said conduit below said link, a valve member supported on said link in said conduit intermediate said bore and opening and closing against said valve seat actuated by said link and float member to an open position for admitting air from the bowl to the conduit, a valve means interconnecting the atmosphere and the bottom of the bowl for emptying the bowl, means in said tubular means in communication with said valve seat actuated by bowl pressure admitted through said valve seat to open said valve means when the valve member is opened by said float.

5. The combination called for in claim **4** including a resilient member constituting the sole interconnection between said link and said valve member to provide a delay and snap action to the valve member when said link is actuated by said float member.

6. The combination called for in claim **4** including a screen shield surrounding said float and tubular means, a sealing gasket disposed between said tubular means and bowl and having a groove therein receiving the lower marginal edges of said screen shield in supported sealed relationship, a closure for the top of the screen above said float having an upwardly extending vent conduit therein.

7. An air line filter comprising a head member defining air inlet and outlet connections, means on the underside of said head member defining a hollow central boss and a pair of concentric shoulders the inner one of which is on said central boss, an annular cup-shaped filter having a round cross-section and a recessed bottom wall with a central aperture therethrough mounted on the inner one of said pair of concentric shoulders, an annular accumulator body mounted on the outer one of said pair of concentric shoulders enclosing said filter, an elongated stud rigidly supported and extending downwardly coaxially from said boss and through said central aperture in the recessed bottom wall of said annular filter, an abutment boss member received on said stud releasably against the filter at said central aperture, a space dividing baffle cooperating with said annular body for defining the space surrounded by said annular body into an upper space above said baffle below the recessed bottom wall and a lower space below said baffle, said baffle being carried on said abutment boss member and being manually operable to release said abutment boss member to remove said filter and having vertically spaced radially extending wall portions defining an annular space therebetween whose minor diameter is substantially less than that of said filter and whose major diameter is at least as great as that of the filter to trap particles moving towards said recessed bottom wall to redirect them against the wall of said accumulator body, and drain means below said baffle for ejecting liquid from the bowl when the liquid level in said bowl reaches a predetermined height.

8. In an air filter an accumulator bowl, a body defining a closure for the bowl with concentric inlet and outlet conduits, a porous filter element in the outlet zone having

a round cross-section and defining an inlet zone in sealed relationship with the outlet from the body, means for separating and collecting foreign matter including liquid carried by the air passing therethrough and including annular baffle elements extending downwardly and outwardly from the top of the porous filter element over the major height thereof and forming a diverging wall confining incoming air to flow along the wall of the bowl over a major portion of the length of the wall with a swirling centrifugal action for the particles carried thereby, and including a lower baffle below the bottom end of the filter element, said lower baffle defining a quiescent zone in the bottom of the bowl, means between said lower baffle and said filter element and spaced below said filter element defining an annular space therebetween whose minor diameter is substantially less than that of said filter and whose major diameter is at least as great as that of the filter to trap particles moving inwardly and upwardly along the top of the lower baffle to redirect their flow back towards the sides of the bowl wall into the downwardly swirling air flow, and drain means supported therein and including a float responsive to the level of liquid collected in the bottom of the bowl, an ejection valve, a piston controlling said ejection valve, valve means disposed adjacent to said lower baffle in said quiescent zone controlled by said float for controlling the air pressure present on one side of the piston, means for venting the other side of the piston to the atmosphere, and bleed conduit means extending through said piston including a self-cleaning pin therein providing a limited flow of said air from the interior of the bowl while said valve means is open, a self-cleaning pin determining the flow capacity of said bleed conduit means and being movable relative thereto with piston movement.

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