Dec. 11, 1956 J. H. ROPER 2,773,827

ELECTRICAL PRECIPITATORS

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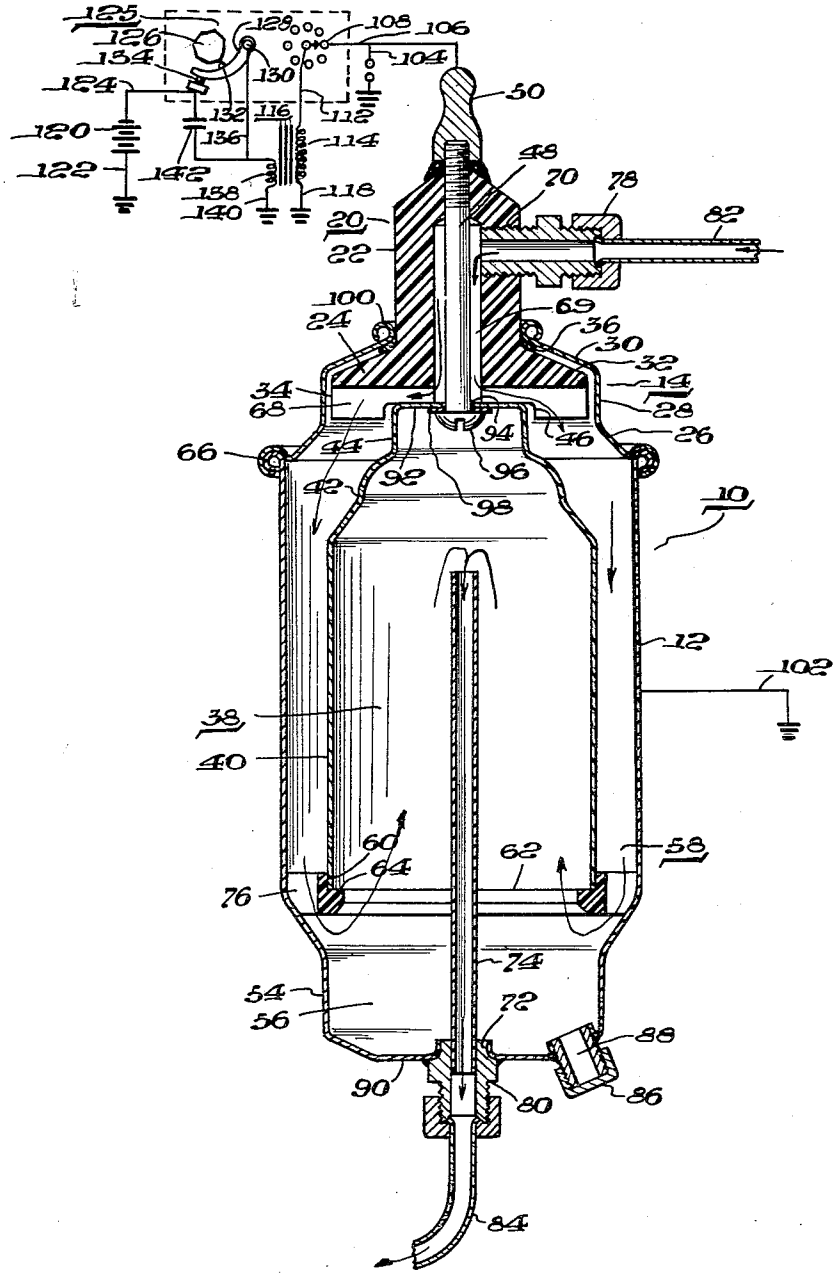


Fig. 1.

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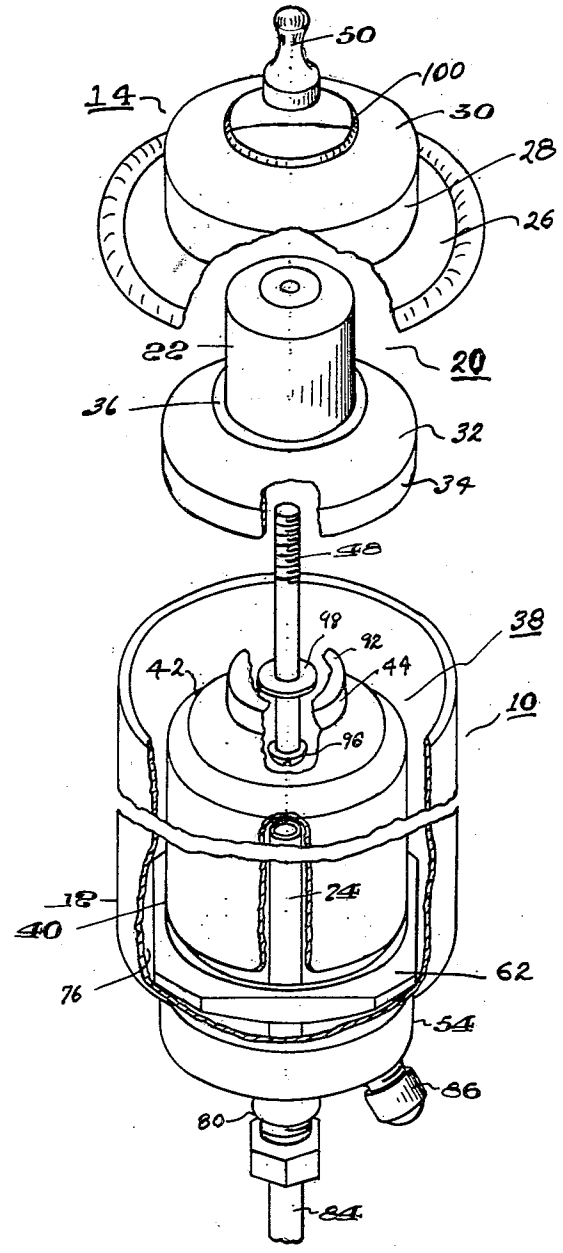


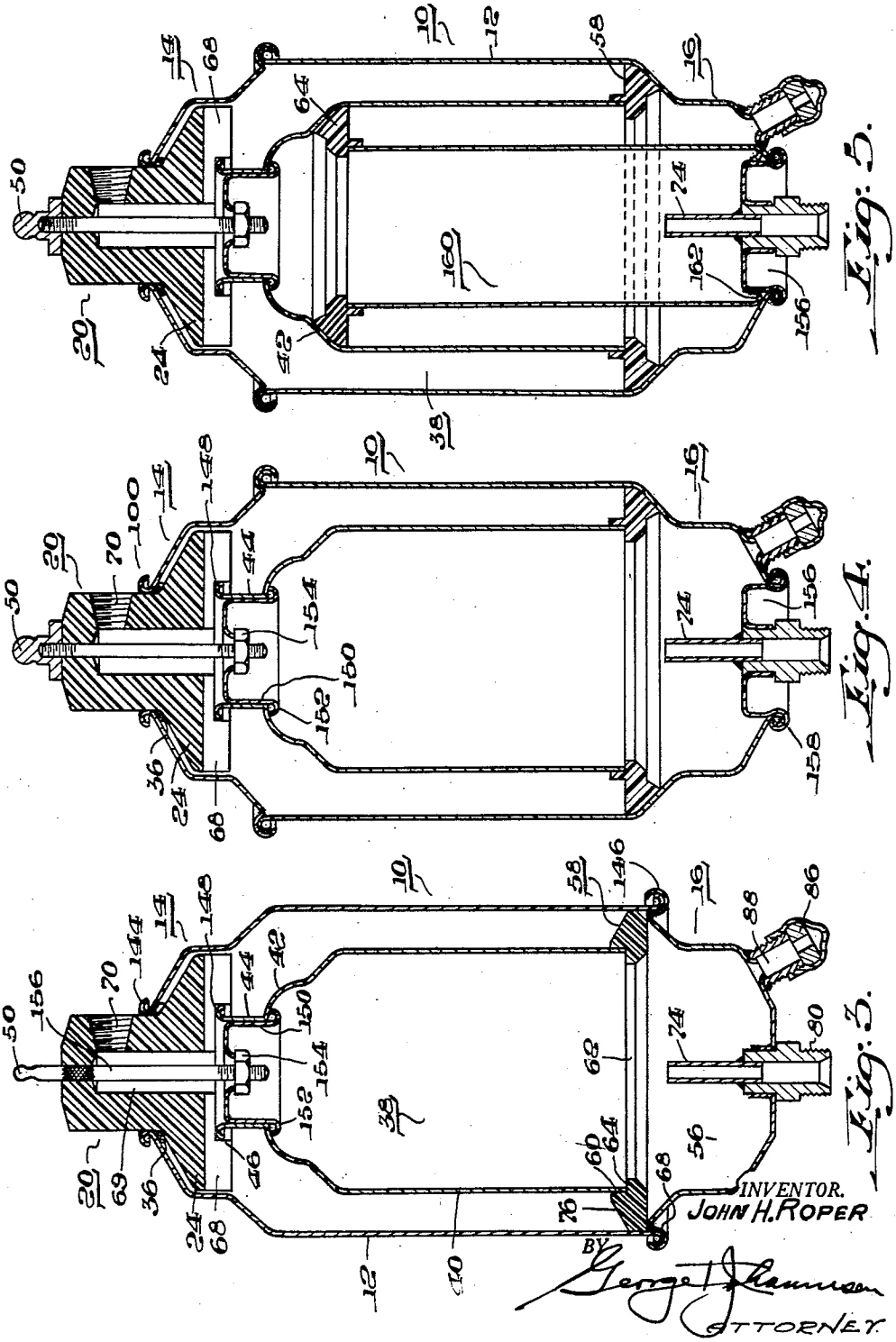
Fig. 2

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ELECTRICAL PRECIPITATORS

Filed Aug. 8, 1952 3 Sheets-Sheet 3



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2,773,827

ELECTRICAL PRECIPITATORS

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Application August 8, 1952, Serial No. 303,307

5 Claims. (Cl. 204—305)

This invention relates to electrical precipitators and is particularly directed to new and useful improvements in electrical precipitators adapted for cleaning oil, particularly in connection with internal combustion engines.

It is generally well known in the art that oil can be cleaned to remove dispersed particles by passing it through the discharge field of an electrical precipitator. It is also well known that water emulsified in oil can be coagulated and removed therefrom by suitable electrical treatments, such as treatment of oil with an alternating current discharge. In my copending application, Serial Number 282,-334, filed April 15, 1952, I have shown how oil used to lubricate internal combustion engines can be cleaned effectively of both dispersed particles and emulsified water by passing it through the discharge field of an electrical precipitator energized by the ignition coil of the internal combustion engine.

It is an object of this invention to provide improved electrical precipitators suitable to purifying oil of an internal combustion engine which precipitator can be energized by the ignition coil of the internal cumbustion engine or any similar Ruhmkorf coil. A further object of this invention is to provide electrical precipitators of the class described which may be constructed cheaply and efficiently. A further object is to provide electrical precipitators of such design and construction that they can be fabricated in can-forming machinery. Further objects will appear as the description proceeds.

It is standard practice in the can industry to form cans suitable for withstanding relative high pressures by deep drawing sheet metal into bell-shaped elements or units having a main cylindrical body portion and a cup-shaped top or bottom. These standard elements are fabricated into suitable pressure vessels commonly used for dispensing insecticides, shampoos, lacquers, and the like. I now have found that these bell-shaped elements or units can also be successfully used in fabricating the shell or housing and the collecting and discharge electrodes of the electrical precipitators according to this invention. Thus by using deep-drawn, seamless can elements suitably arranged to provide concentric collecting and discharge electrodes in a pressure-tight housing, an efficient electrostatic precipitator is provided which can be fabricated by standard can-forming machinery. Units according to the invention are adapted to the mass production characteristic of the can industry and have the advantage of the economy also characteristic of that industry.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages, and specific objects attained with its use, reference should be had to the accompanying drawing and description in which I have illustrated and described preferred embodiments of the invention.

In the drawing:

Figure 1 is a side elevation in section of a preferred modification of the invention;

Figure 2 is an isometric view of the apparatus shown in Figure 1 partly exploded and partly in section; and

Figures 3, 4, and 5 are side elevations in section of modifield forms of the invention.

In the several views like reference numerals are used to indicate like parts.

Referring now more particularly to Figures 1 and 2, but generally to the other forms of the invention shown, it will be seen that the electrical precipitators according to this invention are formed of a housing or shell **10** having a cylindrical main body portion **12** and cup-shaped top and bottom portions **14** and **16** respectively. The housing **10** is closed except for an axially disposed circular opening **18** in the top section **14**, which is closed by an insulator **20**.

The insulator **20** has a cylindrical portion **22** and an outwardly flaring enlarged bottom portion **24** shaped to conform with the shape of the top portion **14** of the shell or housing **10**. The top portion **14** of the shell or housing **10** slopes inwardly at **26** to a cylindrical portion **28** and then inwardly at **30** to the cylindrical portion **22** of the insulator **20**. The bottom portion **24** of the insulator **20** has a shoulder **32** sloping outwardly with the same slope as the inwardly sloping portion **30** of the top portion **14** of the shell or housing **10** and has a cylindrical portion **34** of a diameter to fit snugly in the cylindrical portion **28** of the top portion **14** of the shell or housing **10**.

A ring gasket **36** is disposed between the shoulder **32** and the inwardly sloping portion **30** of the top **14** and by means which will be described is under compression therebetween to provide an hermetic seal whereby the housing **10** is completely closed and pressure tight except for inlets and outlets which will be described.

Arranged within said shell or housing **10** is an inner member **38** supported by the insulator **20** having a cylindrical surface **40** concentric with the cylindrical portion **12** of the shell or housing **10** and spaced therefrom. From the top of cylindrical surface **40**, the inner member **38** slopes inwardly at **42** to cylindrical portion **44** which snugly fits into a circular, axially disposed depression **46** in the bottom of the insulator **20** and is secured therein by a bolt **48** which projects upwardly along the axis through said insulator **20** to a binding post **50**.

The bottom portion **16** of the housing or shell **10** slopes inwardly at **52** to a cylindrical portion **54** to provide a shoulder, also designated by the reference numeral **52**, and a well or sump **56** below said shoulder. Resting on said shoulder is a second insulator **58** having an axially disposed, circular depression **60** in the top thereof shaped to receive with a snug fit the bottom of the cylindrical surface **40** of the inner element **38**. The bottom of the depression **60** is cut away as shown at **62** to provide a central opening therein and to leave a ledge or shoulder **64** on which the bottom of the cylindrical surface **40** rests. It will be seen, therefore, that the insulator **58** is supported by the shoulders **52**, that the inner member is supported by the insulator **58**, and that the insulator **20** is supported by the inner member **38**. Consequently when the elements of the housing **10** are united by a crimp or rolled seam as shown at **66**, Fig. 1, the top portion **14** is forced down onto the ring gasket **36** which is formed from neoprene rubber or other oil-resistant, compressable and resilient material, and compresses it into a permanently compressed condition thereby forming an hermetically sealed and pressure-tight unit.

The insulator **20** is provided with one or more diametrically disposed saw slots **68** across the bottom thereof, an axial bore **69** projecting upwardly from said saw slots into said cylindrical portion **22**, and a radial bore **70** in said cylindrical portion **22** projecting into said axial bore **69**, thus forming a passageway from the exterior through

said radial bore, down said axial bore to said saw slots and into the space between the cylindrical portion 12 of the shell or housing 10 and the cylindrical surface 40 of the inner member 38.

The passages 76 are formed by constructing the insulator 58 as a square-shaped member having its corners cut on the curvature of the shell 10. The curved corners thus rest on the shoulder 52 of the shell 10 and the sides are spaced therefrom to form the passages 76.

Suitable fittings 78 and 80 are provided respectively for the radial bore 70 and the axial opening 72 for connecting with pipes 82 and 84 leading to and from the oil reservoir of an internal combustion engine. In operation, the shell of housing 10 is grounded. The binding post 50 is connected with the lead to one of the spark plugs, and oil is pumped into and out of the unit through lines 82 by a suitable oil pump (not shown), such as, the oil pump used for circulating oil in the internal combustion engine to which the unit is attached. The oil as it passes through the precipitation zone, that is, the space between the cylindrical portion 12 of the shell of housing 10 and the cylindrical surface 40 of the inner member 38, is cleaned of its dispersed particles and emulsified water. These collect in the well or sump 56 and are periodically drained by removing the closure 86 of the drain outlet 88.

In the form of the invention illustrated in Figs. 1 and 2, the cylindrical portion 12 and the bottom portion 16 of the housing 10 are integral parts of a deep-drawn seamless can element. The inner member 38 is a similar deep-drawn, seamless can element of smaller diameter. These elements are stamped and/or drawn from iron or mild steel of deep-drawing quality or other ductile metal, such as, aluminum, copper, brass, and the like. These elements may be subjected to further can-forming operations as will be described in connection with the other modifications, but in the form of invention shown in Figs. 1 and 2, are unfinished except as to provide for the starting of the rolled or crimped seam 66 and to provide a protective coating as will be described later. The tops of these stampings or drawings are left intact as shown at 90 and 92, except for the opening 72 in the bottom portion 16 of the shell or housing 10 and for an opening 94 in the top 92 for the passage of bolt 48. The top 92 is thus secured firmly against the insulator 20 by the head 96 of bolt 48. A suitable washer 98 may be used.

The top portion 14 of shell 10 is formed of a similar stamping or drawing without the cylindrical portion. In this case, however, further can-forming operations have been performed to provide the opening 18 with a rolled edge 100. When the various elements are assembled in the relation shown in Figs. 1 and 2, the seam 66 is rolled, and at the same time, the top portion 14 is forced down with enough force to place the ring gasket 36 under compression as already described.

In the modifications shown in Figs. 1 and 2, the tube 74 extends upwardly to a point adjacent the top of cylindrical surface 40 of the inner member 38 to provide an exit for the cleaned oil as far above the well or sump 56 as practical. Thus as the oil flows through pipe 82 down through the precipitation zone and upwardly to the exit, or while the oil is standing in said unit, ample opportunity is given to permit settling out of any precipitated particles or coalesced water which might have been picked up by the oil as could happen if the well or sump 56 were not drained frequently enough. There is thus provided a unit which can be formed, except for the insulators and fittings, by standard can forming operations. It is thus possible in accordance with this invention to produce units with the economy and efficiency of can forming operations.

The insulators shown are suitably formed as injection mouldings of any suitable plastic, and the forms shown and described are particularly well adapted for injection mouldings. Preferably they are formed of a thermal-setting resin, such as a phenol-formaldehyde resin. Such resins have the advantage of heat stability and economy. Other materials can be used, such as ceramics and like standard insulating materials.

The unit which has thus been described is energized suitably by the ignition coil of the internal combustion engine with which it is used. All that is necessary for this purpose is to connect the housing 12 to ground as shown at 102 and the binding post 50 to one of the leads 108 of the distributor head 110 leading to a spark plug as exemplified by the spark gap 104. The spark plug and the unit are, therefore, in parallel and are actuated through the distributor head 110 by the ignition coil of the engine. Thus the connection 106 leads to one of the distributing points 108 of the distributor head shown diagrammatically in box 110. The rotary contact of the distributor head leads through conductor 112 to the secondary 114 of the ignition coil 116 and to ground through conductor 118. The secondary 114 is energized by battery 120 which has its positive pole connected to ground by conductor 122. The negative pole 124 is connected to the make-and-break circuit 125 of the distributor head 110. This make-and-break circuit comprises a rotating cam 126, a contact arm 128 pivoted at 130 and provided with a cam rider 132 operative on rotation of the cam 136 to make-and-break contacts 134. The contact arm 128 is connected by conductor 136 to the primary 138 of the induction coil 116 which in turn is connected by connector 140 to ground. The condenser 142 is connected across the contact points 134 to minimize arcing. When the contact is made by contact points 134, the primary 138 is energized to the potential of the battery 120. When the contact 134 is broken, this potential goes rapidly to zero and induces in the secondary 114 the high potential necessary to effect the spark discharge across the spark gap of the spark plug 104.

The current thus created is an intermittent, semi-unidirectional current as has been more particularly shown and described in my copending application supra. The direct current component of this discharge, therefore, acts to precipitate out dispersed particles and the alternating component acts to coagulate emulsified water. In operation, the dispersed particles and the coagulated water collect on the surface of the collecting electrode and settle out into the sump 56 when the engine is not in operation. The unit described, therefore, constitutes a cheap, effective, continuously operatable means for purging the oil of an internal combustion engine of dispersed particles and emulsified water, including corrosive salts and acids which may be dissolved in the water.

In the deep-drawing operations necessary to form the bell-shaped seamless units described above, severe stresses are set up in the metal. These stresses coupled with the thin gauge of the metal (in standard practice the units are about sixteen thousandths of an inch thick) lead to severe corrosion problems in contact with the corrosive salts and acids found in the emulsified water in the oils of internal combustion engines. To eliminate this difficulty, it has been found advantageous to coat the units with a corrosion resistant coating. Thus the units in their stressed condition without anealing or otherwise treating to relieve such stresses are coated with a corrosion resistant coating to protect the iron or steel from which they are fabricated from being eaten away by the corrosive salts and acids in the oil. I have found that suitable coating compositions are polyvinyl lacquers and like synthetic lacquers compounded of acid resistant, synethetic resins. These coating, although non-conductors, do not interfere with the efficiency and operation of the units. Other coatings which may be used are coatings of suitably resistant metals, such as tin, which may be applied by the hot-dipping process or by electro plating.

The polyvinyl resin coatings and like synthetic resin coatings have been found particularly suitable, however, and have the advantage of economy and ease of application.

Suitable such polyvinyl resins are the polymers of vinyl chloride, vinyl bromide, vinylidedne chloride, vinyl acetate, vinyl butyrate, styrene, mixtures thereof or copolymers of two or more of these monomers with each other or with methyl acrylate, methyl methacrylate, methyl ethylacrylate and ethyl acrylate. The resins may be compounded with a plasticizer such as tricresyl phosphate, dibutyl phthalate, dioctyl phthalate, undecyl tetrahydronaphthyl ketone or cyclohexyl - o - benzoyl benzoate. The coating compositions are prepared from these resins by dissolving them in solvents well known in the lacquer and varnish industry, such as acetone, alcohol, and the usual spirit solvents. Suitable coating compositions may also be prepared by using the aqueous emulsion or dispersion which results from the emulsion polymerization of the monomers or monomer mixtures. When such aqueous dispersions are used, the coating must be heated above the softening temperature of the resin either during the drying or subsequent thereto to fuse the voids and to give a continuous and impervious film.

The rolled seams may be rolled with a thin layer of neoprene or like gasket material to provide a pressure-tight seam.

The distance between the discharge electrode and the collecting electrode is critical in establishing a discharge field in the precipitation zone. If the distance is too great, no discharge field is set up, if it is too small, arcing over is likely to occur especially if there are imperfections on the surface of the electrodes. This is minimized, however, because the spark plug is in parallel with the unit and rapidly discharges the induced potential. In general, the distance between the two electrodes may be greater if the electrodes are free of imperfections which tend to promote a point discharge and arcing over. The seamless, deep-drawn can elements are of particular advantage, therefore, because of their continuously uninterrupted, smooth, regular surface and because of the high ratio, at least 0.5, of the discharge surface to collecting surface. Thus in apparatus of the character illustrated, it has been found that a distance of 0.25 inch gives satisfactory results. This may be varied a few hundreths inches either way. In general, satisfactory operation is obtained with a distance between the two electrodes from about 0.2 to 0.3 inch.

Referring now more particularly to Fig. 3, there is illustrated a modification in which the parts are assembled in a different manner and in which further can forming operations have been performed on some of the parts. It will be observed first that the housing **10** and top **14** are formed of a single bell-shaped deep-drawn seamless can unit in which a neck has been drawn in the cup-shaped top and rolled back to form the bead **144** which corresponds to bead **100** of Fig. 1, and that the bottom **16** is formed of a deep-drawn seamless can element similar to that already described in connection with the top **14** of Fig. 4. These two units are united by a rolled seam **146** which corresponds to rolled seam **66** of Fig. 1.

The inner member **38** has its neck **34** rolled back to provide a bead **148** which fits snugly into the axial depression **46** and is held therein by the cap-shaped washer **150** which is also a can element formed in a single stamping operation. A rolled edge **152** engages a shoulder **42** of the inner member **38** so that when nut **154** is tightened on bolt **156** the inner member **38** is secured firmly to the insulator **20**. The bolt **156** is knurled or milled at **158** and cast as a unit with the insulator **20**.

The pipe **74** in this modification does not extend upwardly as far as in the modification of Fig. 1. The reason for this is that this modification is designed primarily for an upward flow of oil so that it is only necessary to extend pipe **74** up far enough to provide a quiescent zone in the sump **56** for the accumulated sludge. Otherwise, the unit of Fig. 3 is constructed and operated as the unit of Fig. 1.

Referring now more particularly to Fig. 4, it will be observed that the inner member **38** is constructed and attached to the insulator **20** in the same manner as in the unit of Fig. 3 and that the housing **10**, top **14**, and bottom **16** are formed essentially as in Fig. 1. It will be observed, however, that in bottom section **16** a further can operation has been performed to provide an opening like the opening through which the insulator **20** projects in Fig. 3 and the opening is sealed by a cap **156** by means of the rolled seam **158**. While this requires an added step, it gives added strength and permits the addition of a second collecting electrode as illustrated in Fig. 5 when desired.

In Fig. 5, it will be observed that the cap **156** projects into the sump **56** and that a central, axially arranged tubular member **160** is positioned thereby with its beaded lower end **162** snugly fitting around the cap **156**. The insulator **164**, which is similar to the insulator **58** but smaller in diameter, rests on the shoulder **42** of the inner element **38** and positions the other end. The central, tubular member **160** is concentric with the inner member **38** and is spaced therefrom the same distance that the inner member **38** is spaced from the cylindrical portion **12** of the housing **10**. There is thus provided a unit in which the oil flows in at **70** down through an outer precipitation zone between the cylindrical portion **12** of the housing **10** and the cylindrical portion **40** of the inner member **38** and then upwardly between the central, tubular member **160** and the cylindrical portion **40** of the inner member **38** and then downwardly and out through tube **74**. The capacity of the unit is thus essentially doubled without materially increasing its cost and without increasing its size.

While I have described my invention with reference to particular embodiments, it will be understood that variation may be made therein without parting from the spirit and scope of the invention as set forth herein and in the appended claims.

I claim:

1. An electrical precipitator comprising an insulator having a cylindrical top portion and an outwardly flaring bottom portion; a metal cylinder having a top portion of smaller diameter than the main body portion of said cylinder with sloping sides connecting the two; means for fastening said top portion to the bottom of said insulator with the cylindrical portions of said insulator and said metal cylinder having a common axis; a metal shell surrounding said metal cylinder and having a cylindrical surface spaced from the cylindrical surface of said metal cylinder and arranged concentric therewith and projecting above the main body portion of said metal cylinder; said shell having walls tapering inwardly from the top of said cylindrical surface to the top portion of said insulator and conforming in shape substantially to the outwardly flaring portion of said insulator; a ring gasket disposed between the said outwardly flaring portion of said insulator and the inwardly tapering portion of said shell and having a diameter substantially the same as that of the cylindrical portion of said insulator; said shell having a cup-shaped bottom having inwardly projecting shoulders; an annular insulator resting on said shoulders and having means for engaging the bottom of said metal cylinder; said shell having top and bottom portions united by a crimp seam crimped to place said gasket under compression; inlet and outlet means for introducing and withdrawing a fluid into and from said shell and passageways therebetween for directing fluid to flow between said concentric surfaces in its passage from said inlet means to said outlet means; and an electrical conductor passing upwardly from said metal cylinder along the axis of first-named insulator to the top thereof.

2. The apparatus which comprises a cylindrical metal shell comprising two parts united by a seam, one of which has an inwardly projecting portion and an axially disposed opening therein, a non-metallic closure member in said opening inside said shell, a resilient gasket disposed between said closure member and said inwardly projecting portion, an inner cylidrical metal member in said shell

in axial position and spaced from said shell with one end supported by another non-metallic member which in turn is supported by said shell and the other end engaging said closure, said inner cylindrical member being of sufficient length that said gasket is under compression.

3. An electrical precipitator which comprises an outer metallic shell having a cylindrical surface portion, said shell being comprised of two parts united by means of a rolled seam, said shell having an inwardly projecting portion terminating in an axially disposed opening of smaller diameter than the diameter of said cylindrical surface portion, an insulator disposed in said shell having a portion projecting through said axially disposed opening and another portion fitting under said inwardly projecting portion of said shell and another insulator which engages the opposite end of said shell, a resilient gasket between said other portion of said first named insulator and the inwardly projecting portion of said shell, a cylindrical metallic member axially disposed between said insulators in spaced relation to the cylindrical surface of said shell, said cylindrical member being of such length that said gasket is placed under compression as a result of the rolling of said seam.

4. An electrical precipitator comprising an inner cylindrical electrode and an outer cylindrical electrode concentric therewith; said outer electrode comprising an imperforate housing completely surrounding said inner electrode, insulating means arranged to maintain said electrodes in said concentric relation, said insulating means having a portion projecting through said imperforate housing along the axis of said concentricity and having a shoulder portion extending under said shell, a ring gasket disposed between said shoulder portion and said shell, and means comprising said inner electrode acting against said insulating means maintaining said ring gasket under compression.

5. An electrostatic oil cleaner for motor vehicles powered by an internal combustion engine having a pressure lubrication system arranged to circulate oil through an oil cleaner comprising an imperforate outer housing having a top, a bottom and right cylindrical sidewalls; an inner housing having imperforate right cylindrical side

walls and an imperforate top; said inner housing being insulated from said outer housing and being rigidly supported therein at the top and bottom thereof with its side walls in spaced concentric relation to the side walls of said outer housing; an inlet means projecting through the top of said outer housing into the interior thereof and having a passageway leading from outside said outer housing along the axis to a point intermediate the tops of said housings; said passageway discharging outwardly and radially from said axis whereby the oil entering into said electrostatic cleaner flows radially and outwardly between the tops of said housings and downwardly through the annular space between said housings; an outlet means projecting through the bottom of said outer housing and having an axially disposed passageway leading through the bottom of said outer housing to a position within said inner housing adjacent the top thereof; and an insulated conductor passing through the top of said outer housing and making contact with the top of said inner housing whereby a potential can be impressed across the two housings; said outer housing being small enough to occupy the space provided for an oil cleaner in said motor vehicle and being proportioned to said inner housing so that the outer cylindrical surface of said inner housing is spaced from the inner cylindrical surface of the said outer housing a distance between about 0.2 and about 0.3 inches and has an area at least one half that of the apposite area of the outer housing.

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