

Jan. 7, 1930.

C. E. SUMMERS

1,742,564

AIR CLEANER

Filed Dec. 5, 1924

4 Sheets-Sheet 1

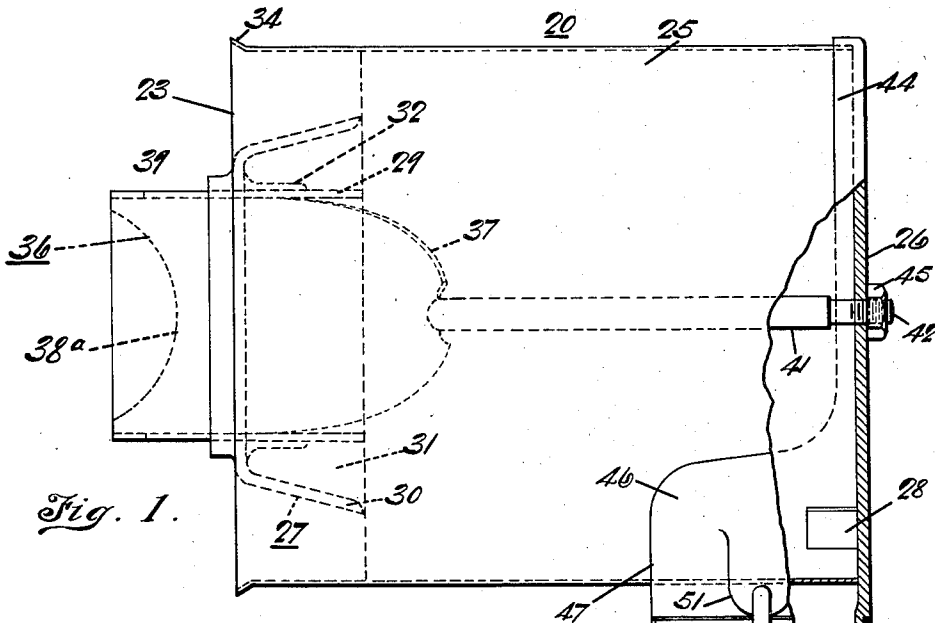


Fig. 1.

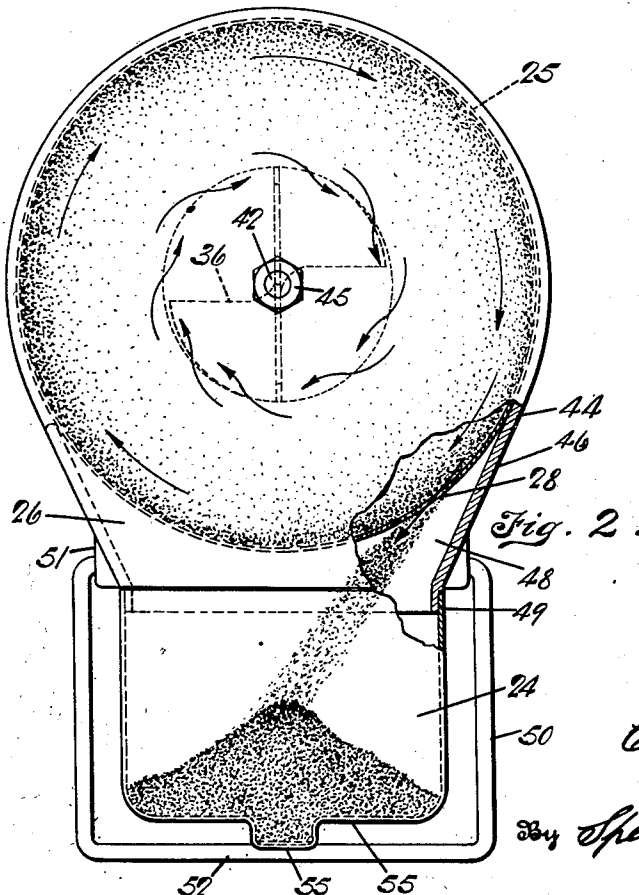


Fig. 2.

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4 Sheets-Sheet 2

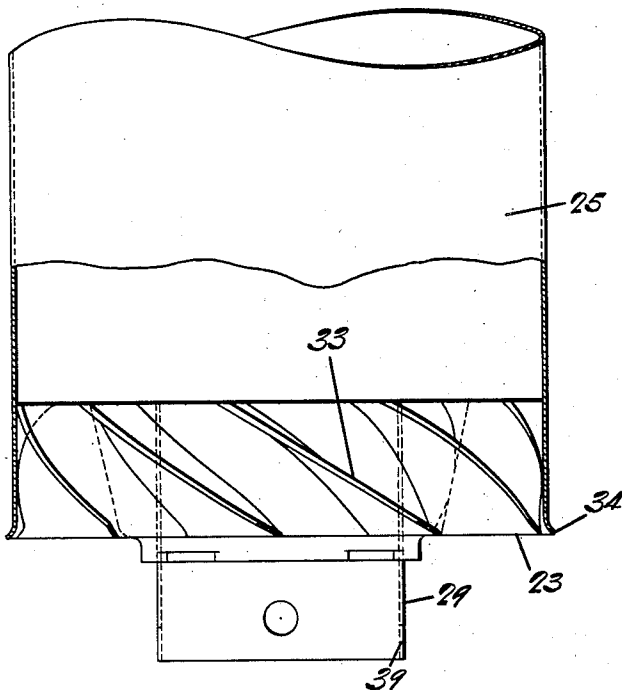


Fig. 3.

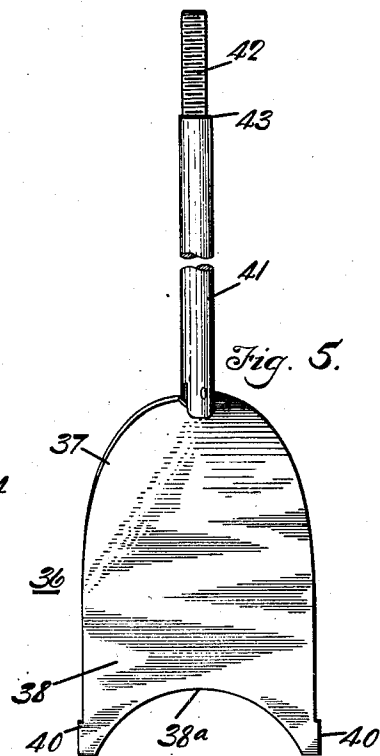


Fig. 5.

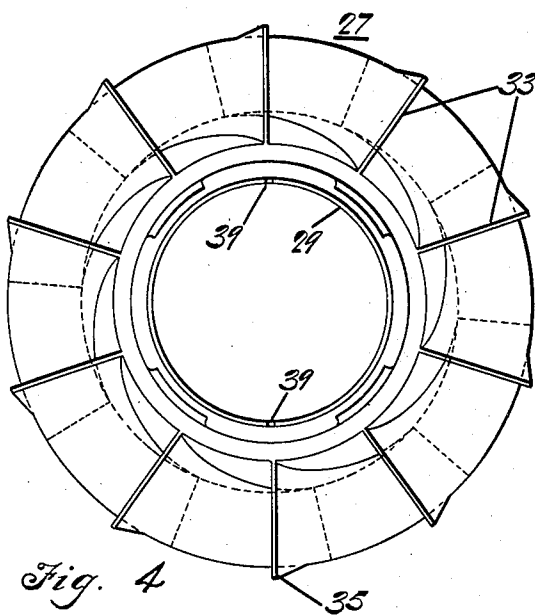


Fig. 4.

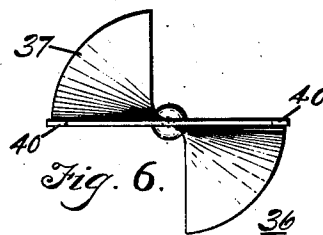


Fig. 6.



Fig. 8.

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Fig. 7. Cabb E. Summers
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4 Sheets-Sheet 3

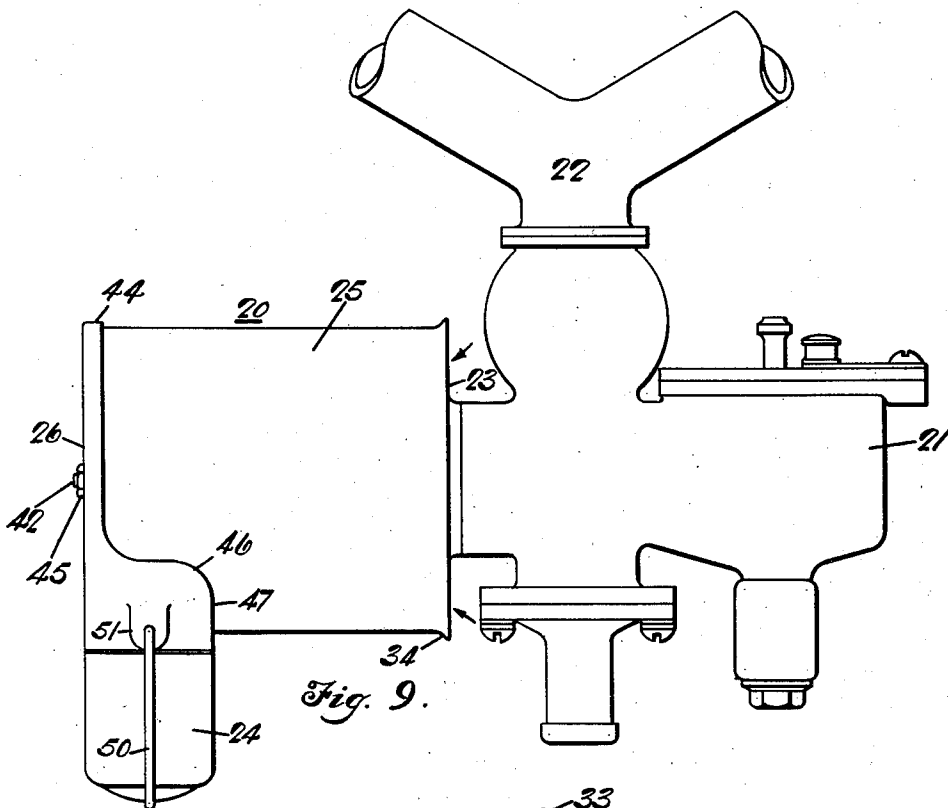


Fig. 9.

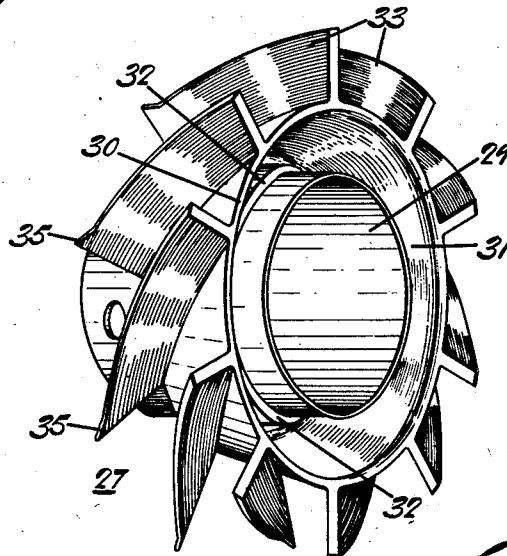


Fig. 10.

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4 Sheets-Sheet 4

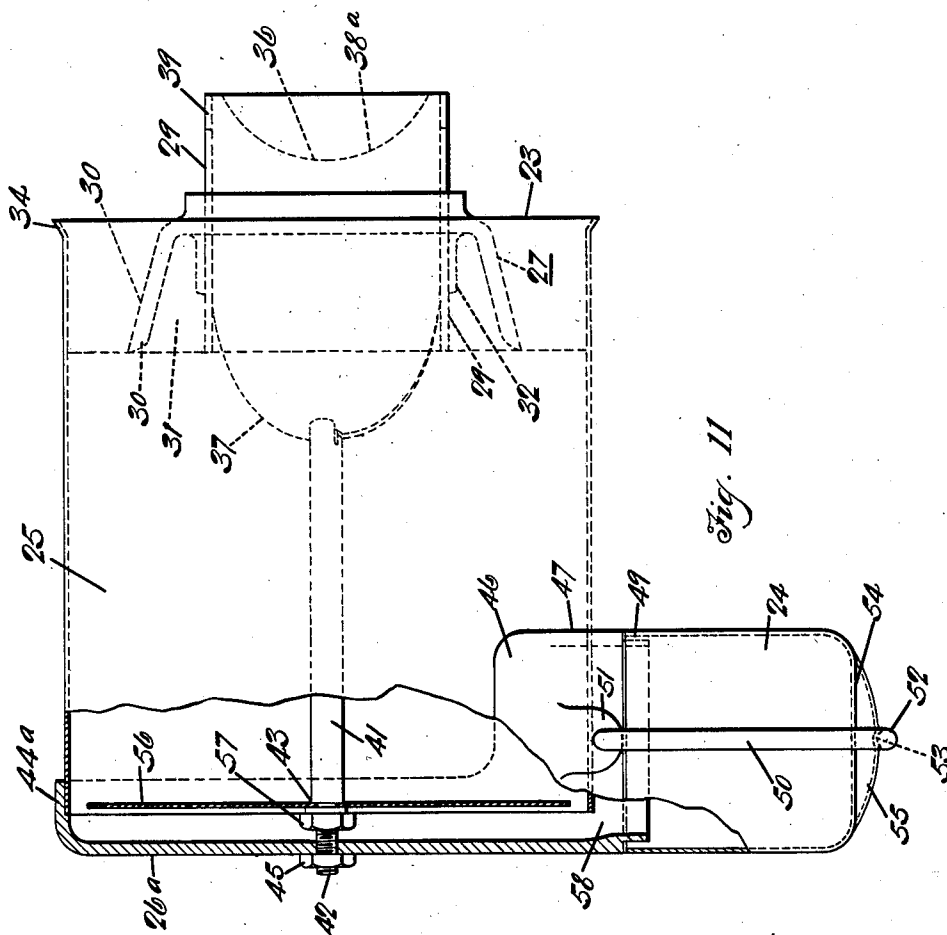


Fig. 11

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UNITED STATES PATENT OFFICE

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AIR CLEANER

Application filed December 5, 1924. Serial No. 754,007.

This invention relates to means for removing from air or other gas particles of solid or liquid matter. Specifically, it concerns instrumentalities utilizing the difference in specific gravity between an aeriform fluid and particles of other matter suspended in it to effect separation by causing the aeriform fluid to flow in a course that changes direction.

The principal object of the invention is to remove foreign particles from air proceeding to a place of use or to moving machine parts; and particularly to prevent sand, dust or other gritty matter from entering the cylinders of internal combustion engines with the fuel mixture.

The invention consists of a device, which may be arranged in or form part of the air intake of an internal combustion engine or other pumping mechanism, for deflecting the current of air on its way to the cylinders or other mechanism in such manner that any particles of heavier matter in the air current will be separated therefrom due to the greater specific gravity of said particles and their consequent superior tendency to continue in the direction of motion originally imparted to the current.

It further consists of certain details of construction fully described hereinafter, illustrated in drawings and defined in the appended claims.

In the accompanying drawings, in which the same reference characters indicate like parts throughout the several views:

Fig. 1 is a side elevation partly in section of a preferred embodiment of the invention;

Fig. 2 is an end elevation, partly in section, viewed from the right of Fig. 1;

Fig. 3 is a detail of the air-entrance end of the air cleaner having a portion of the shell removed to expose the air deflecting means;

Fig. 4 is an end view of an air deflecting means forming a part of the cleaner;

Fig. 5 is a detail showing an air straightener to be seated in the air outlet of the cleaner;

Fig. 6 is a detail showing an end view of the straightener illustrated in Fig. 5.

Figs. 7 and 8 are detail views of helical vanes or partitions forming elements of the air deflecting means;

Fig. 9 is an elevation illustrating use of the air cleaner with a carbureter and intake manifold of an internal combustion engine;

Fig. 10 is a perspective view of the air deflecting member, and

Fig. 11 is a side elevation, partly in section, of a slightly modified form of air cleaner.

In order to avoid rapid wear of the cylinders, pistons and valves of the internal combustion engines of motor vehicles, or improper seating of the valves due to admission, with the fuel charge, of bits of sand or other grit, it is desirable to provide means for cleaning the air used for supporting combustion in the cylinders before it mixes with the fuel.

To be adapted for use with motor vehicle engines an air cleaner should be of such construction as to continue in operation indefinitely or for long periods without requiring attention from the operator, and should have a high degree of efficiency in cleaning without materially increasing the restriction of the air intake passage or decreasing the absolute pressure of the air at the entrance of the carburetor.

Of all known types of air cleaners the so called deflection or centrifugal type has the greatest capacity of operating for long periods without attention and is therefore best adapted for motor vehicle engines in the particular that it does not require that constant attention which the operator is unlikely to give.

The deflection or centrifugal air cleaner herein described and claimed is so constructed that no attention need be given it other than removing, emptying and replacing, from time to time, a dust receiver detachably connected to it.

The cleaner is also constructed so as to deflect the air only in such directions as to most effectively throw out of the air course all heavier particles; and when its work in this respect is completed the whirling air tends by its own inertia to escape from the separating chamber and in so doing becomes straightened out in a direct non-whirling stream toward the engine. Thus all useless and disturbing eddy

currents are avoided and no drag exists in air going to the engine by distortions of the current to no useful end.

Fig. 9 illustrates a deflection type air cleaner combined as contemplated with the carburetor and intake manifold of an internal combustion engine. The carburetor 21 is coupled to the lower end of the riser of the intake manifold 22. Air cleaner 20, which has a cylindrical separating chamber, is attached to the carburetor with the axis of the chamber substantially horizontally positioned when the engine is upright, with the clean air outlet of the separating chamber communicating with the air intake of the carburetor. Thus, the intake manifold, carburetor mixing chamber and carburetor air intake constitute a draft or eduction conduit in which a low pressure is produced by the operation of the engine, thereby drawing air through the separating chamber of the air cleaner to the combustion spaces of the engine. In the embodiments illustrated the inlet for air to be cleaned and also the outlet for clean air are at the end of the chamber that is next the carburetor, while at the other end is a wall that checks movement of air in an axial direction and an opening radially distant from the axis of the chamber providing for escape of dust or other heavier than air particles. The air inlet occupies an annular space in the end 23 of the chamber, the inlet facing in a direction parallel with the axis of the chamber, and is associated with means for imparting a whirling movement to the incoming air, thus producing a vortex within the chamber, the outer portion of which is moving at a high speed adjacent the periphery and thus tending to thrust all particles of matter that are heavier than air outward against the periphery and to cause them to move in helical paths toward the other end of the chamber. The outlet for heavy particles is preferably in the low portion of the chamber and communicates directly with the outer high speed portion of the vortex where the heavy particles are carried so that the latter will be projected forcibly through said outlet. The clean air outlet communicates directly with the inner portion of the vortex which is substantially free from dust or other heavy particles. The clean air outlet is preferably a tubular member extending into the chamber concentric with the axis thereof and is of a cross sectional area not greater than the area of the circle encompassed by the annular air inlet. As shown in Fig. 9, this outlet may be at the same end as the inlet and concentric therewith in order to gain increased separating effect by compelling the air to reverse its general direction of movement within the chamber in order to get out. The clean air outlet and the outlet for dust and other heavier particles are separated both radially and longitudinally and are in such relative posi-

tions with respect to the inner and outer portions of the vortex that substantially no dust can pass to the carburetor with the air drawn into it.

The air cleaning element shown in Figs. 1 to 10 comprises a cylindrical shell at one end of which is an air deflecting member 27 containing inlet passages for air to be cleaned and an outlet for clean air. At the other end of the shell is an end wall consisting of a cap 26 which checks further movement in an axial direction of air to be cleaned which has entered through the inlet.

Figs. 1 and 9 indicate a favorable position of the air cleaner of this particular embodiment in use, its axis being approximately horizontal. An orifice 28 in the shell 25 allows the separated grit or other relatively heavy impurities to leave the separating chamber tangentially and enter the dust receiver 24 well toward the middle of the latter.

The air deflecting member 27 comprises a preferably straight tubular core 29 surrounded, as shown, by an annular flange or dome 30 of truncated cone shape flaring toward the interior of the chamber the free edge of which is in substantially the same plane as the inner end of said straight tubular core 29 and concentric with it. The other or outer end of tubular core 29, in the embodiment illustrated, projects some distance beyond the smaller end of flange 30 and beyond the open end of shell 25, and serves as a means of connecting the air cleaner with the manifold or carburetor, when the air cleaner is made separate, as shown, instead of as an integral part of the equipment. When the cleaner is in operation a current of air circulates continuously in the annular channel 31 between the flange 30 and the tubular core 29. When the flange 30 is made separate from the core 29, the band 32, integral with the flange 30, serves as a convenient member by which the flange may be secured firmly to the core. Partition vanes 33, of helical form, are fashioned on or attached to the exterior of the flaring flange 30 and are so contoured as to fit snugly within the open end of the cylindrical shell 25. These vanes are therefore narrower at the larger end of the conical flange than at the smaller end thereof, and the passages between them correspondingly contract in cross sectional area from one end,—the entrance end,—to the other. When deflecting member 27 is assembled with the shell 25, the core 29 protrudes some distance beyond the open end of the shell, as stated, and the wider ends of the vanes 33 are substantially flush with said open end. Thus, helical passageways for the entrance of air are provided close to the interior surface of the shell the inlet orifices of which face outward from the chamber in a direction substantially parallel with the axis of the shell 25. These passage-

ways decrease in cross sectional area from their exterior or inlet ends to their outlet ends within the separating chamber by reason of the slant of their inner walls toward the inner surface of the shell, so that air forced through said passages is given a smooth, helical motion of high speed entering the cylindrical shell as a relatively thin walled tube, as it were, of whirling air. With the described arrangement of the blades 33 it will be noted that they have their inner ends spaced from the axis of the shell 25 by an amount substantially equal to the radius of the clean air outlet constituted by the tubular core 29. In the assembly shown the open end of shell 25 is slightly flared, as at 34, and the wide ends of vanes 33 are correspondingly inclined and offset, as at 35, to engage the flared end of the shell, in order to facilitate assemblage and accurate location of the air deflecting member longitudinally with respect to the shell. Although for convenience of manufacture the shell and air deflector are shown and described as made of separate parts assembled together it will be evident they would function in the same manner if made integral.

The tubular core 29 of deflector 27 provides an exit for the air that has been drawn into the separating chamber through said helical passages. In order to get out, the air current, to which a vortical motion of high speed has been imparted by the rush through the helical passages over the conoidal flange 30, must double back centrally of the intrushing current by way of the tubular passage in core 29 on its course toward the engine cylinders. By reason of its inertia, the whirling motion imparted to the air, if not checked, would continue during its passage through the core and thus impose a needless resistance to the engine, since the useful work of the whirling current has been completed. In order to gradually check the whirling motion within the core 29 there is provided an air straightener 36 within said core which is screw formed at its inner end. The straightener 36 consists of a thin plate of suitable material, such as metal, having its edges snugly engaging the inner surface of the tubular core. The inner end of this plate, is of twisted or screw form and this twisted end may protrude into the chamber within the shell 25. The other portion that lies within the core toward the outlet end is plane or flat. Said straightener plate 36 may have a twist for a portion of its length forming a pilot vane as at 37 extending across the inner end of the passage through the core. Plate 36 may be plain or flat for the remaining portion of its length as at 38. The pitch of the pilot vane or twisted portion of the straightener plate is opposite to that of the helical inlet passages in the illustrated embodiment and is in the same general direction

as the helical path of the air. If, for example, the vanes 33 of the inlet passages, looking toward the inlet end—the left hand end of Figure 1, or the bottom of Figure 3,—have a left hand pitch, then the pilot vane of the straightener plate will have a right hand pitch at its inner end, and preferably of the same pitch angle as that of the helical path of the air, but gradually increasing in pitch until it merges with the flat portion, 38, and so is adapted to guide the whirling current of air within the shell into the central outlet through the core and gradually convert it into a straight flowing stream without setting up eddies. Thus the vortical current of air tends to screw itself out through the outlet and gradually changes, in normal stream lines, into a straight flowing current moving out of the separating chamber in a direction reverse to that of the inward rush after the work of throwing out the heavy particles has been completed. The curved recess 38^a at the outer end of the straightener plate is merely to avoid obstruction to the movements of a butterfly choke valve, should one be used in close proximity to the end of said plate.

In the embodiment illustrated, the flat portion of the straightener plate is approximately vertical or in a plane that intersects the dust cup or receiver 24 from top to bottom, although this is not essential. Opposite notches 39 are formed in the outward projecting end of tubular core 29, which are engaged by lugs or projections 40 on opposite sides of air straightener 36. A rod 41 has one end attached to the inner twisted end of the straightener. The other end of this rod is reduced and threaded, as shown at 42, leaving a shoulder at 43. By reason of this construction the straightener 36 and attached rod 41 may serve as a stay bolt or tie to bind the assembled parts of this air cleaner together as will presently be explained.

The cap of cover 26 at the end of shell 25 that is opposite the air inlet and outlet is relatively stiff. It may be a die casting of light, strong metal having a flange 44 within which the end of shell 25 nicely fits. A central hole in cap 26 permits the passage therethrough of the threaded end 42 of rod 41. Nut 45 screwed upon the end 42 against the outer face of the cap binds together the entire assembly of shell, cap, air deflecting and straightening members.

Looking towards the closed end of the air cleaner, the cap 26 appears, as in Fig. 2, circular in outline for the greater portion of its circumference, but departing from a circular outline for the remainder or lower part in such manner as to form a space between opposing portions of the flange and shell into which space the dust discharging orifice opens. The flange 44 of cap 26 is abruptly widened where the circumference of the cap

departs from a circle, as indicated at 46, and the edges 47 of said wide flange portions 46 are connected by a wall 48, which is curved on an arc fitting the curvature of shell 25. Thus the lower portion of cap 26 is of hopper-like formation, two of the sides of which are symmetrically inclined, narrowing the space between them toward an open lower end while the other two sides are substantially parallel.

The lower end of the hopper-like part of cap 26 may be rabbeted as at 49, to receive the upper edge of the dust cup or receiver 24. The dust receiver 24 is shown as held in place by a bail 50, preferably of somewhat elastic wire, having its ends pivoted in socketed lugs 51 on the wide flanged parts 46 of the cap. The lower transverse part 52 of the bail is adapted to seat in a shallow notch or groove 53 in the bottom 54 of receptacle 24. That part of the bottom 54 that contains the notch or groove 53 should of course project lower than other parts to permit the bail to swing free of the corners of the receiver. In the form shown the bottom 54 has an elongated, arcuate depression 55 embossed therein, extending in a direction lengthwise of the air cleaner axis, in the exterior of which the shallow notch 53 is formed. The dust receiver may be readily detached, emptied, and again attached by the means described.

In Fig. 11 there is illustrated a slight modification wherein a baffle 56 is secured in such position as to form an annular air space between it and the inner surface of the cap 26^a and an annular entrance for dust to said air space around its outer edge. As a suitable means for securing the baffle 56 in place, a hole is formed in the center of it through which the threaded portion 42 of tie rod 41 is passed. The baffle 56 rests against shoulder 43 of the tie rod and is there rigidly secured by a nut 57 screwed against it. As long as the baffle provides an air space between it and the cap and an annular entrance for the dust whirling along the inside of the shell toward the cap, it functions as intended irrespective of the particular means by which it is held in correct position. By reason of the presence of the baffle minor changes in the construction of the cap are desirable. This cap 26^a has a flange 44^a which is somewhat wider than the flange shown in Fig. 1 and has an internal rabbet for receiving the end of shell 25 thereby spacing the end of said shell farther from the inner face of the cap, as shown. The spacing of the end of shell 25 from the inner face of the cap affords a wide opening, circumferentially, between the lower portion of the end of said shell and the outer wall of the hopper-like lower portion of the cap, as indicated at 58. Through this wide opening the dust and grit thrown into annular air space may drop

under the influence of gravity into the receiver 24.

Although the described air cleaner has been particularly designed for use with internal combustion engines it is clearly capable of use in other relations. When in operation to clean the air used as a supporter of combustion for internal combustion engines the moving pistons of the engine will draw air into the separating chamber through the described annular row of helical inlet passages and out in a reverse direction through the central outlet passage toward the engine intake. The helical, gradually contracting inlet passages impart a high speed helical movement to the dust laden air which tends, by reason of the inclination of the inner walls of said helical passages and the inertia of the air and dust, to hug the inside of shell 25 as a relatively thin whirling layer and continue to whirl within the separating chamber after leaving the passages. According to the principle on which centrifugal or deflection separators operate any particles of matter floating in the air streams that are heavier than air are thrown outward in helical paths along the inner wall of the chamber toward the cap or closure at the other end, while the whirling air currents soon lose their impetus toward the cap, but, still whirling, begin to travel toward the outlet, retreating, inside of the entering currents, parallel to the general direction of their entrance. As the whirling air engages the twisted end of the straightener plate it tends to screw itself, as it were, by its own inertia out through the outlet, and so its vortical movement becomes gradually checked and the current converted to a straight flow through the hollow core; and thus the air becomes separated from dust and grit. In the form of air cleaner shown in Fig. 1 the dust and grit are projected out forcibly in a tangential stream through the orifice 28, the orifice being preferably placed in such position that the stream will enter the dust receiver 24 at a median point well within its edges. In the construction shown in Fig. 11 the dust and grit thrown into the space behind the baffle 56 will have there lost to some extent its whirling movement and will gravitate through the wide opening 58 into the receiver 24. The annular channel 31 between the core 29 and the conical flange 30 is filled, during operation, with air traveling at high speed around the core in the same angular direction as the main body of air. This circular current of air prevents dust from creeping along the inner surfaces from the inlet passages to the outlet passage, as it has been found dust has a tendency to do when it finds a smooth surface to creep on.

The main parts of this air cleaner may be made of any suitable materials, preferably of die cast and wrought light alloys; though

the tie rod 41 and spring bail 50 may be made of steel.

The term air, as used in the specification and claims, may be deemed to include any aeriform fluid.

It will be understood that the proper functioning of the air cleaner to which this invention relates is not dependent upon the particular materials or exact details of construction described hereinbefore. The best forms in which the invention has thus far been embodied have been described as required by the patent laws, but the scope of the invention is not intended to be limited to these specific forms.

What I claim and desire to secure by Letters Patent is:

1. A separator of the class described comprising a separating chamber having inlet and outlet passages of less cross sectional area than the chamber and adapted to have air passed therethrough; means for imparting a whirling movement to the air entering the chamber; an air straightener comprising a pilot vane disposed across the outlet passage, said vane having the surfaces of its inner end angularly disposed with respect to the surfaces of its outer end and being so formed as to gradually straighten the stream of air entering the outlet passage.

2. A separator of the class described comprising a separating chamber having inlet and outlet passages of less cross-sectional area than the chamber and adapted to have air passed therethrough; means for imparting a whirling movement to the air entering the chamber; an air straightener comprising a pilot vane of screw-like form disposed across the outlet passage, the pilot vane being pitched in the same general direction as the whirling air and increasing in pitch from its inner end.

3. A separator of the class described comprising a separating chamber having inlet and outlet passages of less cross-sectional area than the chamber, and adapted to have air passed therethrough; means for imparting a whirling movement to the air entering the chamber; an air straightener comprising a pilot vane of screw-like form disposed across the outlet passage, the pilot vane having its inner end pitched at substantially the same angle as the helical path of the whirling air and gradually increasing in pitch from its inner end.

4. A separator of the class described comprising a separating chamber having inlet and outlet passages; means for imparting a whirling movement to the air entering the chamber; an air straightener comprising a pilot vane of screw-like form at its inner end disposed at least in part within the outlet passage and a flat portion within said outlet passage into which said screw-like form merges.

5. A separator of the class described, comprising a separating chamber having at one end an annular series of helical air inlet passages, an outlet passage the axis of which is substantially in line with the center about which said inlet passages are disposed, and an air straightener within said outlet passage having a screw-like inner end.

6. A separator of the class defined in claim 5 in which the screw like inner end of the straightener merges in to a flat portion toward its outer end in the outer portion of the outlet passage.

7. A separator of the class defined in claim 5 in which the inlet passages diminish in cross sectional area from their entrance ends toward their discharge ends within the chamber.

8. A separator of the class defined in claim 5 in which the inner walls of the helical passages incline from their entrance ends toward the periphery of the chamber.

9. A separator of the class described, comprising a separating chamber having at one end an annular row of helical inlet passages surrounding and concentric with an outlet passage, and an air straightener within the outlet passage having a screw-like inner end of pitch opposite to that of the surrounding inlet passages and increasing in pitch from its inner end.

10. A separator of the class described, comprising a separating chamber having at one end an annular row of helical inlet passages surrounding and concentric with an outlet passage, and an annular channel concentric with the outlet and inlet passages, said channel spacing the inner end of said outlet passage from the inner end of the inlet passages within the chamber.

11. A separator of the class described comprising a shell of circular section having a closure at one end and an air deflecting member at the opposite end, said air deflecting member consisting of a tubular core surrounded by a conoidal flange and helical partitions between the exterior of the flange and the inner surface of the shell, there being an annular channel between the conoidal flange and the tubular core.

12. A separator of the class described comprising a substantially cylindrical separating chamber adapted to operate with its axis horizontal, said chamber having inlet and outlet passages at one end and a cap at the other end; said cap having a hopper like formation at its side which underlies the chamber and said chamber having a dust outlet disposed so as to discharge into the hopper.

13. A separator of the class described in claim 12 in which a dust receiver is fitted to the lower end of the hopper and a bail pivoted at points on opposite side of the hopper detachably engages the receiver.

14. A separator of the class described com-

prising a shell of circular section, a deflecting device providing entrance and exit passages for air at one end of said chamber, and a closure cap at the other end; and a tie rod extending centrally from end to end of the shell engaging said cap and deflecting device and holding them in correct relative position with respect to the shell.

15. A separator of the class defined comprising a shell of circular section, a deflecting device having a tubular core, an annular row of helical inlet passages surrounding and concentric with the core, an air straightener secured within said tubular core, a rod secured to the air straightener, a cap closing the opposite end of the shell, one end of said rod being secured to the cap.

16. A centrifugal separator, comprising a separating chamber having an inlet, an air outlet tube projecting within the chamber, there being an annular channel surrounding the inner end of said outlet tube and spaced from the periphery of the chamber.

17. A separator of the class described, comprising a separating chamber of circular cross section having at one end an annular series of helical inlet passages for external air, the entrance ends of said passages facing outward in directions substantially parallel with the axis, an outlet passage for clean air concentric with the axis of the chamber and an outlet for relatively heavy impurities eccentrically disposed at the end opposite to that containing the inlet passages; and a baffle disposed adjacent the end of said chamber that is opposite the end having the inlet passages, said baffle providing an annular space around its edge for the passage of the heavy impurities and a space back of it with which said outlet for the heavy impurities is in communication.

18. In an air cleaner for internal combustion engines and the like, the combination of a substantially cylindrical shell terminating at one end,—and at a region of maximum diameter,—in a plane at substantially right angles to the axis of the shell providing an axial air inlet open to the atmosphere and of maximum diameter, an outwardly and rearwardly flared dome centrally arranged in the open end of the shell, an annular series of centrifugally acting stationary vanes longitudinally inclined in the direction of the axis of the shell extending from the dome to the shell for guiding the air in an axial helical swirl around the interior of the shell, said dome simultaneously directing the air outwardly against the shell, said shell provided in its periphery and at the other end thereof with a dust discharge port, an axial clean air outlet pipe extending into the shell and having its inner end shielded by the dome against the direct entrance of air currents passing the vanes.

19. In an air cleaner for internal combustion engines and the like, the combination of

a substantially cylindrical shell terminating at one end,—and at a region of maximum diameter,—in a plane at substantially right angles to the axis of the shell providing an axial air inlet open to the atmosphere and of maximum diameter, an outwardly and rearwardly flared dome centrally arranged in the open end of the shell, an annular series of centrifugally acting stationary vanes longitudinally inclined in the direction of the axis of the shell extending from the dome to the shell for guiding the air in an axial helical swirl around the interior of the shell, said dome simultaneously directing the air outwardly against the shell, said shell provided in its periphery and at the other end thereof with a dust discharge port, and an axial clean air outlet in the form of a pipe piercing the dome and having its inner end shielded by the dome against the direct entrance of air currents passing the vanes.

20. An air cleaner for internal combustion engines and the like comprising a cylindrical casing provided with an air inlet arranged to impart a whirling motion to the entering air, said casing being provided with a peripheral dust discharge orifice and with an axial clean air outlet, and an air straightener associated with said outlet for removing the whirl from the outgoing air.

21. An air cleaner for internal combustion engines and the like comprising a cylindrical casing having one end open and the other end closed, said open end being provided with an axial clean air outlet tube and an annular series of helical blades extending from the outlet tube to the casing wall to impart to the entering air a whirling motion, the opposite end of the casing being provided with an aperture arranged to discharge dust into the atmosphere, and an air straightener associated with the clean air outlet for removing the whirl from the outgoing air.

22. An air cleaner for internal combustion engines and the like comprising a cylindrical casing having an axial clean air outlet and being provided at one end with an annular series of helical blades for imparting a whirling motion to the entering air, said blades being inclined longitudinally of the casing and having their inner ends spaced from the axis of the casing by an amount substantially equal to the radius of said clean air outlet, said casing being provided at the other end with a peripheral dust discharge orifice, and an air straightener associated with said clean air outlet for removing the whirl from the outgoing air.

23. In an air cleaner for internal combustion engines and the like, the combination of a substantially cylindrical shell having an axial clean air outlet and terminating at one end,—and in a region of maximum diameter,—in a plane at substantially right angles to the axis of the shell providing an axial

air inlet open to the atmosphere and of maximum diameter, said cleaner being provided at said end and terminating substantially in the said plane with an annular series of helical blades for imparting a whirling motion to the entering air, said blades being inclined longitudinally of the casing and having their inner ends spaced from the axis of the cleaner by an amount substantially equal to the radius of said clean air outlet, said casing being provided at the other end with a peripheral dust discharge orifice positioned radially outward of said clean air outlet for the discharge of dust segregated by the whirling motion impressed on the air stream by the helical blades.

24. In an air cleaner for internal combustion engines and the like, the combination of a substantially cylindrical shell having one end closed and terminating at the other end and at a region of maximum diameter in a plane at substantially right angles to the axis of the shell providing an axial air inlet open to the atmosphere and of maximum diameter, an axial clean air outlet in the open end of the shell, and an annular series of substantially helical blades extending from the outlet to the adjacent portions of the casing wall, said blades being longitudinally inclined in the direction of the axis of the shell for guiding the air in an axial helical swirl around the interior of the shell, said shell being provided in its periphery and at the other end thereof with a dust discharge port.

In testimony whereof I hereto affix my signature.

CALEB E. SUMMERS.