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BEFORE THE TRADEMARK TRIAL AND APPEAL BOARD

Proceeding	91200832
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Attachments	O6NOR (Public Version Part 1).PDF(5365184 bytes) O6NOR (Public Version Part 2).pdf(2173009 bytes) O6NOR (Public Version Part 3).pdf(904881 bytes)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE TRADEMARK TRIAL AND APPEAL BOARD

BRIGGS & STRATTON CORPORATION Opposer, vs. HONDA GIKEN KOGYO KABUSHIKI KAISHA, Applicant.	Opposition No. 91200832 (Parent)
KOHLER CO. Opposer, vs. HONDA GIKEN KOGYO KABUSHIKI KAISHA, Applicant.	Opposition No. 91200146

United States Patent and Trademark Office
Trademark Trial and Appeal Board
P.O. Box 1451
Alexandria, Virginia 22313-1451

OPPOSERS' SIXTH NOTICE OF RELIANCE
(REDACTED – PUBLIC VERSION)

Pursuant to 37 C.F.R. § 2.122, Opposers Briggs & Stratton Corporation ("Briggs") and Kohler Co. ("Kohler") (collectively, "Opposers"), by and through their attorneys, hereby submit their Sixth Notice of Reliance. Opposers' Sixth Notice of Reliance includes the following attached materials:

1. U.S. Patent No. 4,813,385, included as **Exhibit M;**
2. U.S. Patent No. 6,362,533, included as **Exhibit N;**
3. U.S. Patent No. 6,489,690, included as **Exhibit O;**

4. U.S. Patent No. 6,331,740, included as **Exhibit P;**

5. U.S. Patent No. 6,941,919, included as **Exhibit Q;**

6. U.S. Patent No. 6,525,430, included as **Exhibit R;**

7. U.S. Patent No. 7,086,389, included as **Exhibit S;**

8. Japanese utility model application/publication No. H03-13535, including the agreed-upon English translation pursuant to the Parties' December 12, 2014 stipulation, included as **Exhibit T** (filed under seal);

9. Japanese utility model application/publication No. S57-30407, including the agreed-upon English translation pursuant to the Parties' December 12, 2014 stipulation, included as **Exhibit U** (filed under seal);

10. Japanese utility model application/publication No. S58-156124, including the agreed-upon English translation pursuant to the Parties' December 12, 2014 stipulation, included as **Exhibit V** (filed under seal);

11. Japanese utility model application/publication No. S59-40536, including the agreed-upon English translation pursuant to the Parties' December 12, 2014 stipulation, included as **Exhibit W** (filed under seal);

12. Japanese utility model application/publication No. S59-59577 and Application S57-170212, including the agreed-upon English translation pursuant to the Parties' December 12, 2014 stipulation, included as **Exhibit X**;

13. Japanese utility model application/publication No. S59-62263, including the agreed-upon English translation pursuant to the Parties' December 12, 2014 stipulation, included as **Exhibit Y** (filed under seal);

14. Japanese utility model application/publication No. S62-18699, including the agreed-upon English translation pursuant to the Parties' December 12, 2014 stipulation, included as **Exhibit Z** (filed under seal);

15. Japanese utility model application/publication No. S62-31640, including the agreed-upon English translation pursuant to the Parties' December 12, 2014 stipulation, included as **Exhibit AA** (filed under seal);

16. Japanese utility model application/publication No. S62-33961, including the agreed-upon English translation pursuant to the Parties' December 12, 2014 stipulation, included as **Exhibit BB** (filed under seal);

17. Japanese utility model application/publication No. S62-126264, including the agreed-upon English translation pursuant to the Parties' December 12, 2014 stipulation, included as **Exhibit CC** (filed under seal);

18. Japanese utility model application/publication No. S63-27046, including the agreed-upon English translation pursuant to the Parties' December 12, 2014 stipulation, included as **Exhibit DD** (filed under seal);

19. Japanese utility model application/publication No. S63-32344, including the agreed-upon English translation pursuant to the Parties' December 12, 2014 stipulation, included as **Exhibit EE**;

20. Japanese utility model application/publication No. S63-35160, including the agreed-upon English translation pursuant to the Parties' December 12, 2014 stipulation, included as **Exhibit FF** (filed under seal);

21. Japanese utility model application/publication No. S63-46266, including the agreed-upon English translation pursuant to the Parties' December 12, 2014 stipulation, included as **Exhibit GG** (filed under seal);

The attached exhibits are marked with sequential page numbers in the upper right corner in the form of [Exhibit Letter – Page Number]. For example, the first page of Exhibit M is "M-1" and so forth. Where the upper right corner of a document does not allow for such marking, page numbers will be located along the right hand margin of the document. For briefing purposes, material within this Notice of Reliance will be identified as "O6NOR" (an acronym for Opposers' Sixth Notice of Reliance). For example, a reference to the first page of Exhibit M in the trial brief would be O6NOR M-1.

Opposers intend to rely upon and hereby make of record the attached exhibits. Certain of the attached exhibits contain information that Applicant considers confidential pursuant to the Stipulated Protective Order entered into by the parties and approved by the Board. Accordingly, Opposers are simultaneously filing and serving an unredacted copy. Redactions are based on input from Applicant, and are not necessarily considered worthy of redaction by Opposers.

Respectfully Submitted,

Dated: July 15, 2015

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CERTIFICATE OF SERVICE

I hereby certify that a true copy of the foregoing OPPOSERS' SIXTH NOTICE OF RELIANCE (Redacted – Public Version) was served via first class mail, postage prepaid, this 15th day of July, 2015 upon:

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United States Patent [19]

Yamaguchi et al.

[11] **Patent Number: 4,813,385**

[45] **Date of Patent: Mar. 21, 1989**

[54] **GENERAL-PURPOSE INTERNAL COMBUSTION ENGINE**

[75] Inventors: **Yoshinobu Yamaguchi; Mutsumi Terasawa**, both of Saitama; **Mitsuo Sasagase**, Shizuoka, all of Japan

[73] Assignees: **Honda Giken Kogyo Kabushiki Kaisha**, Tokyo; **Toyoroki Seizo Co., Ltd.**, Shizuoka, both of Japan

[21] Appl. No.: **143,299**

[22] Filed: **Jan. 11, 1988**

Related U.S. Application Data

[63] Continuation of Ser. No. 793,410, Oct. 31, 1985, abandoned.

[30] **Foreign Application Priority Data**

Nov. 1, 1984	[JP]	Japan	59-230915
Nov. 1, 1984	[JP]	Japan	59-230916
Nov. 1, 1984	[JP]	Japan	59-230917
Nov. 1, 1984	[JP]	Japan	59-165832[U]
Nov. 1, 1984	[JP]	Japan	59-165833[U]
Nov. 1, 1984	[JP]	Japan	59-165834[U]

[51] **Int. Cl.**[4] **F02B 65/00**

[52] **U.S. Cl.** **123/2**; 55/320

[58] **Field of Search** ..... 123/2, 195 C, 193 C; 290/1 R, 1 A, 1 B; 55/317, 318, 320, 337

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,521,726	7/1970	Freyn	123/198 E
3,952,640	4/1976	Knechler	55/31 E
4,013,105	3/1977	Wuskallio	123/198 E
4,276,067	6/1981	Lindman	55/337
4,610,229	9/1986	Wissmann et al.	92/169

FOREIGN PATENT DOCUMENTS

2399200	3/1979	France .
2524551	10/1983	France .
2534626	4/1984	France .
27-5504	7/1952	Japan .
54-20689	7/1979	Japan .
56-50126	11/1981	Japan .
57-61155	4/1982	Japan .

Primary Examiner—Tony M. Argenbright
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[57] **ABSTRACT**

A general-purpose internal combustion engine comprises an engine unit, a recoil starter, a fuel tank disposed on the engine unit, a main air cleaner disposed on the engine unit and coupled with a precleaner, and a muffler disposed on the engine unit. The main air cleaner and the muffler are disposed laterally of the fuel tank in parallel relation to each other, the main air cleaner being located closely to the recoil starter, and the muffler being disposed remotely from the recoil starter. The precleaner has an air inlet member disposed remotely from the muffler and positioned without projecting out of a plane containing a side of the main air cleaner which is remote from the muffler. The precleaner has an air outlet and the main air cleaner has a case with an air inlet defined in a side thereof and a substantially cylindrical filter housed centrally in the case coaxially with the vertical axis thereof. The air inlet has a central axis sidewardly offset a distance from a horizontal axis of the case and connected to the air outlet.

6 Claims, 4 Drawing Sheets

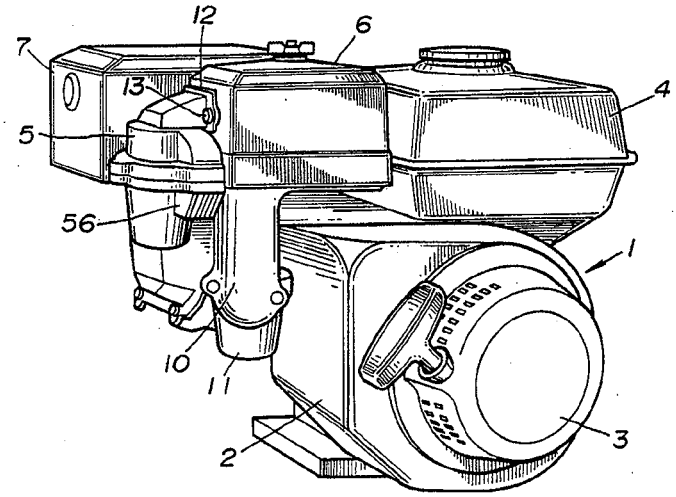

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FIG. 1

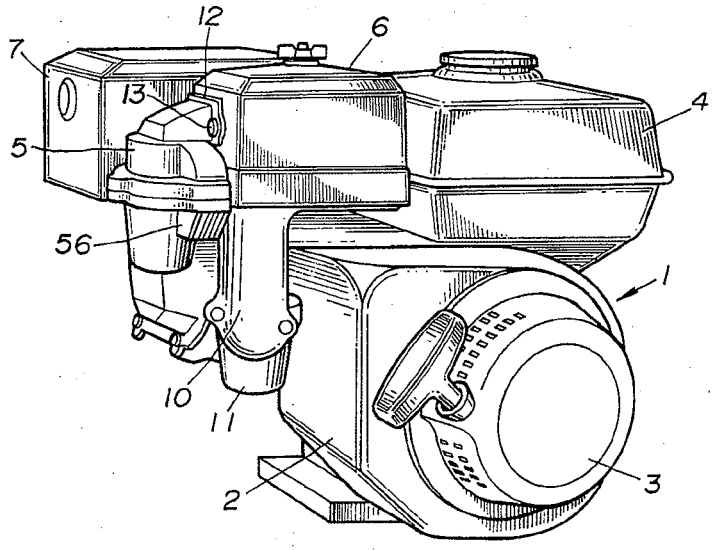

FIG. 2

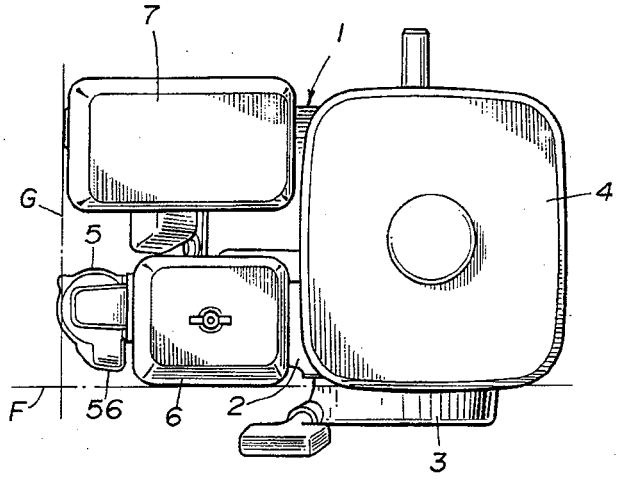

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FIG.3

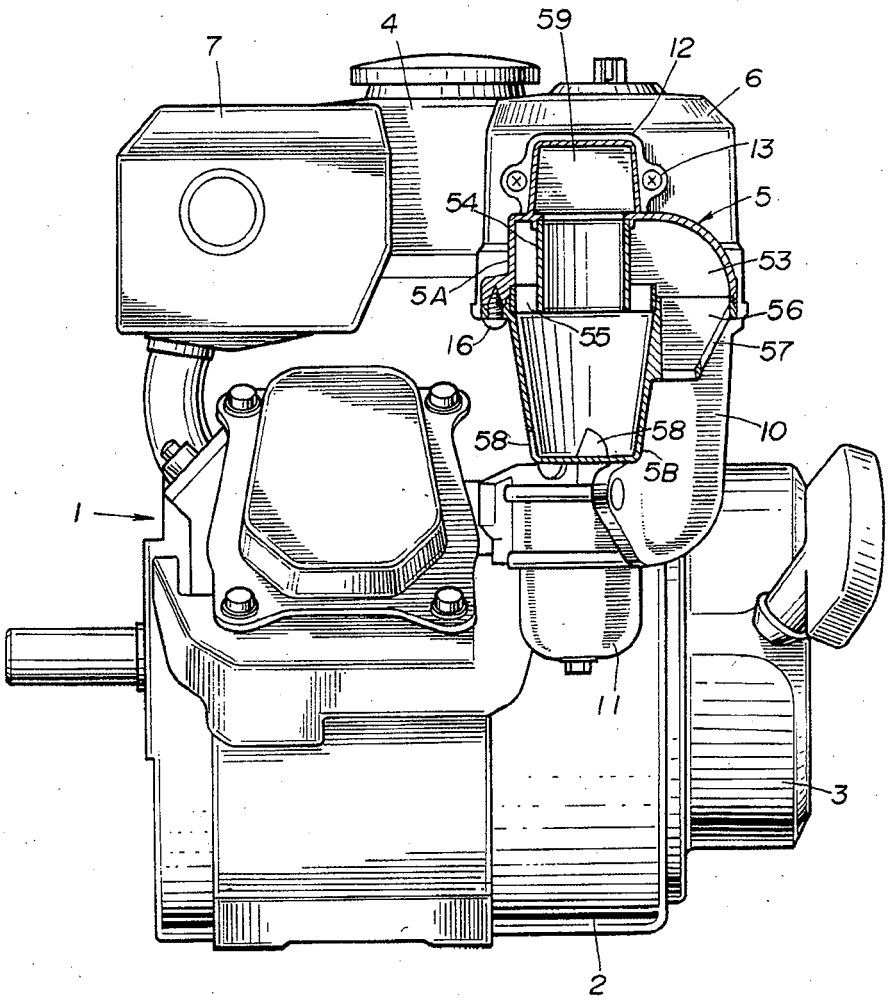
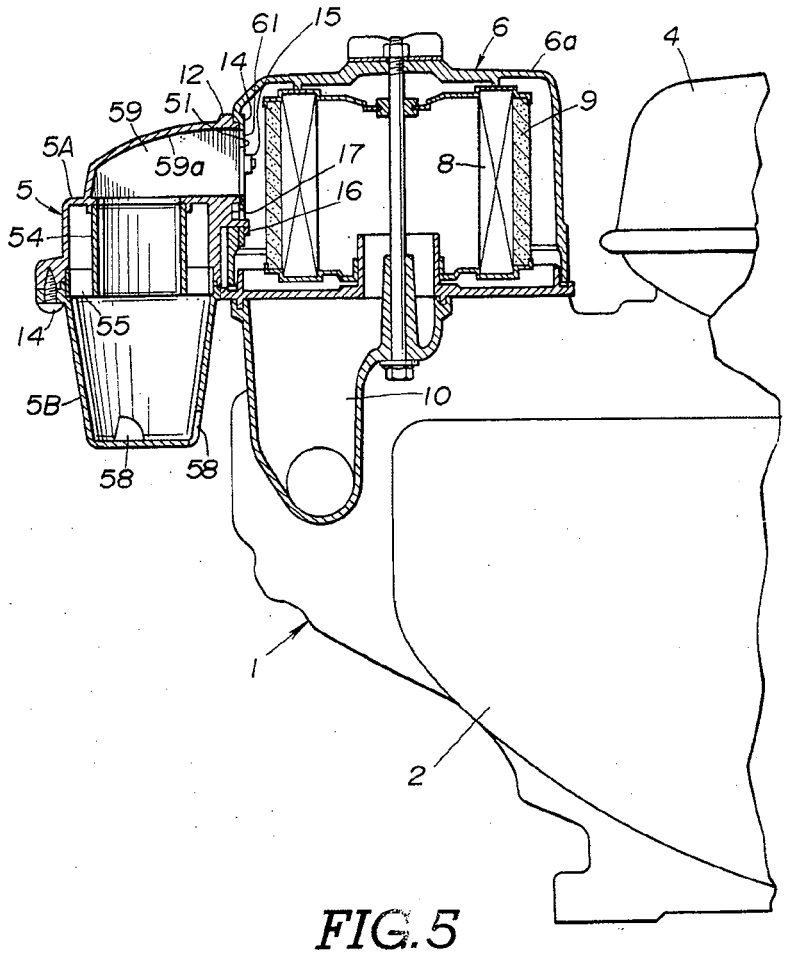


FIG. 4


61
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6a
4
12
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5A
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5B
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FIG. 5

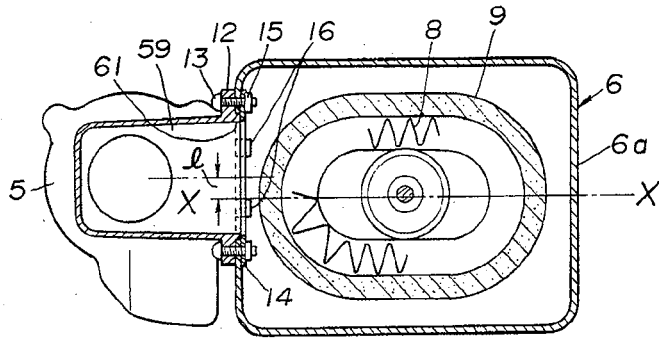
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FIG. 6

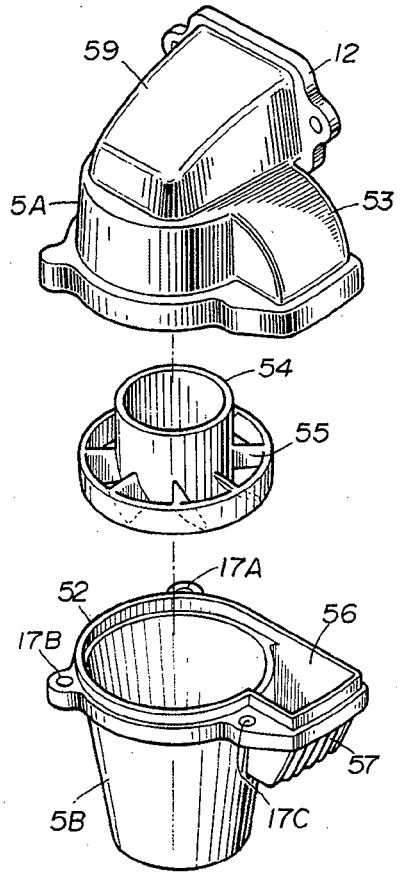


FIG. 7

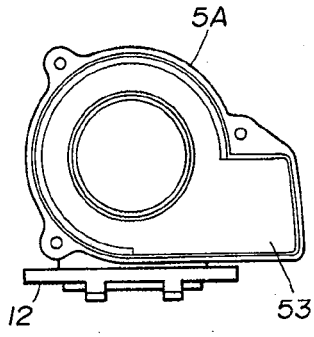


FIG. 8

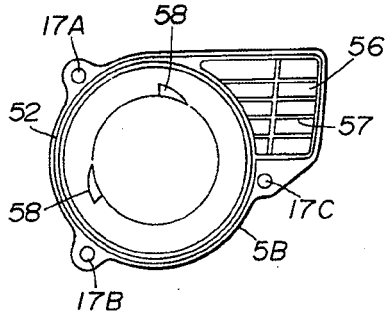
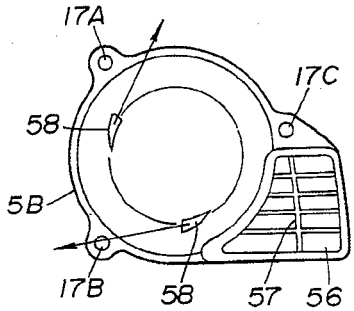


FIG. 9



GENERAL-PURPOSE INTERNAL COMBUSTION ENGINE

This application is a continuation of application Ser. No. 793,410 filed Oct. 31, 1985, now abandoned.

BACKGROUND OF THE INVENTION

The present invention relates to a general-purpose internal combustion engine for use as a prime mover in various machines for agricultural, civil construction, and other uses and in various portable machines such as electric generators and pumps, and more particularly to such a general-purpose internal combustion engine having an air cleaner with a precleaner.

Internal combustion engines for use as prime movers in various machines for agricultural, civil construction, and other uses and in various portable machines such as electric generators and pumps, are often used in dusty places. Therefore, the filters in the air cleaners of such internal combustion engines are liable to get clogged soon, and have to be frequently cleaned or replaced. to avoid this shortcoming, there have been proposed general-purpose internal combustion engines as disclosed in Japanese Utility Model Publication Nos. 27-5504 and 54-20689, for example. The disclosed internal combustion engines have a main air cleaner employing a filter of paper and/or urethane foam and a cyclone-type precleaner positioned laterally of the main air cleaner. Dust-laden air is first introduced into the precleaner which removes most of the dust from the air. The air from the precleaner is then introduced into the main air cleaner through a port defined in a side thereof.

With the conventional air cleaner arrangements, however, the precleaner is simply connected to the air inlet port of the main air cleaner. The prior air cleaner structures have failed to meet the following requirements:

(a) The precleaner should not project out of the assembly of an engine, a fuel tank, a muffler, and an air cleaner, so that the precleaner would not impair the appearance of the engine assembly, would not obstruct the operation of a recoil starter, or would be damaged by being hit by an object;

(b) The precleaner should be located so as not to draw air heated by a heating body such as a muffler;

(c) The main air cleaner and the precleaner should should be interconnected by a joint duct having a small resistance to the flow of air therethrough;

(d) The precleaner should be structured so that it could easily be formed;

(e) The precleaner should be arranged so that dust discharged therefrom would not be drawn through its own air inlet port into the precleaner; and

(f) The joint between the precleaner and the main air cleaner should be durable.

The filter of the main air cleaner is oval or generally cylindrical in shape and housed centrally coaxially in an air cleaner case having a complementary shape. The filtered air discharged from the precleaner is introduced into the main air cleaner case toward the vertical axis thereof and impinges substantially perpendicularly upon the outer circumferential surface of the oval or cylindrical filter, with the result that the filter portion hit by the filtered air tends to get clogged soon. Therefore, the entire circumferential surface of the filter is not effectively utilized, and it is uneconomical to clean or replace the entire filter when the other filter portion is not appreciably clogged.

The present invention has been made in an attempt to meet the aforesaid requirements of the general-purpose internal combustion engines and also to solve the above problem of the conventional air cleaner combined with the cyclone-type precleaner.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a general-purpose internal combustion engine having a precleaner attached to a main air cleaner so that the precleaner will not impair the appearance of the engine assembly, will not obstruct the operation of a recoil starter, and will not be damaged by being hit by an object, the precleaner being located so as not to introduce air heated by a heating body such as a muffler.

Another object of the present invention is to provide a general-purpose internal combustion engine having a main air cleaner and a precleaner which are interconnected by a joint duct having a small resistance to the flow of air therethrough.

Still another object of the present invention is to provide a general-purpose internal combustion engine having a precleaner structured so that it could easily be formed;

A still further object of the present invention is to provide a general-purpose internal combustion engine having a precleaner arranged so that dust discharged therefrom will not be drawn through its own air inlet port into the precleaner.

A yet still further object of the present invention is to provide a general-purpose internal combustion engine having a precleaner and a main air cleaner which are interconnected by a durable joint.

Still another object of the present invention is to increase the cleaning or replacement interval and the air purifying efficiency of the filter in an air cleaner having a cyclone-type precleaner.

According to the present invention, there is provided a general-purpose internal combustion engine comprising an engine unit, a recoil starter disposed parallel to the engine unit, a fuel tank disposed on the engine unit, a main air cleaner and a muffler disposed on the engine unit laterally of the fuel tank in parallel relation to each other, the main air cleaner being located closely to the recoil starter, the muffler being disposed remotely from the recoil starter, and a precleaner connected to the main air cleaner and having an air inlet member disposed remotely from the muffler an positioned without projecting out of a plane containing a side of the main air cleaner which is remote from the muffler.

The precleaner comprises an upper cleaner cases and a lower dust pan which are detachably coupled to each other, the upper cleaner case having an air inlet duct projecting laterally and having a lower open end, the dust pan having the air inlet member which projects laterally and opens upwardly, the air inlet member defining an air inlet port directed substantially downwardly, the cleaner case and the dust pan being coupled together with the air inlet duct and the air inlet member held in registry with each other. Each of the cleaner case and the dust pan is substantially cylindrical in shape, the air inlet duct and the air inlet member projecting tangentirally from the cleaner case and the dust pan, respectively, the dust pan having a dust outlet hole defined in a bottom thereof and opening away from the air inlet port.

The precleaner has an integral air duct at its upper portion, the air duct having an air outlet at an outer end thereof, the main air cleaner having an air inlet defined in a side thereof and connected to the air outlet, the air duct having an upper surface curved progressively upwardly toward the air outlet.

The air duct of the precleaner has a flange surrounding the air outlet, the air outlet and the air inlet being coupled by the flange, the precleaner engaging the main air cleaner at a position below the air outlet and the air inlet which are coupled to each other.

According to the present invention, there is also provided an air cleaner comprising a cyclon-type precleaner having an air outlet, and a main air cleaner including a case having an air inlet defined in a side thereof and a substantially cylindrical filter housed centrally in the case coaxially with the vertical axis thereof, the air inlet having a central axis sidewardly offset a distance from an axis of the case and connected to the air outlet of the precleaner.

The above and further objects, details and advantages of the present invention will become apparent from the following description of a preferred embodiment thereof, when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a general-purpose internal combustion engine according to the present invention;

FIG. 2 is a plan view of the general-purpose internal combustion engine;

FIG. 3 is an enlarged front elevational view of the general-purpose internal combustion engine, with a precleaner shown in vertical cross section;

FIG. 4 is an enlarged fragmentary side elevational view of the general-purpose internal combustion engine, with the precleaner and a main air cleaner in vertical cross section;

FIG. 5 is a horizontal cross-sectional view of the main air cleaner and the precleaner;

FIG. 6 is an exploded perspective view of the precleaner;

FIG. 7 is a bottom view of a precleaner case;

FIG. 8 is a plan view of a dust pan; and

FIG. 9 is a bottom view of the dust pan.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIGS. 1 and 2, a general-purpose internal combustion engine includes an engine unit 1 having an air guide cover 2 disposed on one side thereof in covering relation to an engine cooling fan integral with a flywheel. A recoil starter 3 is attached to the outer surface of the air guide cover 2 in parallel relation to the engine unit 1.

A fuel tank 4 is disposed on the upper surface of the engine unit 1 at one side thereof. A main air cleaner 6 coupled with a cyclone-type precleaner 5 and a muffler 7 are disposed laterally of the fuel tank 4 parallel to each other, the main air cleaner 6 and the precleaner 5 being located closely to the recoil starter 3. Each of the fuel tank 4, the main air cleaner 6, and the muffler 7 is substantially rectangularly shaped when viewed in plan.

As illustrated in FIGS. 4 and 5, the main air cleaner 6 accommodates a substantially cylindrical or elliptical filter centrally in a cleaner case 6a coaxially with the vertical axis thereof, the cylindrical or oval filter comprising a paper filter member 8 and a urethane foam member 9 surrounding the paper filter member 8. The cylindrical or oval filter has an inner space communicating through an air duct 10 with a carburetor 11 (FIGS. 1 and 3).

As shown in FIG. 5, the main air cleaner 6 has an air inlet 61 defined in a side thereof and having a central axis sidewardly displaced or offset a distance l from a horizontal axis X—X of the cleaner case 6a, and the precleaner 5 has an air outlet 51 defined by the outer end of an air duct 59 thereof. The precleaner 5 is attached to the main air cleaner 6 by a flange 12 surrounding the air outlet 51 with the air inlet 61 and the air outlet 51 held in registry with each other. As shown in FIG. 4 and 5, bolts 13 extend through the flange 12 threadedly into nuts 15 on a patch plate 14 disposed in the main air cleaner 6 and held against the inner side thereof in surrounding relation to the air inlet port 61. The precleaner 5 has a pair of hooks 16 (FIGS. 4 and 5) projecting into the main air cleaner 6 below the air outlet 51 and the air inlet 61 and held in engagement with a case of the main air cleaner 6 and an edge of a hole 17 defined in the patch plate 14. The precleaner 5 may have a horizontally elongate single hook rather than the pair of hooks 16.

As illustrated in FIG. 6, the precleaner 6 comprises an upper cleaner case 5A substantially in the form of a hollow cylinder, and a lower dust pan 5B substantially in the form of a hollow cylinder. The upper cleaner case 5A and the lower dust pan 5B are fitted together through a socket and spigot joint 52 (FIG. 6) and fastened together by a plurality of screws 16. (FIGS. 3 and 4).

The air duct 59 is integral with the upper cleaner case 5A and has an upper surface 59a which is gradually curved progressively upwardly toward the main air cleaner 6.

The upper cleaner case 5A has an integral air inlet duct 53 projecting tangentially outwardly and opening downwardly. An air guide sleeve 54 with a plurality of revolving guide blades 55 integrally formed therearound is removably fitted centrally in the upper cleaner case 5A.

The lower dust pan 5B has an integral air inlet member projecting laterally outwardly tangentially therefrom and opening upwardly. The air inlet member defines an an air inlet port 56 held in registry with the open end of the air inlet duct 53. The air inlet port 56 opens obliquely downwardly remotely from the muffler 7 through a grid 57.

The air inlet duct 53 and the air inlet port 56 are joined through a socket and spigot joint contiguous to the socket and spigot joint 52. The dust pan 5B has a plurality of dust outlet holes 58 defined in the bottom thereof along its peripheral edge. The dust outlet holes 58 are directed away from the air inlet hole 56 so that dust discharged from the dust outlet holes 58 will not be directed toward the air inlet hole 56 as indicated by the arrows in FIG. 9.

The dust pan 5B have screw holes 17A, 17B, 17c which are spaced at irregular intervals so that the air inlet port 56 and the dust outlet holes 58 will properly be positioned with respect to each other when the cleaner case 5A and the dust pan 5B are coupled by screws through the screw holes 17A, 17B, 17C.

With the cyclone-type precleaner 5 mounted on the main air cleaner 6, the air inlet port 56 of the precleaner 5 is positioned remotely from the muffler 7 as shown in

FIG. 1 and 2, and does not project out of a plane F in which sides of the main air cleaner 6 and the fuel tank 4 lie. The precleaner 5 also does not project out of a plane G extending perpendicularly to the plane F and in which the end face of the muffler 7 lies. The fuel tank 4, the main air cleaner 6 with the precleaner 5 attached thereto, and the muffler 7 are positioned in a substantially rectangular space as seen in plan.

When the engine operates, dust-laden air is introduced through the air inlet port 56 into the precleaner 5 and caused to revolve by the tangential duct 53 and the revolving guide blades 55. Dust of a large specific gravity such as sand particles drops along the inner wall surface of the dust pan 5B and is discharged out of the dust pan 5B through the dust outlet holes 58. Air from which most dust has been removed is drawn upwardly through the central air guide sleeve 54 and then through the duct 59 and the ports 51, 61 into the main air cleaner 6, in which the air is purified by the filter members 8, 9. Since the air inlet 61 of the main air cleaner 6 having a central axis sidewardly offset the distance l of the horizontal axis X - X thereof, the air having entered the main air cleaner 6 is caused to flow along the inner peripheral surface of the cleaner case 6a. Therefore, dust can be removed form the air by the cyclonic action, and the air can be filtered through the entire circumference of the filter. Thus, the filter is prevented from being locally clogged with dust. The interval for cleaning or replacing the filter is increased, and the air purifying efficiency of the filter is also increased. The filter is accordingly economical in use.

Although there has been described what is at present considered to be the preferred embodiment of the present invention, it will be understood that the invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all aspects as illustrative, and not restrictive. The scope of the invention is indicated by the appended claims rather than by the foregoing description.

We claim:

1. A general-purpose internal combustion engine comprising:

an engine unit having a crank case and a cylinder;

a recoil starter disposed adjacent and coaxially with respect to said engine unit;

a fuel tank disposed over said crank case;

a main air cleaner and a muffler disposed on said engine unit laterally of said fuel tank in parallel relation to each other, said main air cleaner being located closely to said recoil starter, said muffler being disposed remotely from said recoil starter and above said cylinder;

a precleaner connected to said main air cleaner and having an air inlet member disposed remotely from said muffler, said precleaner comprising an upper cleaner case and a lower dust pan which are detachably coupled to each other, said upper cleaner case having an air inlet duct projecting laterally and having a lower open end, said dust pan having said air inlet member which projects laterally and opens upwardly, said air inlet member defining an air inlet port directed substantially downwardly, said cleaner case and said dust pan being coupled together, with said air inlet duct and said air inlet member held in registry with each other.

2. A general-purpose internal combustion engine according to claim 1, wherein each of said fuel tank, said muffler, and said main air cleaner is substantially rectangularly shaped as viewed in plan.

3. A general-purpose internal combustion engine according to claim 1, wherein said air inlet duct and said air inlet member project tangentially from said cleaner case and said dust pan, respectively, said dust pan having a dust outlet hole defined in a bottom thereof and opening away from said air inlet port.

4. A general-purpose internal combustion engine according to claim 1, wherein said precleaner has an integral air duct at its upper portion, said air duct having an air outlet at an outer end thereof, said main air cleaner having an air inlet defined in a side thereof and connected to said air outlet, said air duct having an upper surface curved progressively upwardly toward said air outlet.

5. A general-purpose internal combustion engine according to claim 1, wherein said air duct of said precleaner has a flange surrounding said air outlet, said air outlet and said air inlet being coupled by said flange, said precleaner engaging said main air cleaner at a position below said air outlet and said air inlet which are coupled to each other.

6. A general-purpose internal combustion engine according to claim 1, wherein said main air cleaner has an oval filter disposed centrally therein in alignment with a vertical axis thereof, said air inlet having a central axis sidewardly offset a distance from a horizontal axis of said warm air cleaner.

* * * * *

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Morohoshi et al.

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(45) **Date of Patent: Mar. 26, 2002**

(54) **ENGINE GENERATOR UNIT**

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(73) Assignee: **Honda Giken Kogyo Kabushiki Kaisha** (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/572,744**

(22) Filed: **May 16, 2000**

(30) **Foreign Application Priority Data**

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(52) **U.S. Cl.** ..... **290/1 A**; 322/1; 123/41.56
(58) **Field of Search** ..... 290/1 A, 40 R, 290/40 C; 322/14, 1, 15, 16; 123/2, 3, 41.56

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,714,449	A	*	1/1973	De Bella 290/1
4,595,841	A	*	6/1986	Yaguchi ..... 290/1 A
4,647,835	A	*	3/1987	Fujikawa et al. 322/1
4,907,546	A	*	3/1990	Ishii et al. 123/41.56
5,086,748	A	*	2/1992	Yokoyama 123/549
5,121,715	A	*	6/1992	Nogami et al. 123/41.7
5,212,952	A	*	5/1993	Yokoyama et al. 60/721
5,977,667	A	*	11/1999	Hirose 310/51
6,084,313	A	*	7/2000	Frank ..... 290/40 C
D441,714	S	*	5/2001	Yuzuriha D13/116

FOREIGN PATENT DOCUMENTS

JP	64-9452	2/1989
JP	7-24922	6/1995

OTHER PUBLICATIONS

Coleman Powermate Generators. Product ad publication. 1997.*
Coleman Powermate Maxa ER Series Electric Generators. Product ad publication. 1995.*

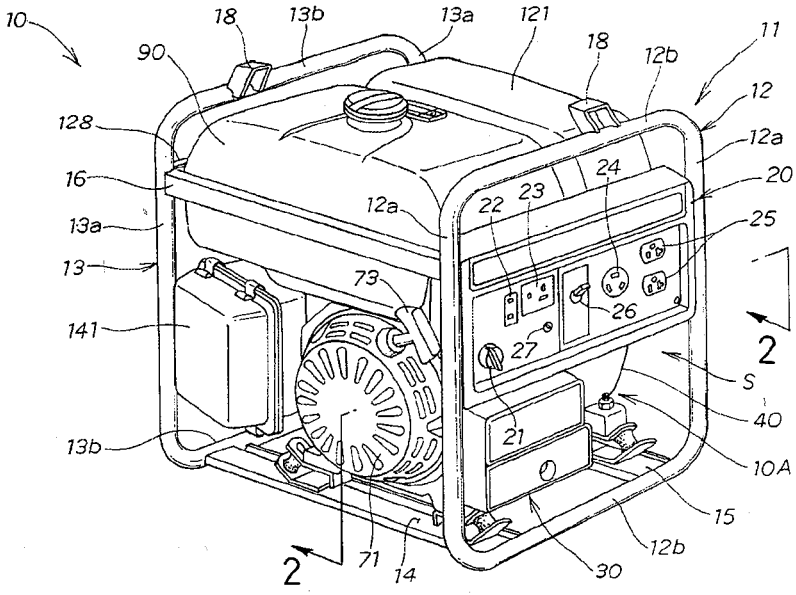
* cited by examiner

Primary Examiner—Nicholas Ponomarenko
(74) *Attorney, Agent, or Firm*—Adams & Wilks

(57) **ABSTRACT**

In an engine generator unit, a framework has vertical pipe frame portions at its four corners, and an engine and an electric-power generator to be driven by the engine are provided coaxially in a direction of an engine output shaft within a space defined by the framework. Fuel tank is provided above the engine and electric-power generator between a pair of support members each spanning between a different pair of the vertical pipe frame portions. Muffler connected to an exhaust-discharging end of the engine is positioned adjacent the fuel tank in a side-by-side relation to the fuel tank. Heat blocking cover covers top and side portions of the muffler and is placed between the pair of support members in such a way that a substantially entire top region of the space defined by the framework is covered with the fuel tank and the heat blocking cover. Thus, it is possible to increase the capacity of the muffler while providing for a large capacity of the fuel tank.

6 Claims, 13 Drawing Sheets



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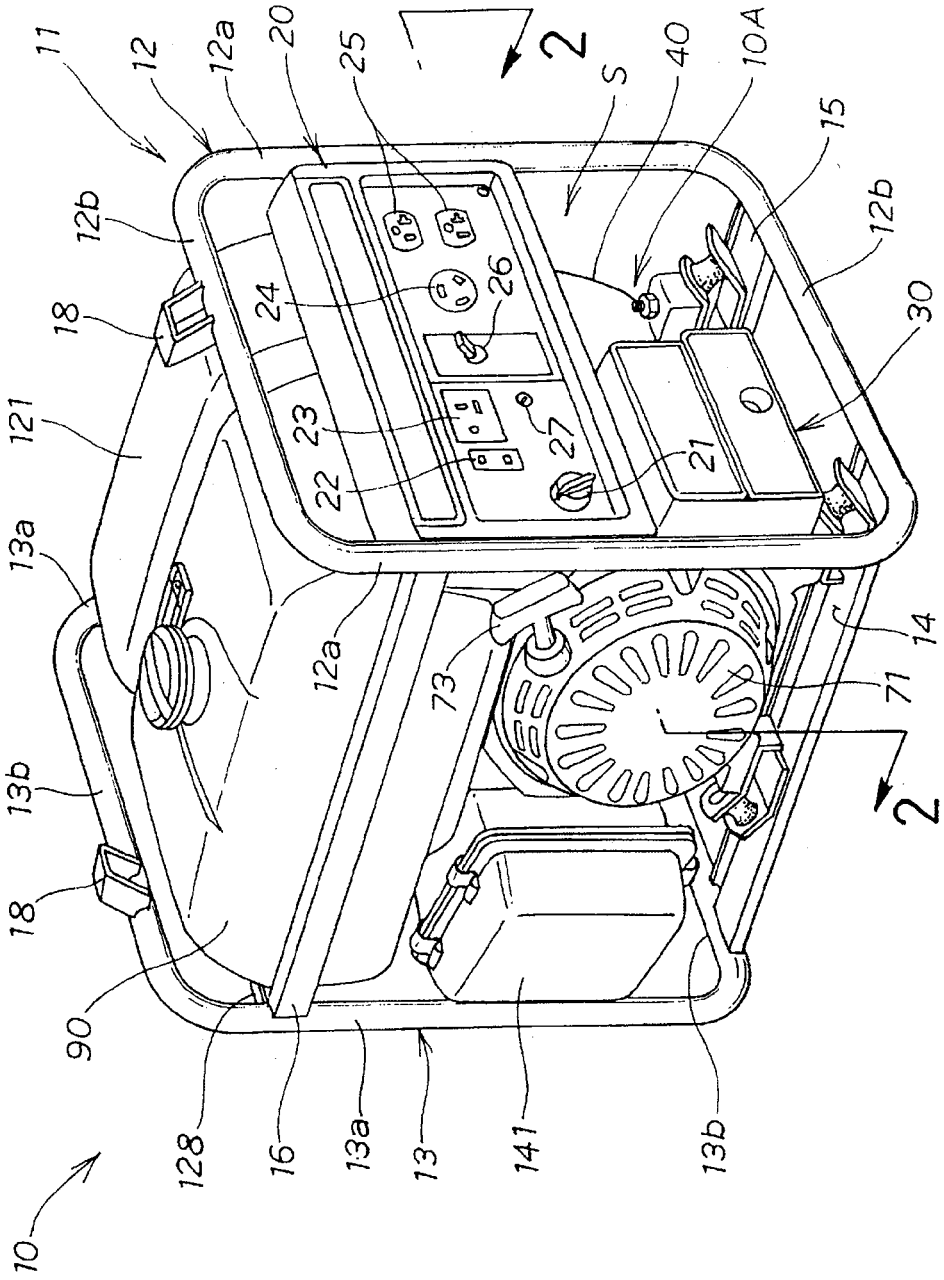
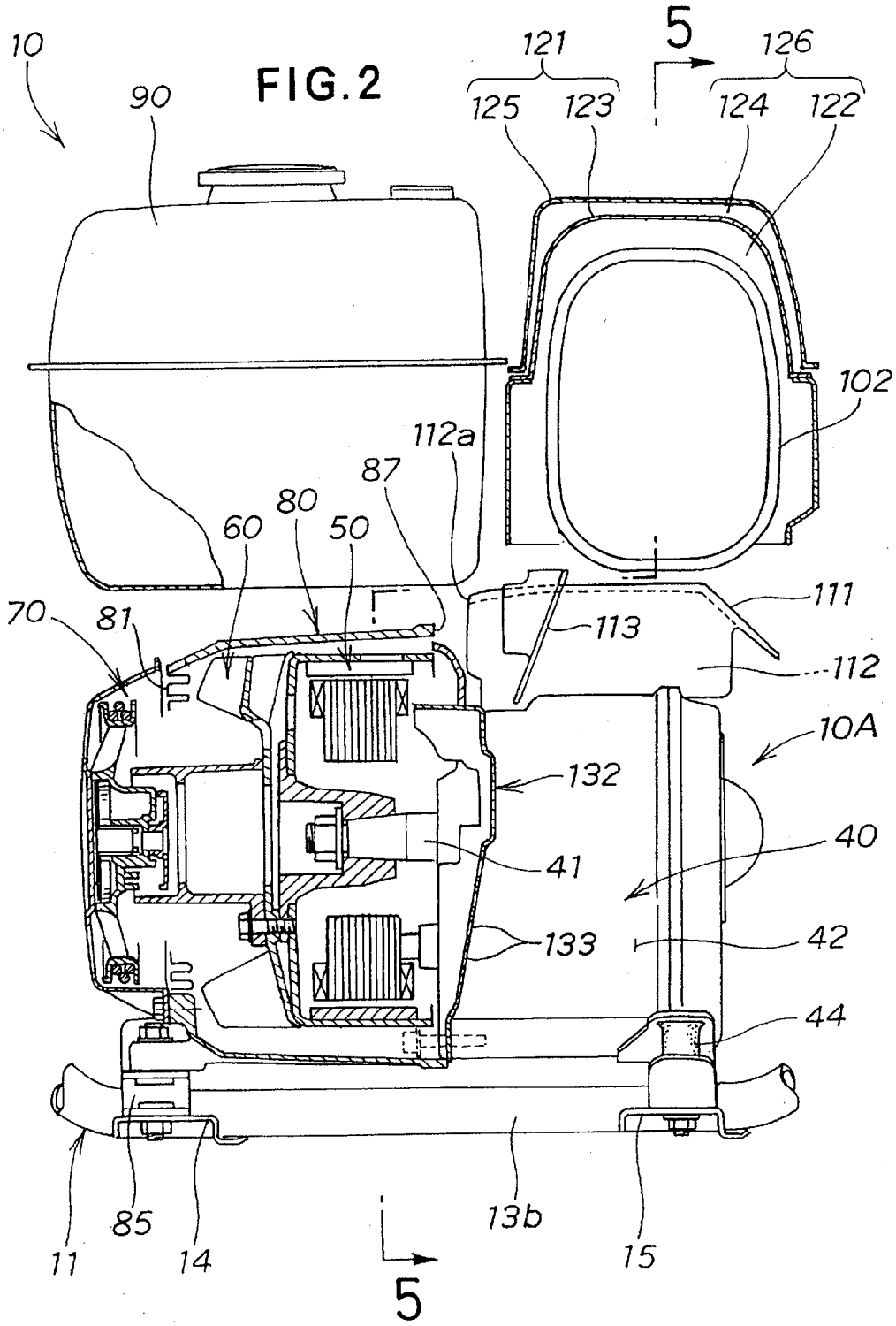


FIG. 1

FIG. 2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133
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85
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13b
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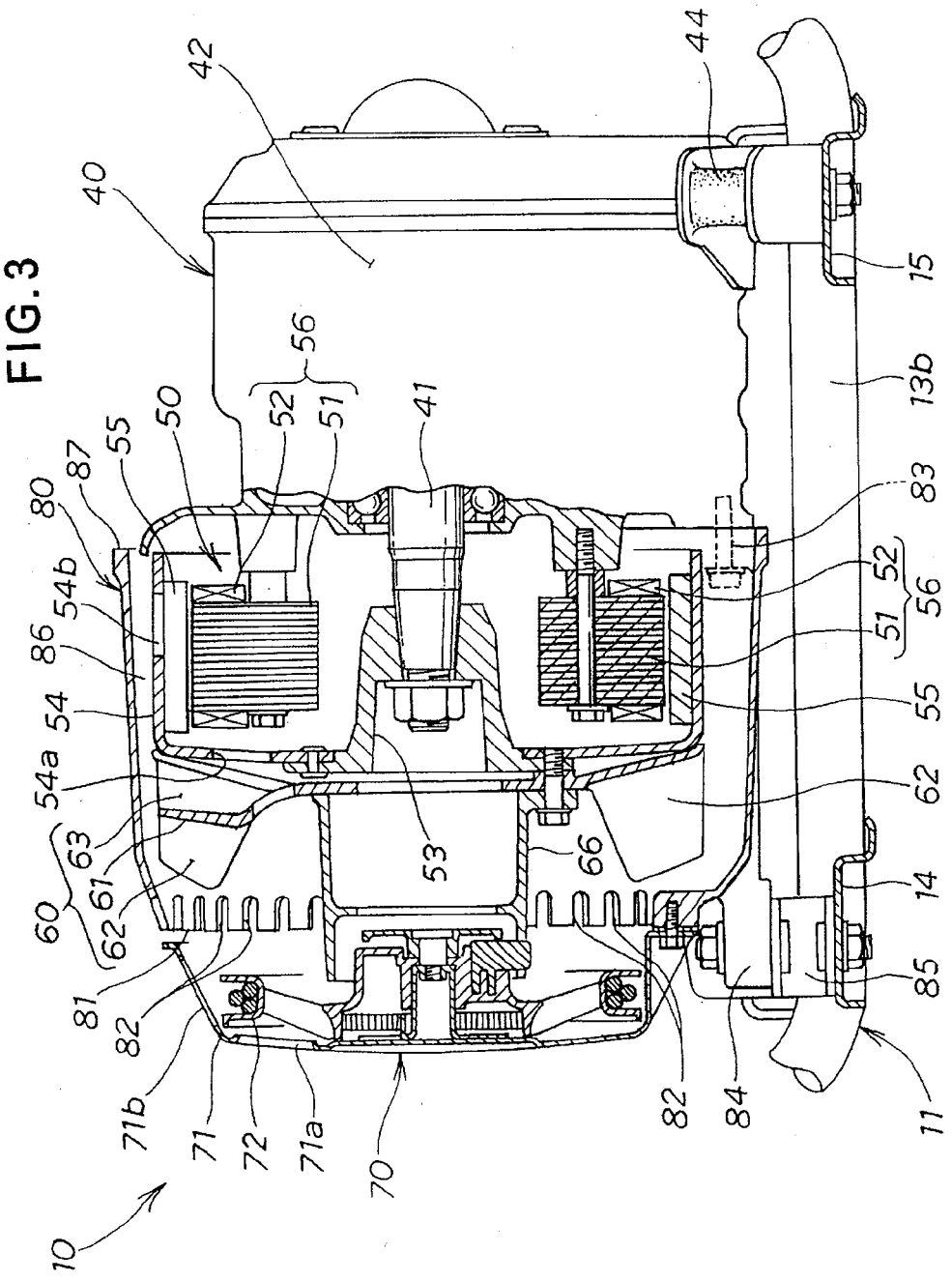
FIG. 3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62
63
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71a
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84
11
10

FIG.4

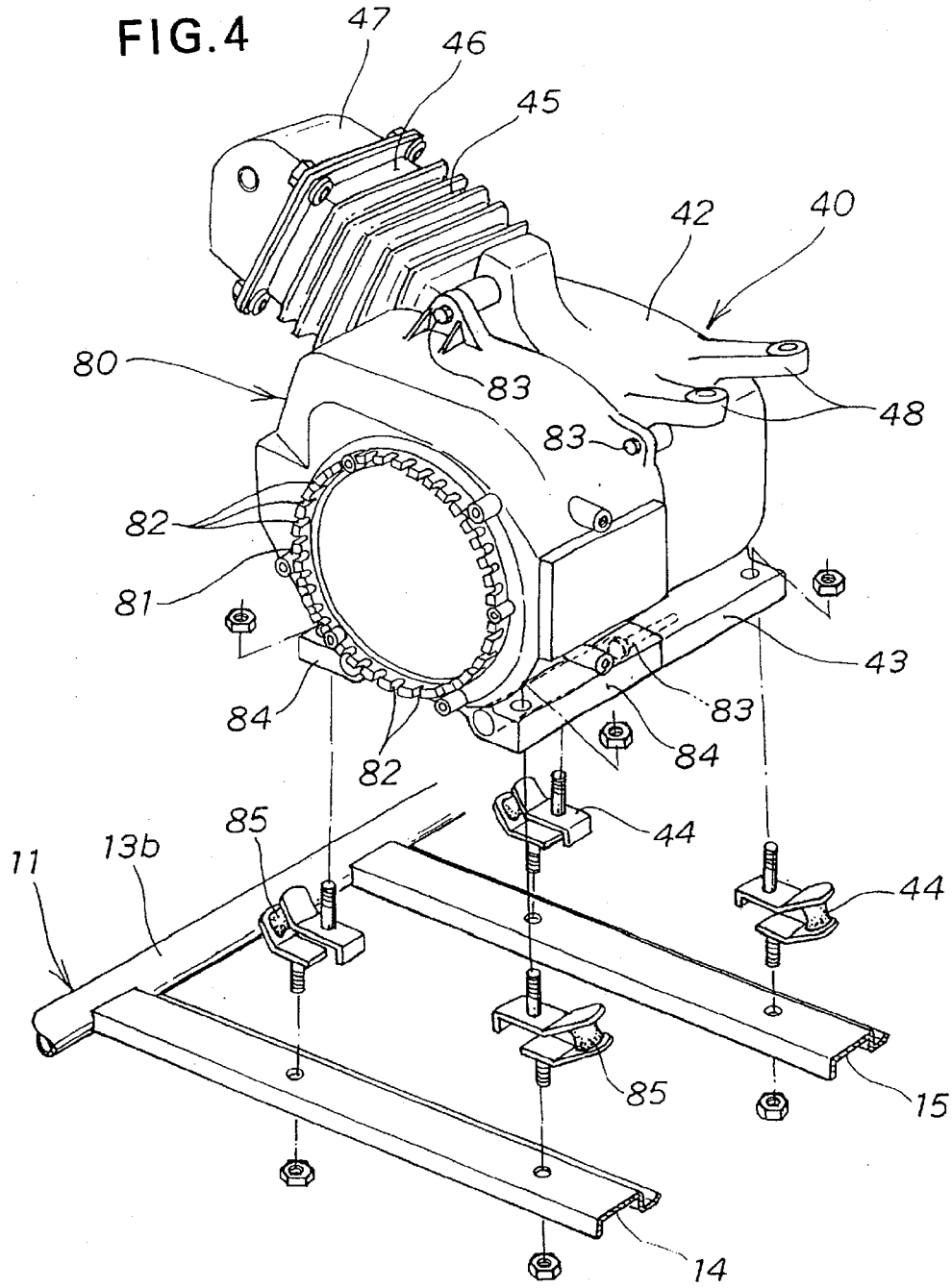
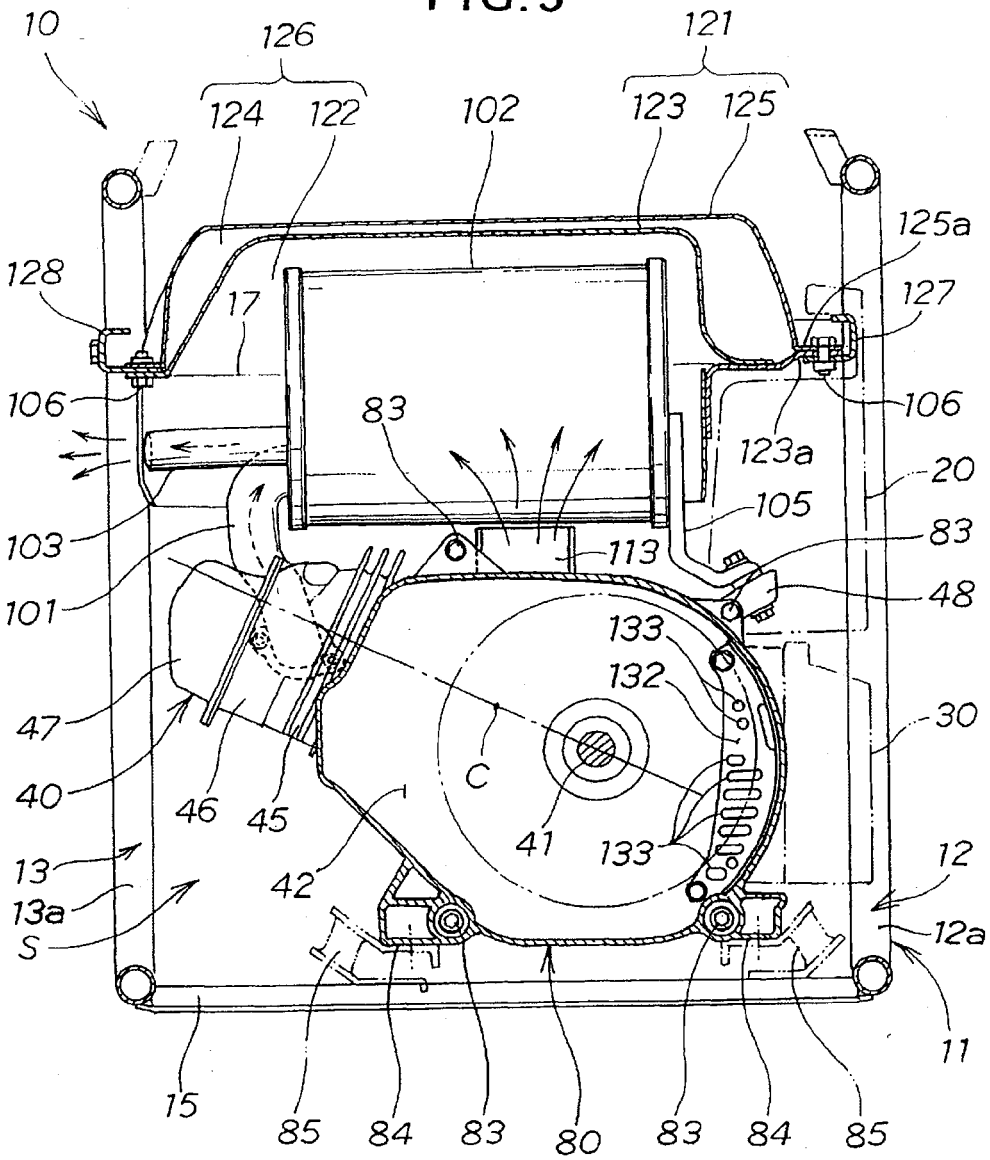


FIG. 5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101
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FIG.6

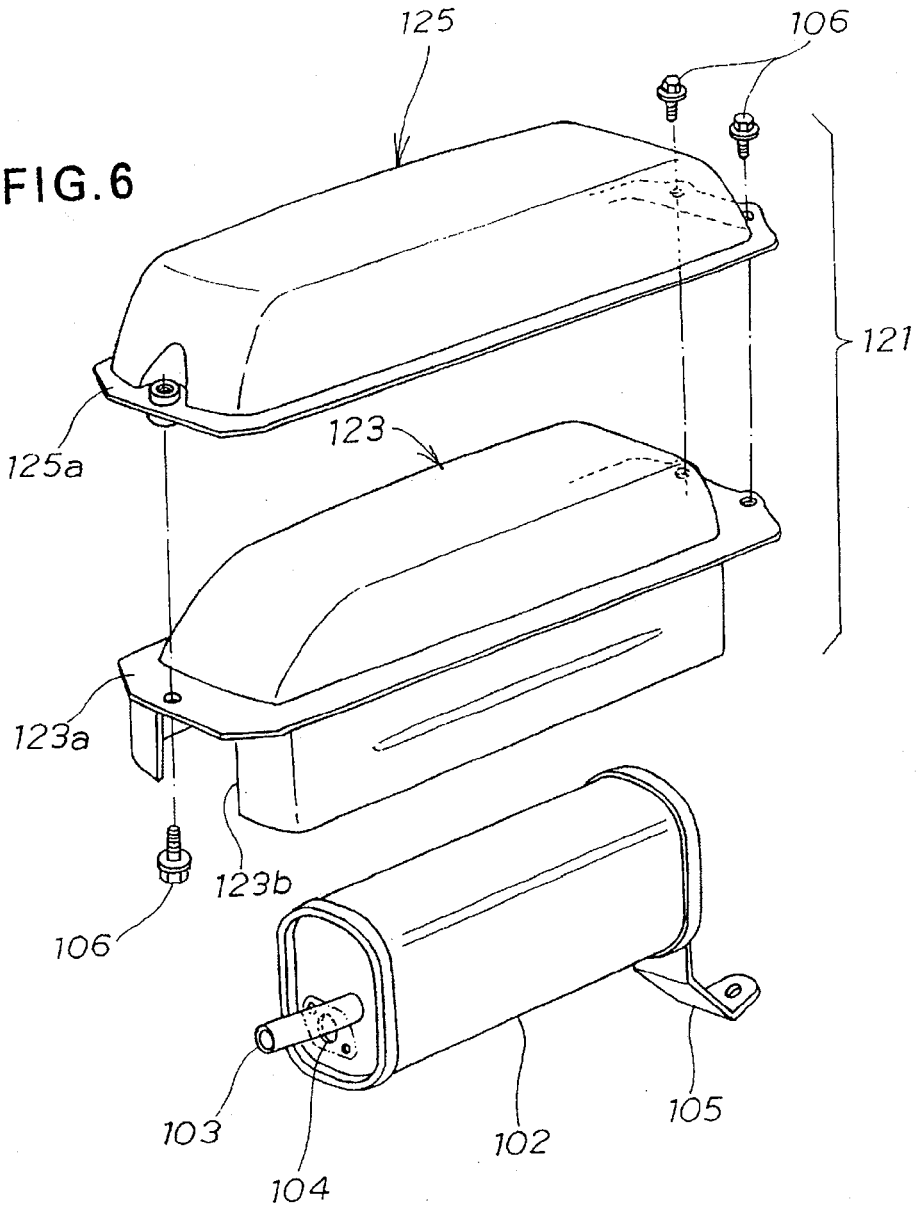
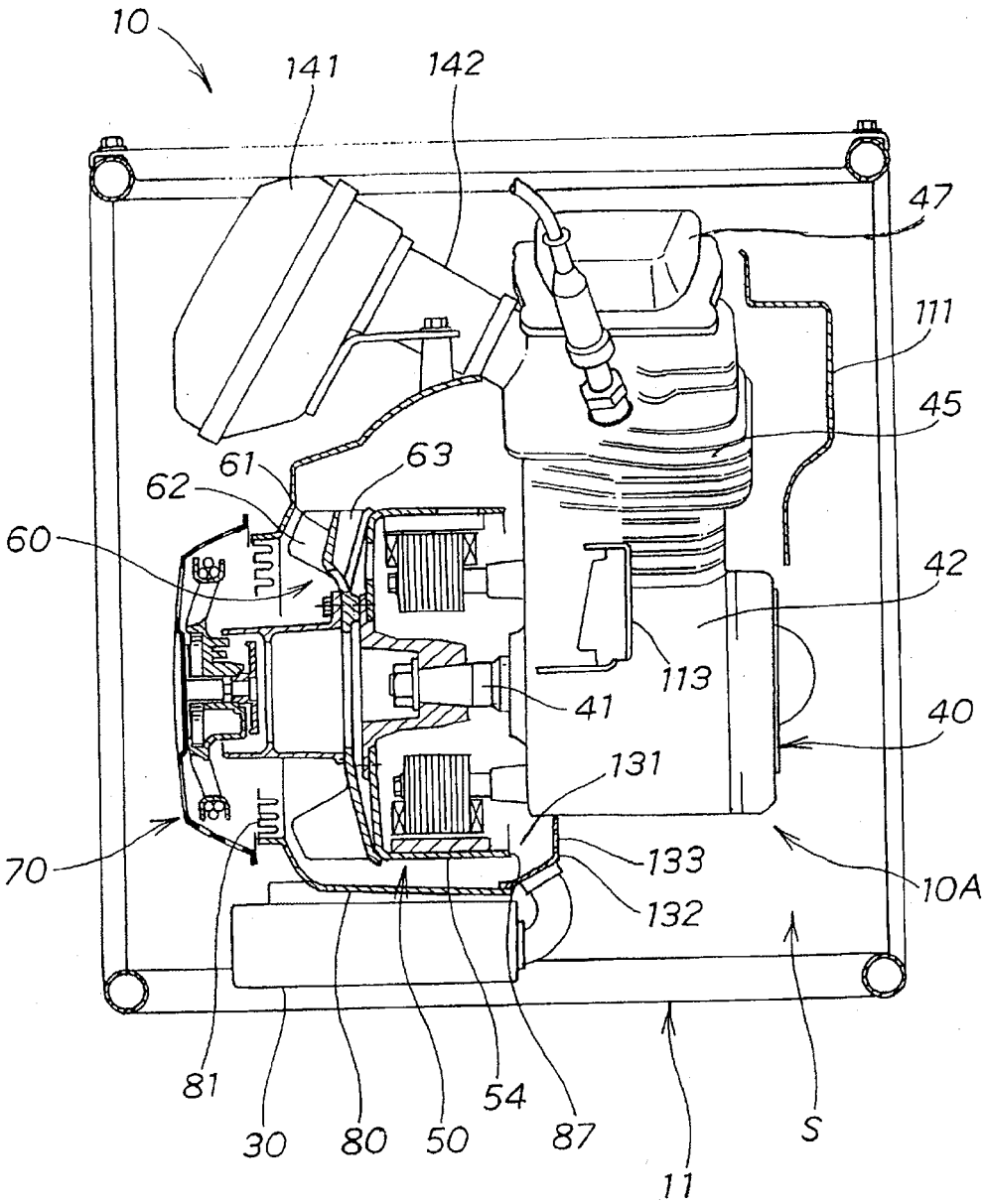


FIG.7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50
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87
11
S

FIG.8

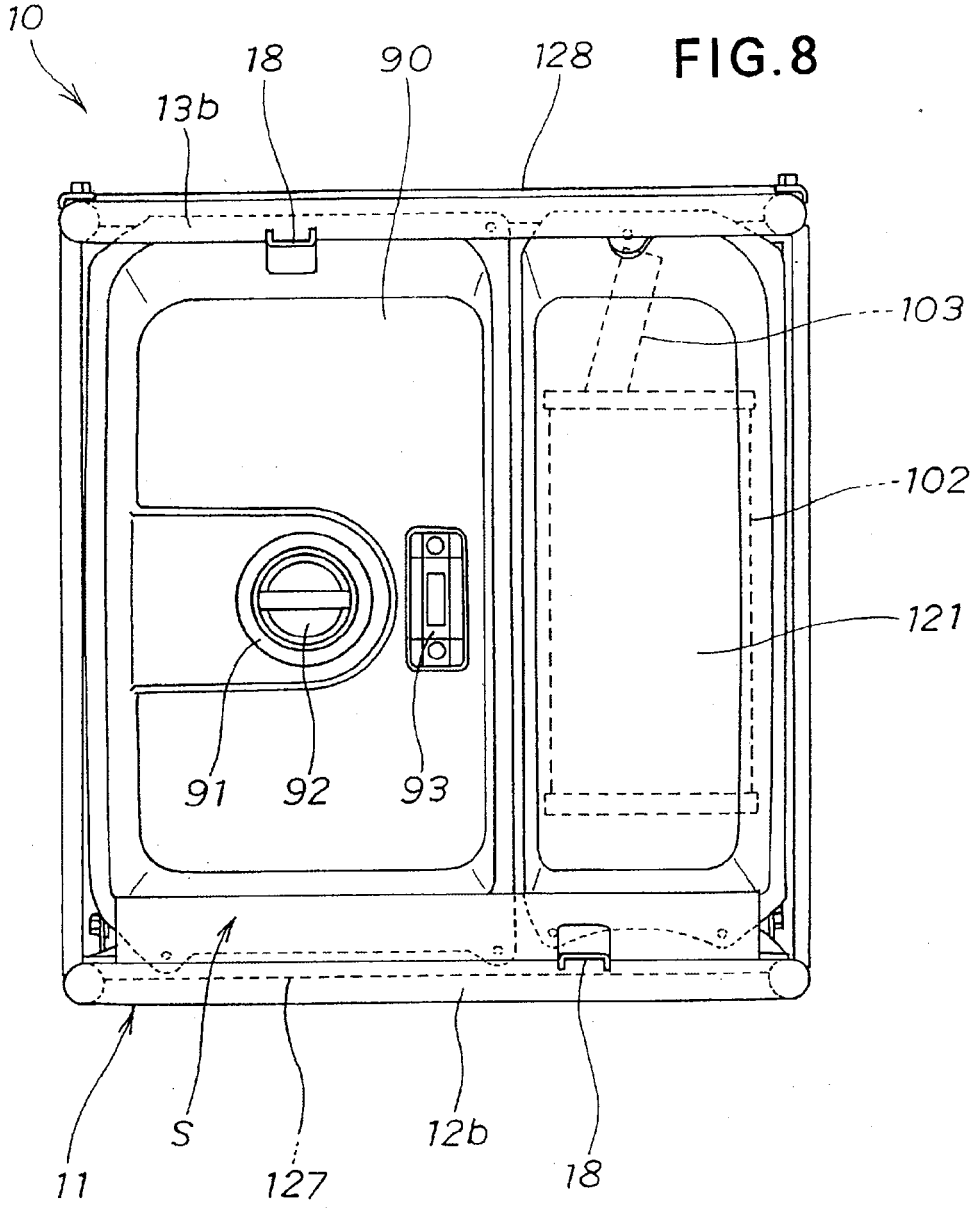

FIG.9

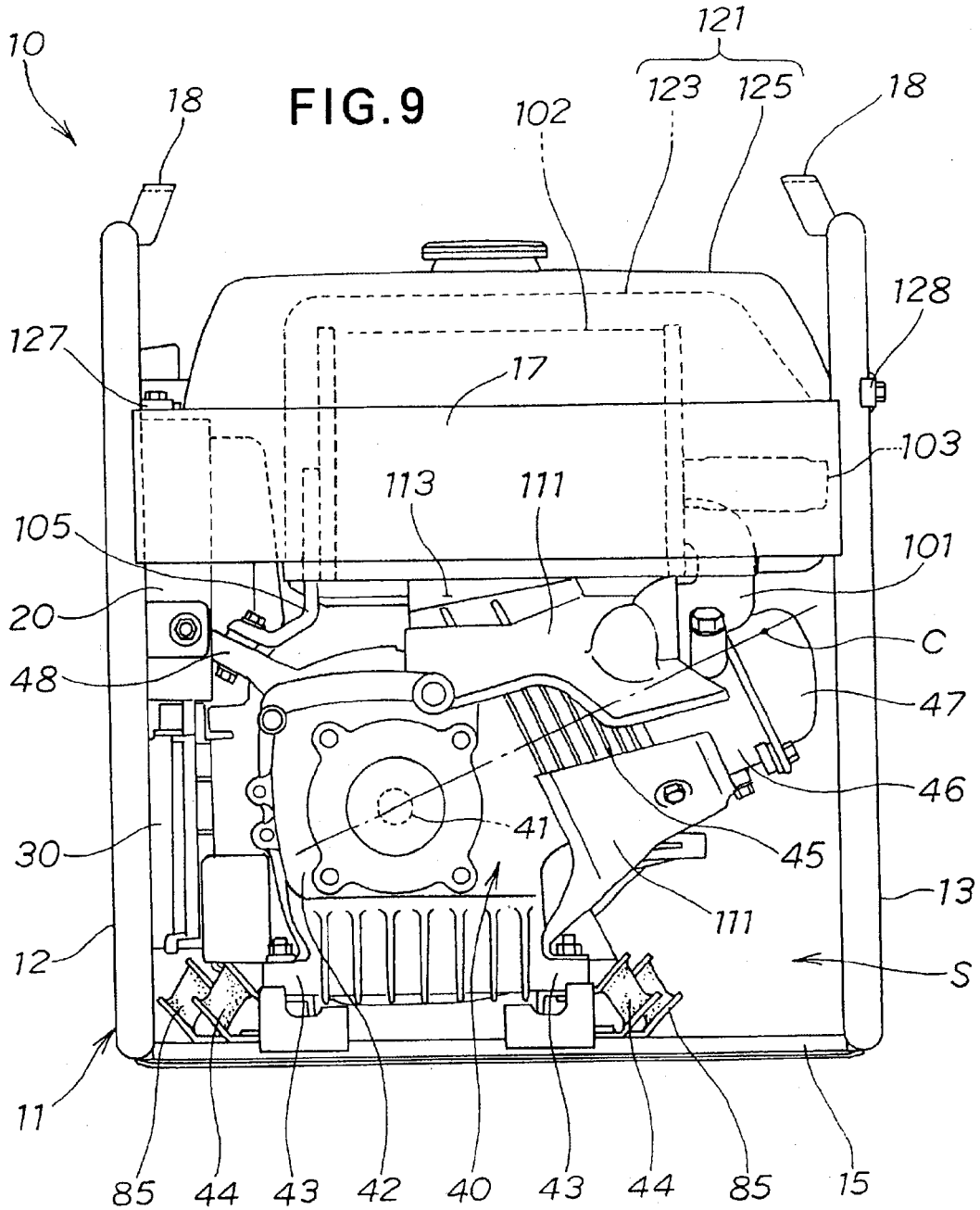
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FIG. 10

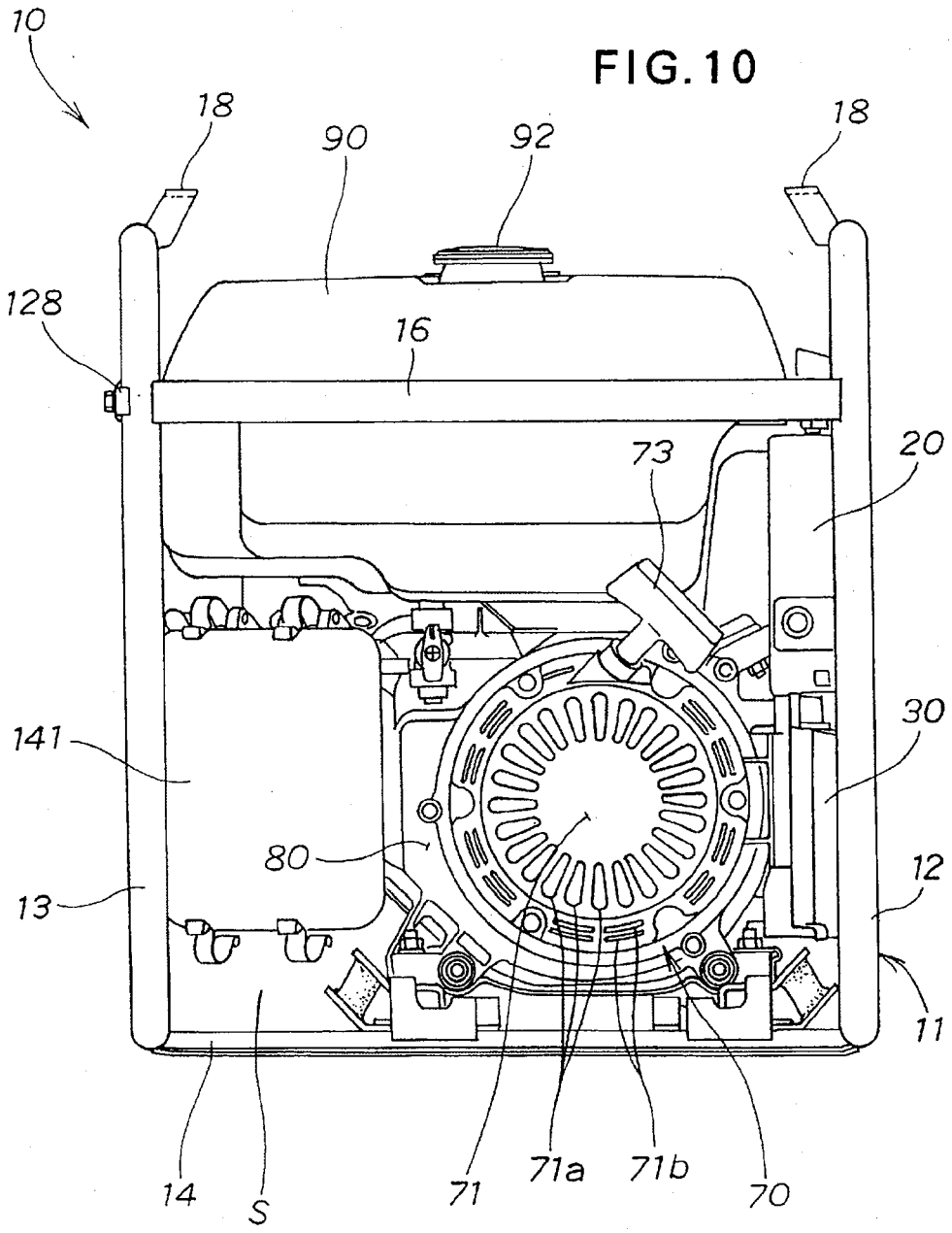
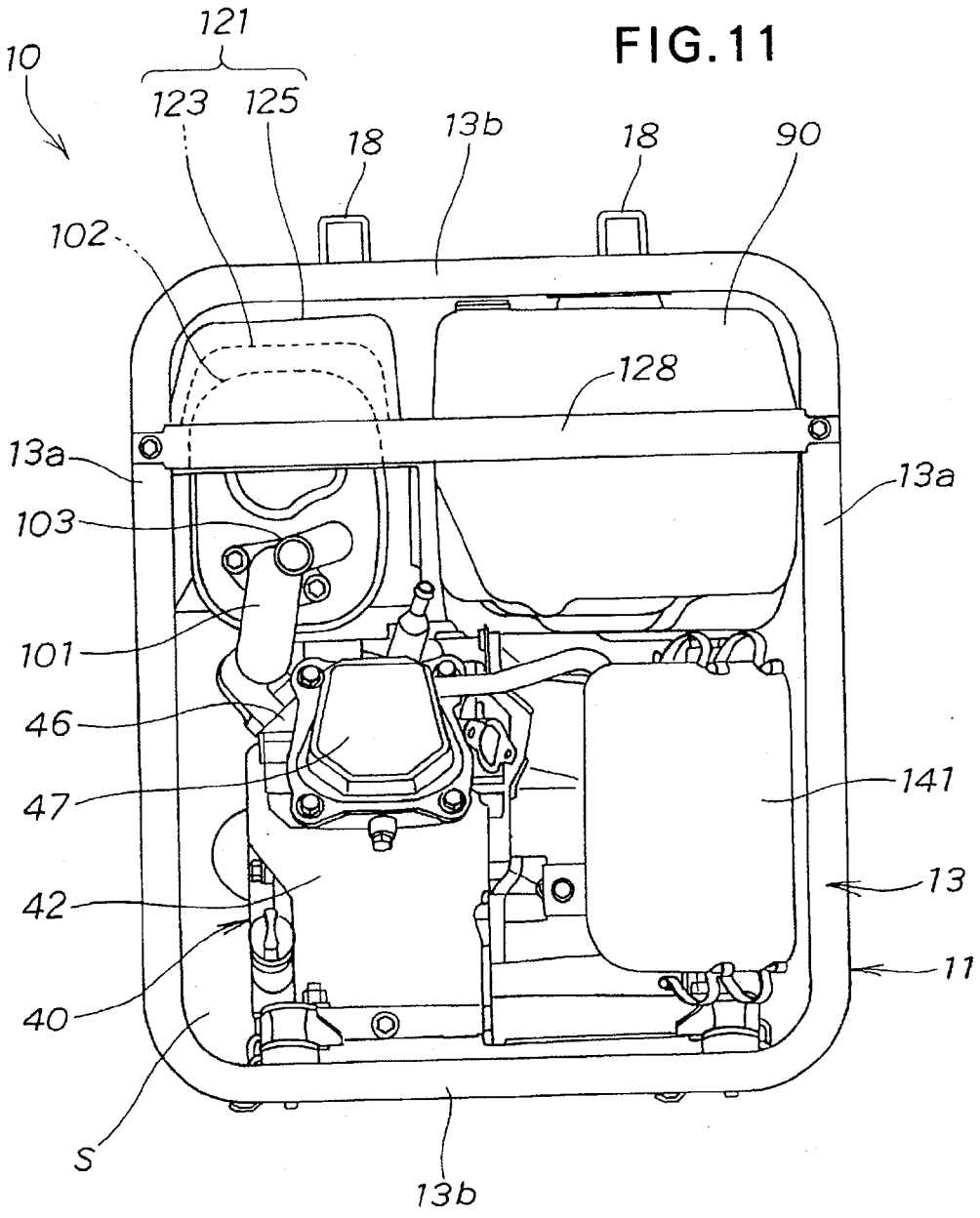


FIG. 11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121
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13b
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S
13b

FIG. 12

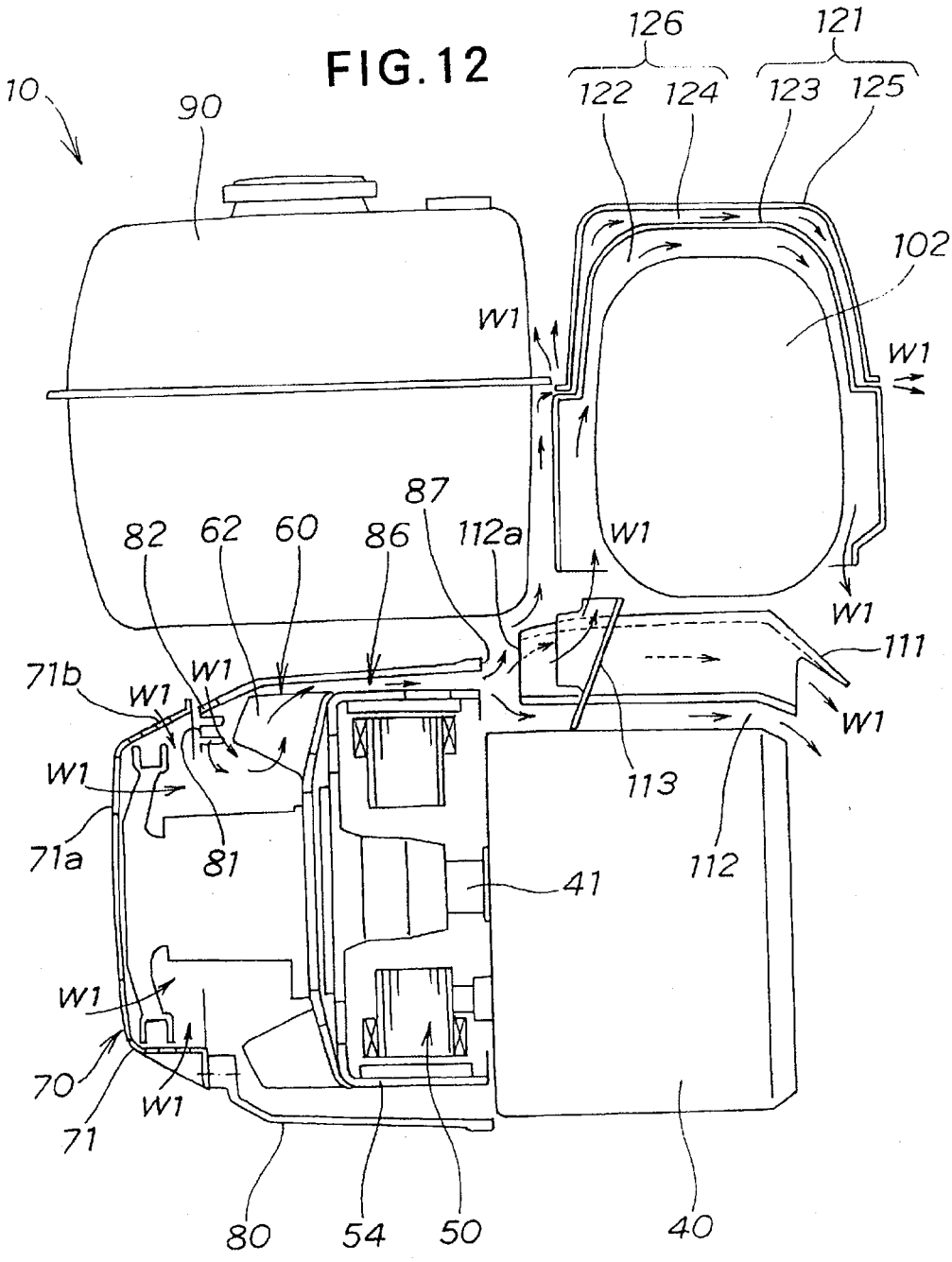
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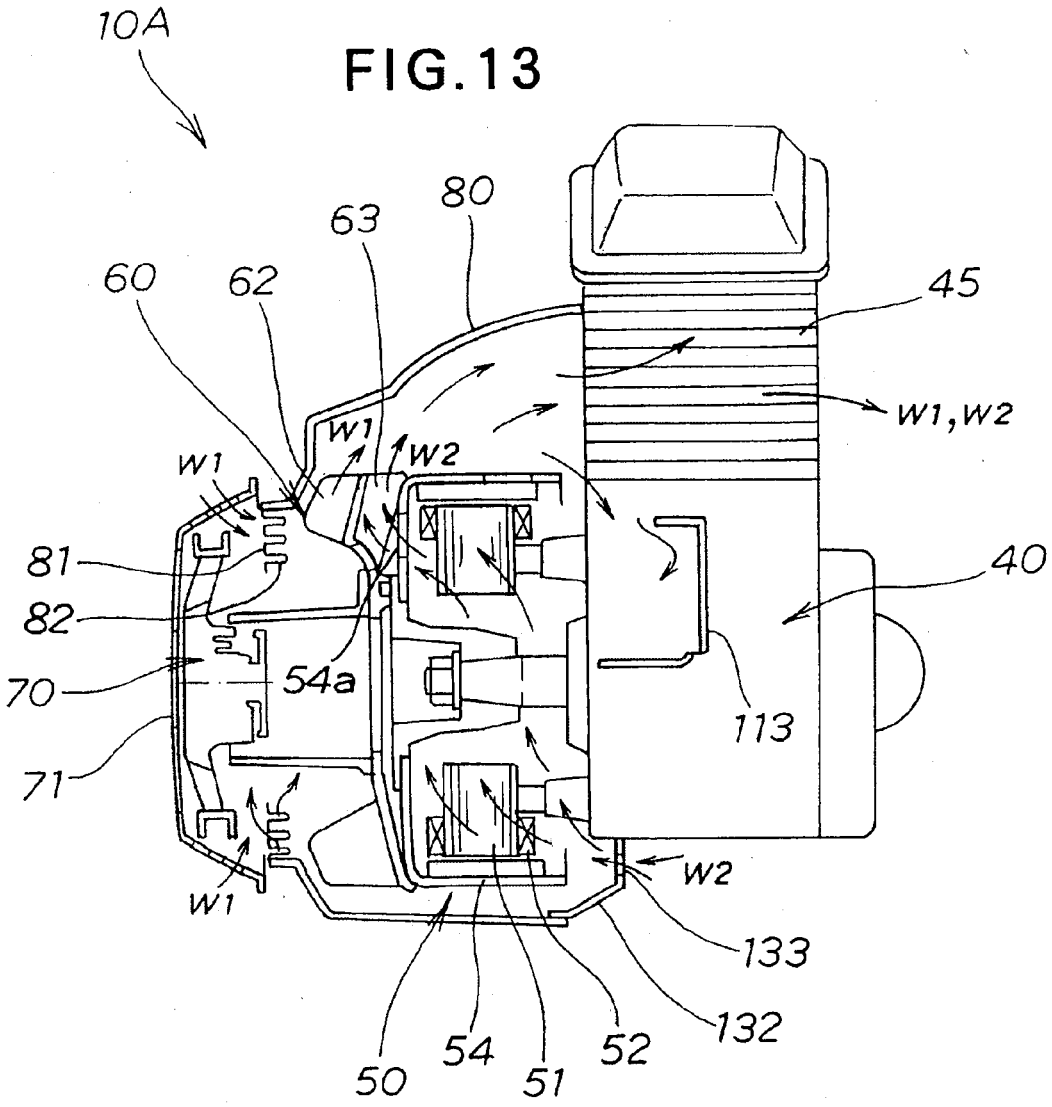
FIG. 13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W1,W2
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W2
W1
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54a
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113
71
W1
W2
133
132
50
54
51
52

ENGINE GENERATOR UNIT

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an engine generator unit which includes an engine and an electric-power generator to be driven by the engine that are mounted within a space defined by a pipe-shaped framework.

2. Related Prior Art

Among general-purpose power supply devices suitable for outdoor use is the so-called open-type engine generator unit which includes an engine and an electric-power generator to be driven by the engine that are mounted within a space defined by a framework. Typical examples of such an open-type engine generator unit are shown in Japanese Patent Publication No. HEI 1-9452 and Japanese Utility Model Publication HEI 7-24922.

In the engine generator unit disclosed in Japanese Patent Publication No. HEI 1-9452, the engine and electric-power generator to be driven by the engine are mounted side by side within a space defined by a framework made of pipe members. Within the space, a muffler and an air cleaner are also provided alongside of the generator and engine, respectively, and a generally flat fuel tank is provided over the engine, generator, muffler and air cleaner so as to cover a substantially entire top region of the space above the engine and generator.

Similarly, in the engine generator unit disclosed in Japanese Utility Model Publication HEI 7-24922, the engine and electric-power generator to be driven by the engine are mounted side by side within a space defined by a protective framework made of pipe members. Within the space, a muffler enclosed by a muffler cover is disposed above the generator, and a generally flat fuel tank is provided over the engine, generator and muffler so as to cover a substantially entire top region of the space above the engine, generator and muffler.

With the engine generator unit disclosed in the No. HEI 1-9452 publication, however, the capacity (size) and position of the muffler, which becomes particularly hot during operation, have to be carefully chosen (and hence are subject to considerable limitations) because the engine, generator, muffler and air cleaner are packed together in the framework-defined limited space under the fuel tank. Also, the capacity of the fuel tank has to be carefully chosen (and hence is subject to considerable limitations) in order to prevent the fuel tank from interfering with the other components provided in the small space below the fuel tank; for example, there are needs to appropriately shape the underside of the fuel tank, to provide a buffering space for avoiding thermal influences from components lying underneath the fuel tank. The engine generator unit disclosed in the No. HEI-7-24922 publication faces similar inconveniences and problems.

SUMMARY OF THE INVENTION

It is accordingly an object of the present invention to provide an improved engine generator unit which can increase the capacity of the muffler while providing for a large capacity of the fuel tank.

To accomplish the above-mentioned object, the present invention provides an engine generator unit which comprises: a framework having vertical pipe frame portions at its four corners; an engine; an electric-power generator to be driven by the engine, the engine and the electric-power generator being provided coaxially in a direction of an engine output shaft within a space defined by the framework; a fuel tank disposed above the engine and electric-power generator between a pair of support members each spanning between a different pair of the vertical pipe frame portions; a muffler connected to an exhaust-discharging end of the engine and positioned adjacent the fuel tank in a side-by-side relation thereto; and a heat blocking cover covering top and side portions of the muffler, the heat blocking cover being placed between the pair of support members in such a way that a substantially entire top region of the space defined by the framework is covered with the fuel tank and the heat blocking cover.

With the arrangements that the muffler covered with the heat blocking cover is disposed above the engine and electric-power generator and adjacent the fuel tank in a side-by-side relation thereto and the fuel tank and heat blocking cover together cover a substantially entire top region of the space defined by the framework, the muffler in the inventive engine generator unit is less subject to limitations on its capacity (size) and mounting position than in the prior counterparts where the engine, generator, muffler etc. are packed in an extremely narrow space under the fuel tank. Thus, with the present invention, the size and hence capacity of the muffler can be increased with ease. Further, the present invention can effectively reduce undesired heat radiation from the muffler to the fuel tank by closing the top and side portions of the muffler with the heat blocking cover, so that adverse thermal influences of the muffler on the fuel tank can be reliably avoided even where the muffler is located close to the fuel tank. In addition, because the muffler is not placed under the fuel tank, the empty space under the fuel tank can be accessed or used with ease, and the bottom portion of the fuel tank can be increased in size, which thereby provides for an increased overall capacity of the fuel tank.

In a preferred implementation of the present invention, a cylinder of the engine is mounted in a downwardly tilted posture with respect to a general vertical axis of the engine generator unit, and the muffler is mounted with its general plane lying substantially horizontally above the cylinder of the engine in an orientation where a longitudinal axis of the muffler crosses the engine output shaft at right angles thereto. By thus tilting the engine cylinder, the overall height or profile of the engine can be significantly lowered, which leaves a relatively large empty space above the thus-lowered engine cylinder within the space surrounded by the framework. The relatively large empty space can be utilized to position the horizontal muffler substantially at right angles to the engine output shaft, with the result that a large-size muffler can be mounted within the space defined by the framework.

Preferably, the heat blocking cover is generally in the shape of an elongate semicylindrical bowl closed at opposite ends and opening downward to cover an upper surface of the muffler, and a cooling air passage is provided between the heat blocking cover and the muffler. The outer surface of the muffler can be cooled with cooling air flowing through the cooling air passage. Further, by the presence of the cooling air passage, the heat of the muffler is not transferred directly to the heat blocking cover so that the outer surface temperature of the heat blocking cover can be prevented from getting very high.

Further, in a preferred implementation of the present invention, the muffler has an exhaust port positioned near the distal end of the cylinder of the engine mounted in the downwardly tilted posture, and a control panel is disposed

on a side of the engine generator unit opposite or remote from the exhaust port. With this arrangement, the exhaust from the muffler can be prevented from flowing toward the control panel, which is therefore not thermally influenced by the muffler exhaust and can be constantly maintained in a suitable operating condition for a human operator to appropriately manipulate the panel as necessary.

Preferably, the electric-power generator is an outer-rotor/multipolar-magnet generator that has an outer rotor functioning also as a flywheel of the engine, and it further comprises an electric power controller for converting an output from the outer-rotor/multipolar-magnet generator to electric power of a predetermined frequency. Here, an output from the outer-rotor/multipolar-magnet generator, rather than the conventional synchronous generator, is converted via the electric power controller into electric power of a predetermined frequency and the outer rotor can function also as the flywheel of the engine, which can eliminate a need for a separate flywheel. The dimension of the engine generator unit in the axial direction of the engine output shaft can be reduced accordingly. In addition, because the fuel tank and muffler are placed side by side above the engine and generator, the engine generator unit can be constructed compactly into a generally cubic configuration and therefore can be installed appropriately in a small mounting space.

Preferably, the framework includes a pair of upper horizontal pipe frame portions each connecting between a predetermined pair of the vertical pipe frame portions, and the pair of upper horizontal pipe frame portions provide grips that can be suitably used when the engine generator unit is to be carried by hand. Such upper horizontal pipe frame portions allow the engine generator unit of the present invention to be carried or handled with utmost facility.

With the arrangements that the engine and the electric-power generator are provided coaxially in the direction of the engine output shaft within the mounting space defined by the framework, the engine cylinder is mounted in the downwardly tilted posture and the muffler is disposed above the engine and generator and adjacent the fuel tank in a side-by-side relation thereto, the inventive engine generator unit can be reliably kept in good weight balance with its center of gravity set substantially set at the center of the space defined by the framework. As a result, the engine generator unit can be carried and handled with great facility, using the upper horizontal pipe frame portions as grips.

BRIEF DESCRIPTION OF THE DRAWINGS

Certain preferred embodiments of the present invention will be described in greater detail with reference to the accompanying sheets of drawings, in which:

FIG. **1** is a perspective view showing a general construction of an engine generator unit in accordance with a preferred embodiment of the present invention;

FIG. **2** is a vertical sectional view taken along the **2—2** line of FIG. **1**;

FIG. **3** is a partly-sectional front view of the engine-operated generator unit shown in FIG. 1;

FIG. **4** is a perspective view showing a fan cover attached directly to an engine shown in FIG. 1;

FIG. **5** is a vertical sectional view taken along the **5—5** line of FIG. **2**;

FIG. **6** is an exploded perspective view showing a muffler and a heat blocking cover in the preferred embodiment;

FIG. **7** is a sectional top plan view of the engine generator unit in accordance with the preferred embodiment of the present invention, which particularly shows the engine and generator;

FIG. **8** is a top plan view of the engine generator unit in accordance with the preferred embodiment of the present invention;

FIG. **9** is a right side view of the engine generator unit in accordance with the preferred embodiment of the present invention;

FIG. **10** is a left side view of the engine generator unit in accordance with the preferred embodiment of the present invention;

FIG. **11** is a rear view of the engine generator unit in accordance with the preferred embodiment of the present invention;

FIG. **12** is a view explanatory of behavior of the inventive engine generator unit; and

FIG. **13** is also a view explanatory of the behavior of the inventive engine generator unit.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following description is merely exemplary in nature and is in no way intended to limit the invention, its application or uses.

FIG. 1 is a perspective view showing a general construction of an engine generator unit in accordance with a preferred embodiment of the present invention. As shown, this engine generator unit **10** is of the open type which includes a pipe framework **11** that, in the illustrated example, is generally formed into a hollow cubic shape and composed of front and rear generally-square or rectangular pipe-shaped frames **12** and **13**. The generator unit **10** has a control panel **20** fixed to the front frame in an upper hollow region defined by the rectangular front frame, and an electric power controller **30** is disposed in a lower hollow region defined by the front frame. The engine generator unit **10** also includes, within a mounting space S between the front and rear frames **12** and **13**, an engine **40**, a fuel tank **90**, an air cleaner **141**, an electric power generator **50** (FIG. **2**) and a muffler **102** (FIG. **2**).

The rectangular front and rear frames **12** and **13** of the pipe framework **11** are interconnected by a pair of left and right lower beams **14** and **15** and a pair of left and right upper beams **16** and **17** (the right upper beam **17** is not visible in FIG. 1 and shown in FIG. **9**). The rectangular front frame **12** consists of a pair of left and right vertical pipe frame portions **12***a* and a pair of horizontal pipe frame portions **12***b*, and similarly the rectangular rear frame **13** consists of a pair of left and right vertical pipe frame portions **13***a* and a pair of horizontal pipe frame portions **13***b*. Thus, the pipe frame **11** has the vertical pipe frame portions **12***a* and **13***a* at its four corners as viewed in plan.

On corresponding positions of the opposed upper horizontal pipe frame portions **12***b* and **13***b*, the pipe frame **11** includes a pair of positioning supports **18** that are used when another engine-operated generator unit (not shown) of the same construction is to be superposed on the engine generator unit **10**. More specifically, the positioning supports **18** are provided on the upper horizontal pipe frame portions **12***b* and **13***b* so that they can engage the other engine generator unit against displacement in the front-rear and left-right directions.

The upper horizontal pipe frame portions **12***b* and **13***b*, connecting between the vertical pipe frame portions **12***a* of the front frame **12** and between the vertical pipe frame portions **13***a* of the rear frame **13**, respectively, are opposed to each other at a same level of the unit **10** and thus can be

suitably used as grips when the unit **10** is to be carried by hand. Namely, the upper horizontal pipe frame portions **12***b* and **13***b* allow the engine generator unit **10** of the present invention to be carried or handled with utmost facility.

The control panel **20** includes various electrical components that constitute an engine control, an electric-power take-out section, etc. More specifically, on the control panel **20**, there are provided an engine switch **21** for turning on an engine ignition system, an ignition controller **22** for controlling the engine ignition, a battery charger socket **23** for charging an external battery, a first take-out socket **24** for taking out a high-level A.C. current, and two second take-out sockets **25** each for taking a current lower in level than that taken out by the first take-out socket **24**. Also provided on the control panel **20** are a circuit breaker **26** for breaking the electric circuit when the output current from any one of the sockets **24** and **25** exceeds a predetermined threshold value, and a frequency changing switch **27** for changing the frequency of the output current from the sockets **24** and **25**. The electric power controller **30** converts the output frequency of the generator **50** into a predetermined frequency and may comprise, for example, a cycloconverter.

FIG. **2** is a vertical sectional view taken along the line **2**—**2** of FIG. **1**, which shows the engine **40**, generator **50**, fuel tank **90** and muffler **102** as viewed from the front of the engine generator unit **10**; note that only a lower end portion of the framework **11** is shown in this figure for simplicity of illustration.

Within the space surrounded by the pipe frame **11**, as seen in FIG. **2**, the engine **40** and generator **50** capable of being driven by the engine **40** are positioned side by side in an axial direction of an engine output shaft **41**, and the fuel tank **90** and muffler **102** are disposed above the generator **50** and engine **40**. When the engine generator unit **10** is viewed from its front as in FIG. **2**, the engine **40** is located in the lower right of the generator unit **10**, the generator **50** located in the lower left of the generator unit **10**, the fuel tank **90** located above the generator **50**, and the muffler **102** located above the engine **40** that has an overall height significantly reduced by placing the engine cylinder in a downwardly tilted posture with respect to a general vertical axis of the generator unit **10** as will be later described. The fuel tank **90** and muffler **102** are placed substantially horizontally (with their general planes lying substantially horizontally) in a side-by-side relation to each other. Because the fuel tank **90** and muffler **102** are thus mounted side by side right above the generator **50** and engine **40**, the engine-operated generator unit **10** can be constructed compactly into a generally-cubic overall configuration, so that it can be appropriately installed even in a relatively small space with its center of gravity significantly lowered.

FIG. **3** is a partly-sectional front view of the engine-operated generator unit **10** with principal components of the generator unit **10** of FIG. **2** depicted on an enlarged scale. To the pipe frame **11** of the generator unit **10**, there are fixed the engine **40**, the generator **50** operatively connected the engine **40**, a centrifugal cooling fan device **60** disposed on one side of the generator **50** remote from the engine **40** for introducing or sucking in outside air for cooling purposes to be described later, a recoil starter **70** connected to the cooling fan device **60** via a connecting cylinder **66**, and a fan cover **80** enclosing the generator **50** and cooling fan device **60**. Outer rotor **54**, cooling fan device **60** and recoil starter **70** are mounted coaxially relatively to the engine output shaft **41**.

The electric-power generator **50** in the preferred embodiment is an outer-rotor/multipolar-magnet generator whose outer rotor **54** is supported by the engine output shaft **41** in a cantilever fashion. More specifically, the generator **50** is made up of an inner stator **56** including a stator core **51** in the form of axially-stacked rings fixed to a side wall of the crankcase **42** and a plurality of coils wound on the stator core **51**, the outer rotor **54** generally in the shape of a cup and mounted on the engine output shaft **41** by means of a hub **53**, and a plurality of magnets **55** secured to the inner surface of the outer rotor **54**.

The cup-shaped outer rotor **54** surrounds the inner stator **56** (i.e., the stator core **51** and coils **52**) and has its one end (cup bottom portion) coupled with the centrifugal cooling fan device **60**; thus, the centrifugal cooling fan device **60** having a relatively large diameter can be mounted reliably in a simple manner. The large diameter of the centrifugal cooling fan device **60** can suck in a sufficient amount of air for cooling the engine **40** and generator **50**.

The outer rotor **54** in the preferred embodiment also functions as a cantilevered flywheel, which can eliminate a need for a separate flywheel. Thus, the dimension of the generator unit **10** in the axial direction of the engine output shaft **41** can be reduced accordingly to permit downsizing of the framework **11**, so that the generator unit **10** can be reduced in overall size. The cup-shaped outer rotor **54** also has air holes **54***a* and **54***b* in the cup bottom portion and cylindrical side wall.

Mounting accuracy of the fan cover **80** relative to the engine output shaft **41** need not be very high because it only has to enclose the outer-rotor-type generator **50** and the cooling fan device **60** attached to the outer rotor **54**.

The fan cover **80** is generally in the form of a cylinder extending horizontally along the engine output shaft **41** close to the engine **40**. Specifically, the fan cover **80** has a cooling-air inlet portion **81** at its outer end remote from the engine **40**, through which the outside air is introduced into the generator unit **10** by means of the cooling fan device **60** generally located inwardly of the cooling-air inlet portion **81**. More specifically, the cooling-air inlet portion **81** has at its outer end a plurality of parallel air sucking-in slits **82** extending along the longitudinal direction of the fan cover **80**, and a recoil starter cover **71** is attached to the cooling-air inlet portion **81** outwardly of the cooling-air inlet portion **81**.

By means of the recoil starter cover **71**, the recoil starter **70** supports a pulley **72** for rotation about an axis lying in horizontal alignment with the engine outputs haft **41** and operatively connects the pulley **72** with the cooling fan device **60**. The recoil starter cover **71** has a plurality of air holes **71***a*.

At the other or inner end adjacent the engine **40**, on the other hand, the cooling fan cover **80** is secured to the engine crankcase **42** by means of bolts **83** (only one of which is shown in FIG. **3**) while forming a cooling-air outlet portion **87** for blowing the cooling air onto the outer peripheral surface of the engine **40**.

FIG. **4** is a perspective view showing the cooling fan cover **80** secured directly to the engine crankcase **42**. The cooling fan cover **80** is made of die-cast aluminum alloy that has a high thermal conductivity and thus achieves a superior heat-radiating performance. By being made of such die-cast aluminum alloy and directly secured to the engine **40**, the cooling fan cover **80** can function as a very efficient heat radiator. Namely, the heat accumulated in the outer wall of the engine crankcase **42** can be readily transferred to the directly-secured fan cover **80**. This way, in the preferred embodiment, the outer surface of the engine **40** and the entire area of the cooling fan cover **80** can together provide

an increased heat-radiating surface for the engine **40**. With such an increase in the heat radiating surface, the engine **40** can be cooled with increased efficiency, as a result of which the oil temperature and the like in the engine **40** can also be kept low with efficiency.

Further, as shown in FIG. **4**, a pair of supporting leg members **43** (only one of which is visible here) are secured to opposite (front and rear) end portions of the underside of the engine **40**. Similarly, a pair of supporting leg portions **84** are secured to opposite ends of the underside of the cooling fan cover **80**. These supporting leg members **43** and **84** of the engine **40** and cooling fan cover **80** are placed transversely on the above-mentioned left and right lower beams **14** and **15** and bolted to the beams **14** and **15** with shock absorbing members (vibration-isolating mounts) **44** and **85** interposed therebetween.

Because the cooling fan cover **80** made of the die-cast aluminum alloy has relatively great rigidity and such a rigid cooling fan cover **80** is firmly secured to the engine **40** that is also rigid enough in general, the engine generator unit **10** of the present invention can provide a rugged assembly of the fan cover **80** and engine **40** which can be reliably retained on the framework **11** with an appropriate shock absorbing or cushioning capability.

Referring back to FIG. **2**, at least part of the engine **40** is covered with an engine shroud **111** with a relatively large empty space **112** left therebetween, and the empty space **112** serves as an air passage through which air is allowed to pass to cool the engine **40** (hereinafter referred to as an "engine-cooling air passage" **112**). Inlet portion **112***a* to the interior of the engine-cooling air passage **112** faces the cooling-air outlet portion **87** of the fan cover **80**.

The muffler **102** is covered or closed at least at its top end portion with a heat blocking cover **121** which is a dual-cover structure including an inner cover **123** covering the muffler **102** with a predetermined first gap **122** formed therebetween and an outer cover **125** covering the outer surface of the inner cover **123** with a predetermined second gap **124**. The inner cover **123** of the dual heat blocking cover structure **121** is generally in the shape of a halved cylinder (elongate semicylindrical bowl) closed at opposite ends and opening downward to cover an almost entire outer surface of the muffler **102** except for a lower end surface of the muffler **102**. The outer cover **125** is also generally in the shape of a halved cylinder (elongate semicylindrical bowl) closed at opposite ends and opening downward to cover an upper surface of the inner cover **123**.

The first gap **122** between the inner cover **123** and the muffler **102** functions as a first cooling-air path, while the second gap **124** between the inner cover **123** and the outer cover **125** functions as a second cooling-air path. Thus, these first and second cooling-air paths **122** and **124** together constitute a divided muffler-cooling air passage **126** separate from the engine-cooling air passage **112**.

As further shown in FIG. **2**, the engine shroud **111** has an air guide **113** integrally formed thereon for diverting a proportion of the cooling air from the engine-cooling air passage **112** upwardly into the muffler-cooling air passage **126**. With this air-diverting guide **113**, the cooling air drawn in from the outside via the cooling fan device **60** having cooled the generator **50** is allowed to flow into both the engine-cooling air passage **112** and the muffler-cooling air passage **126**, so that the engine **40** and muffler **102** can be cooled by the same cooling air having cooled and passed the upstream generator **50**. Because the air guide **113** is used only to divert a proportion of the cooling air within the engine shroud **111**, it can be of simple structure.

FIG. **5** is a vertical sectional view taken along the **5**—**5** line of FIG. **2**, which shows the left side of the framework **11**, engine **40** and muffler **102** and where illustration of the generator **50** is omitted for simplicity. In the preferred embodiment, as shown in FIG. **5**, the engine **40** is constructed to have a lower profile, i.e., a smaller height, than the conventional counterparts by tilting the cylinder **45**, cylinder head **46** and head cover **57**, i.e., the longitudinal axis of the engine **40**, rearwardly downward about the engine output shaft **41** with respect to the general vertical axis of the unit **10**, so as to be located obliquely upward of the engine output shaft **41**.

As further shown in FIG. **5**, the muffler **102** is connected via an exhaust pipe **101** to an exhaust port of the engine **40**.

As also seen from FIG. **5**, the horizontal muffler **102** extends to cross the engine output shaft **41**, substantially at right angles thereto, above the engine cylinder **45** and is secured to an engine bracket **48**. More specifically, tilting the cylinder **45** as above can lower the overall height or profile of the engine **40** and leaves a relatively large empty space above the thus-lowered cylinder **45**. This relatively large empty space is utilized to position the horizontal muffler **102** to cross the engine output shaft **41** substantially at right angles thereto; this arrangement can further increase the capacity of the muffler **102**.

Further, an exhaust port (tailpipe) **103** of the muffler **102** is positioned near the distal end of the engine cylinder **45** and extends in the same rearward direction as the cylinder **41** extends from the engine output shaft **41** in the downwardly tilted posture, and the control panel **20** is positioned on the front of the generator unit **10** opposite or remote from the muffler exhaust port **103**, as denoted by phantom line.

In the preferred embodiment thus arranged, the exhaust from the muffler **102** is prevented from flowing toward the control panel **20**, which is therefore not thermally influenced by the muffler exhaust and can be constantly maintained in a suitable operating condition for a human operator to appropriately manipulate the panel **20** as necessary.

The inner and outer covers **123** and **125** of the dual heat blocking cover structure **121** are elongate covers spanning between the front and rear frames **12** and **13** and secured to the frames **12** and **13** with their opposite end flanges **123***a* and **125***a* superposed on each other. Further, a front support member **127** is provided between the vertical pipe frame portions **12***a* of the front frame **12** while a rear support member **128** is provided between the vertical pipe frame portions **13***a* of the rear frame **13**. Two pairs of the superposed end flanges **123***a* and **125***a* are bolted to the front and rear support members **127** and **128**, respectively, by which the dual heat blocking cover structure **121** is secured between the front and rear frames **12** and **13** above the muffler **102**.

FIG. **6** is an exploded perspective view showing the muffler **102** and heat blocking cover **121** and is particularly explanatory of a relationship between the muffler **102** and the inner and outer covers **123**, **125** in the preferred embodiment. As shown, the inner cover **123** has an opening **123***b* in its rear wall to avoid mechanical interference with the tailpipe **103** of the muffler **102**. The muffler **102** also has an exhaust inlet and a stay **105**, and reference numeral **106** is a bolt for insertion through the end flanges of the inner and outer covers **123** and **125**.

FIG. **7** is a sectional top plan view of the engine generator unit **10** in accordance with the preferred embodiment of the present invention, which particularly shows the engine **40** and generator **50** with the fuel tank **90**, muffler **102** and

control panel **20** removed for clarity. As shown in the figure, a set of the engine **40**, generator **50**, electric power controller **30**, engine shroud **111**, air cleaner **141** and carburetor **142** is mounted snugly within a square space defined by the framework **11**, and the air guide **113** of the engine shroud **111** has a generally U-shape opening toward the cooling fan cover **80** as viewed in top plan.

As viewed in top plan, the cooling fan cover **80** bulges greatly along the engine cylinder **45**, and thereby allows the cooling air to be readily introduced into the space within the engine shroud **111**. The cooling fan device **60** is a double-side fan which includes a main fan **62** formed integrally on the rear surface of a base **61** and an auxiliary fan **63** formed integrally on the front surface of the base **61**. The main fan **62** functions to direct the outside air, introduced through the main cooling-air inlet portion **81**, toward the engine **40**, while the auxiliary fan **63** functions to direct the outside air, introduced through a plurality of auxiliary cooling-air inlets **133** and passed through the generator **50**, toward the engine **40**.

The cooling fan cover **80** has a predetermined gap **131** adjacent the engine **40** so that the gap **131** serves as the auxiliary cooling-air inlets **133** for drawing in the outside air to cool the interior of the generator **50**. Namely, the gap **131** having a relatively large size is formed between one end of the fan cover **80** and one side of the crankcase **52** remotely from the engine cylinder **45**, and this gap **131** is closed by a plate **132** having the auxiliary cooling-air inlets **133** formed therein. The auxiliary air inlets **133** are formed in the plate **132** inwardly of the outer rotor **54** so as to be close to the center of the centrifugal cooling fan **60**. Because the central area of the centrifugal cooling fan **60** is subject to a greater negative pressure, the outside air can be efficiently sucked in through the auxiliary cooling-air inlets **133** located close to the center of the cooling fan **60** and then directed through the interior space of the generator **50** to the auxiliary fan **63**. The closing plate **132** bolted to the engine **40** and the auxiliary cooling-air inlets **133** formed in the closing plate **132** are illustratively shown in FIG. **5**.

FIG. **8** is a top plan view of the engine generator unit **10** in accordance with the preferred embodiment of the present invention. As shown, the muffler **102** is disposed adjacent the fuel tank **90** in a side-by-side relation thereto and covered at its top with the heat blocking cover **121**. Further, the fuel tank **90** and heat blocking cover **121** span horizontally between and secured to the front and rear support members **127** and **128**, so that the entire top region of the space defined by the pipe-shaped framework **11** is substantially closed by the fuel tank **90** and heat blocking cover **121**. In this figure, reference numeral **91** represents an oil filler hole, **92** an oil filler cap, and **93** an oil surface gauge.

FIG. **9** is a right side view of the engine generator unit **10** in accordance with the preferred embodiment of the present invention, which particularly shows that the muffler **102** is supported by the engine **40** via the above-mentioned exhaust pipe **101** and stay **105** and that the cylinder **45** and cylinder head **46** of the engine **40** are covered with a pair of upper and lower engine shroud members **111**.

FIG. **10** is a left side view of the engine generator unit **10** in accordance with the preferred embodiment of the present invention, which particularly shows that an actuating handle **73** of the recoil starter **70** is provided on a front left portion of the engine generator unit **10** and the air cleaner **141** is provided on a rear left portion of the unit **10**.

Further, FIG. **11** is a rear view of the engine generator unit **10** in accordance with the preferred embodiment of the present invention, which particularly shows that the muffler **102** is connected via the exhaust pipe **101** to the engine cylinder head **46** and that the rear support member **128** is bolted at its opposite ends to the vertical pipe frame portions **13***a* of the rear frame **13**.

Now, a description will be made about exemplary behavior of the engine generator unit **10** constructed in the above-mentioned manner, with particular reference to FIGS. **12** and **13**.

FIG. **12** is a view explanatory of the behavior of the inventive engine generator unit **10**. Upon power-on of the engine **40**, the engine output shaft **41** causes the outer rotor **54** to start rotating, by which electric power generation by the generator **50** is initiated.

Simultaneously, the cooling fan device **60** is caused to rotate with the outer rotor **54** functioning as a magnetic rotor, so that the main fan **62** of the device **60** sucks in the outside air W1 through the air holes **71***a*, **71***b* of the recoil starter cover **71** and air sucking-in slits **82** of the fan cover **80**. The thus-introduced outside air W1 flows in the space enclosed by the fan cover **80** and is discharged radially out of the space by the centrifugal force of the main fan **62**. Then, the cooling air W1 flows through a cooling passage **86** to thereby cool the generator **50** and fan cover **80**, after which it exits via the cooling-air outlet portion **87** of the fan cover **80**. A proportion of the cooling air W1 from the cooling-air outlet portion **87** then enters the space defined by the engine shroud **111** and flows through the engine-cooling air passage **112** while cooling the outer surface of the engine **40**, after which it is discharged back to the outside. Because that proportion of the cooling air W1 flowing through the engine-cooling air passage **112** has just cooled and passed only the generator **50** and thus is still at a relatively low temperature, it can cool the engine **40** with sufficient efficiency. Further, because the air sucking-in slits **82** are formed in the cooling-air inlet portion **81** of the fan cover **80**, a sufficient amount of the outside air W1 can be introduced through these slits **82** into the engine generator unit **10** although the recoil starter **70** is provided in the inlet portion **81**.

The remaining portion of the cooling air W1 from the cooling-air outlet portion **87**, on the other hand, is diverted, via the air guide **113**, upwardly into the first and second passageways **122** and **124** of the divided muffler-cooling air passage **126**. The air guide **113** provides for positive and efficient diversion, and hence sufficient introduction, of the cooling air W1 into the muffler-cooling air passage **126**.

More specifically, the cooling air W1 diverted via the air guide **113** flows in the first cooling-air path **122** of the divided muffler-cooling air passage **126** along the inner surface of the inner cover **123**, to thereby cool the outer surface of the muffler **102**. The cooling air W1 diverted via the air guide **113** also flows in the second cooling-air path **124** of the divided muffler-cooling air passage **126** along the outer cover **125**, to thereby cool the outer surface of the inner cover **123**. The cooling air W1 flowing through the second cooling-air path **124** functions as a heat blocking air layer, namely, an air curtain, that effectively blocks the heat transfer from the inner cover **123**.

In the preferred embodiment, the outer surface temperature of the outer cover **125** can be reduced sufficiently by the cooling air W1 flowing through the two paths **122** and **124** of the divided muffler-cooling air passage **126** in the manner as described above. Further, because the proportion of the cooling air W1 flowing through the two cooling-air paths **122** and **124** has just cooled and passed only the generator **50** and thus is still at a relatively low temperature, it can cool

the muffler **102** with sufficient efficiency. The cooling air W1 having thus cooled and passed the muffler **102** is discharged back to the outside.

Furthermore, the preferred embodiment can effectively reduce undesired heat radiation from the muffler **102** to the fuel tank **90**, by closing the top and side portions of the muffler **102** with the heat blocking cover **121**. Also, the cooling air W1 flowing between the fuel tank **90** and the muffler **102** can form an air curtain blocking the heat transfer between the two. Furthermore, with the cooling air W1 flowing through the muffler-cooling air passage **126**, the outer surface temperature of the heat blocking cover **121** can be kept low so that adverse thermal influences of the muffler **102** on the fuel tank **90** can be reliably avoided even where the muffler **102** is located close to the fuel tank **90**. Thus, in the preferred embodiment of the present invention, the fuel tank **90** and muffler **102** both having a great capacity can be safely positioned very close to each other, and such a great-capacity muffler **102** can reduce an undesired roar of the engine exhaust to a significant degree.

FIG. **13** is also a view explanatory of the behavior of the inventive engine generator unit **10**. The auxiliary fan **63** of the cooling fan device **60** operates to suck in the cooling air from the outside through the auxiliary cooling air inlets **133** formed in the closing plate **132**. The thus-introduced cooling air W2 flows into the space defined by the outer rotor **54** to cool the stator core **51** and coils **52** and then is directed, through the air holes **54***a* formed in the bottom wall of the outer rotor **54**, onto the auxiliary fan **63**. Then, the cooling air W2 is discharged back to the outside by the centrifugal force of the fan **63** and merges with the above-mentioned cooling air W1 discharged via the main fan **62**.

In summary, the present invention arranged in the above-described manner affords various superior benefits as follows.

The engine generator unit of the present invention is characterized primarily in that the muffler connected to the exhaust-discharging end of the engine is positioned adjacent the fuel tank in a side-by-side relation thereto, the heat blocking cover covers the top and side portions of the muffler and the heat blocking cover is placed between the opposed support members in such a way that a substantially entire top region of the space defined by the framework is covered with the fuel tank and the heat blocking cover. With the arrangements, the muffler in the inventive engine generator unit is less subject to limitations on its capacity (i.e., size) and mounting position than in the prior counterparts where the engine, generator, muffler etc. are packed together in an extremely narrow space under the fuel tank. Thus, with the present invention, the size and hence capacity of the muffler can be increased with ease. Further, the present invention can effectively reduce undesired heat radiation from the muffler to the fuel tank by closing the top and side portions of the muffler with the heat blocking cover, so that adverse thermal influences of the muffler on the fuel tank can be reliably avoided even where the muffler is located close to the fuel tank. Furthermore, the large-capacity muffler achieves enhanced performance to thereby reduce an undesired roar of the engine exhaust to a significant degree.

Because the muffler is not placed under the fuel tank in the present invention, the empty space under the fuel tank can be accessed or used with ease, and the bottom portion of the fuel tank can be increased in size, which thereby provides for an increased overall capacity of the fuel tank. Further, the fuel tank and muffler can be simplified in their shapes and flexibility in designing these components can be significantly enhanced. In addition, the inventive engine generator unit can be effectively reduced in its overall size.

With the arrangement that the cylinder of the engine is mounted in a downwardly tilted posture with respect to the general vertical axis of the engine generator unit, the overall height or profile of the engine can be significantly lowered, which leaves a relatively large empty space above the thus-lowered engine cylinder within the space surrounded by the framework. The relatively large empty space can be utilized to position the horizontal muffler substantially at right angles to the engine output shaft, with the result that a large-size muffler can be mounted.

Further, with the arrangement that the heat blocking cover is generally in the shape of an elongate semicylindrical bowl closed at opposite ends and opening downward to cover an upper surface of the muffler with the muffler-cooling air passage provided between the heat blocking cover and the muffler, the outer surface of the muffler can be cooled with cooling air flowing through the cooling air passage. Furthermore, by the presence of the cooling air passage, the heat of the muffler is not transferred directly to the heat blocking cover so that the outer surface temperature of the heat blocking cover can be prevented from getting very high.

Furthermore, with the arrangement that the muffler has its exhaust port positioned near the distal end of the cylinder of the engine mounted in the downwardly tilted posture and the control panel is disposed on a side of the engine generator unit remote from the exhaust port, the exhaust from the muffler can be prevented from flowing toward the control panel, which is therefore not thermally influenced by the muffler exhaust and can be constantly maintained in a suitable operating condition for a human operator to appropriately manipulate the panel as necessary.

Moreover, because the arrangement that the electric-power generator is of the outer-rotor/multipolar-magnet type whose outer rotor functions also as the flywheel of the engine, the dimension of the engine generator unit in the axial direction of the engine output shaft can be reduced accordingly. Further, because the fuel tank and muffler are placed side by side above the engine and generator, the engine generator unit can be constructed compactly into a generally cubic configuration and therefore can be installed appropriately in a small space. In addition, the engine generator unit can be reduced in weight and its center of gravity can be lowered for stabilized installation.

Furthermore, because the framework includes a pair of upper horizontal pipe frame portions each connecting between a predetermined pair of the vertical pipe frame portions and the pair of upper horizontal pipe frame portions provide grips that can be suitably used when the engine generator unit is to be carried by hand. Such upper horizontal pipe frame portions achieve a good weight balance of the inventive engine generator unit and allow the engine generator unit to be carried or handled with utmost facility.

With the arrangements that the engine and the electric-power generator are provided coaxially in the direction of the engine output shaft within the space defined by the framework, the engine cylinder is mounted in the downwardly tilted posture and the muffler is disposed above the engine and generator and adjacent the fuel tank in a side-by-side relation thereto, the inventive engine generator unit can be reliably kept in good weight balance with its center of gravity set substantially set at the center of the space defined by the framework. As a result, the engine generator unit can be carried and handled with great facility, using the upper horizontal pipe frame portions as grips.

What is claimed is:

1. An engine generator unit comprising:

a framework having vertical pipe frame portions at four corners thereof;

an engine;

an electric-power generator to be driven by said engine, said engine and said electric-power generator being provided coaxially in a direction of an engine output shaft within a space defined by said framework;

a fuel tank disposed above said engine and electric-power generator between a pair of support members each spanning between a different pair of the vertical pipe frame portions;

a muffler connected to an exhaust-discharging end of said engine and positioned adjacent said fuel tank in a side-by-side relation thereto; and

a heat blocking cover covering top and side portions of said muffler, said heat blocking cover being placed between said pair of support members in such a way that a substantially entire top region of the space defined by said framework is covered with said fuel tank and said heat blocking cover.

2. An engine generator unit as claimed in claim 1 wherein a cylinder of said engine is mounted in a downwardly tilted posture with respect to a general vertical axis of said engine generator unit, and said muffler is mounted with a general plane thereof lying substantially horizontally above the cylinder of said engine in an orientation where a longitudinal axis of said muffler crosses the engine output shaft at right angles thereto.

3. An engine generator unit as claimed in claim 2 wherein said heat blocking cover is generally in a shape of an elongate semicylindrical bowl closed at opposite ends and opening downward to cover an upper surface of said muffler, and a cooling air passage is provided between said heat blocking cover and said muffler.

4. An engine generator unit as claimed in claim 2 wherein said muffler has an exhaust port positioned near a distal end of said cylinder of said engine mounted in the downwardly tilted posture, and a control panel is disposed on a side of said engine generator unit remote from said exhaust port.

5. An engine generator unit as claimed in claim 2 wherein said electric-power generator is an outer-rotor/multipolar-magnet generator that has an outer rotor functioning also as a flywheel of said engine, and which further comprises an electric power controller for converting an output from said outer-rotor/multipolar-magnet generator to electric power of a predetermined frequency.

6. An engine generator unit as claimed in claim 1 wherein said framework includes a pair of upper horizontal pipe frame portions each connecting between a predetermined pair of the vertical pipe frame portions, and said pair of upper horizontal pipe frame portions provide grips when said engine generator unit is to be carried by hand.

* * * * *

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Hatsugai et al.

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(45) **Date of Patent: Dec. 3, 2002**

(54) **PORTABLE ENGINE GENERATOR HAVING A FAN COVER WITH HEAT RADIATING SURFACE**

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(52) **U.S. Cl.** ..... **290/1 A**; 290/1 B; 290/1 R; 123/2; 322/1

(58) **Field of Search** ..... 290/1 A, 1 R, 290/1 C

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,597,623 A * 8/1971 Gillardi 290/40
5,977,667 A * 11/1999 Hirose 310/51
6,084,313 A * 7/2000 Frank ..... 290/40 C
6,091,160 A * 7/2000 Kouchi et al. ..... 290/1 A
6,119,636 A * 9/2000 Fan 123/2
6,331,740 B1 * 12/2001 Morohoshi et al. 123/41.56
6,362,533 B1 * 3/2002 Morohoshi et al. 123/41.56

FOREIGN PATENT DOCUMENTS

EP 0893586 1/1999
JP 5-96543 12/1993

* cited by examiner

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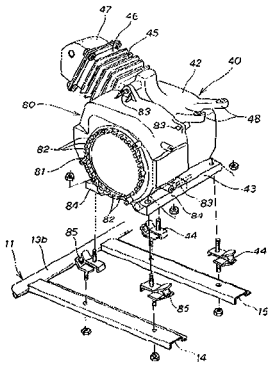
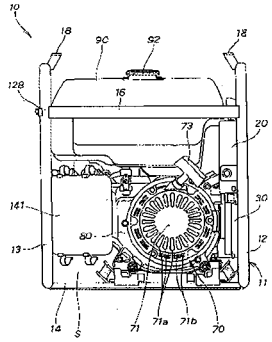
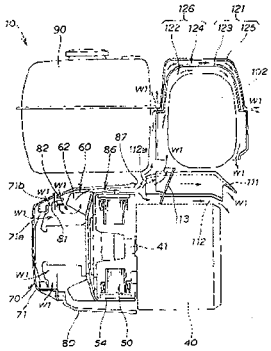
(57) **ABSTRACT**

In an engine generator unit, an engine is connected with an outer-rotor/magnet type generator that has a cantilevered outer rotor functioning also as a substitute for an engine fly wheel. Cooling fan device is attached to the outer rotor. The generator and cooling fan device are covered with a fain cover that is made of die-cast aluminum alloy. The fan cover has, at its one end remote from the engine, a cooling-air inlet portion for introducing cooling air from the outside via the cooling fan device, and a recoil starter is attached to the cooling-air inlet portion. Also, the fan cover is connected at its other end to the engine with a gap formed therebetween for blowing the cooling air onto an outer peripheral surface of the engine. Supporting leg members are secured to the fan cover and engine, and these leg members are also mounted to a framework via shock-absorbing members.

10 Claims, 13 Drawing Sheets







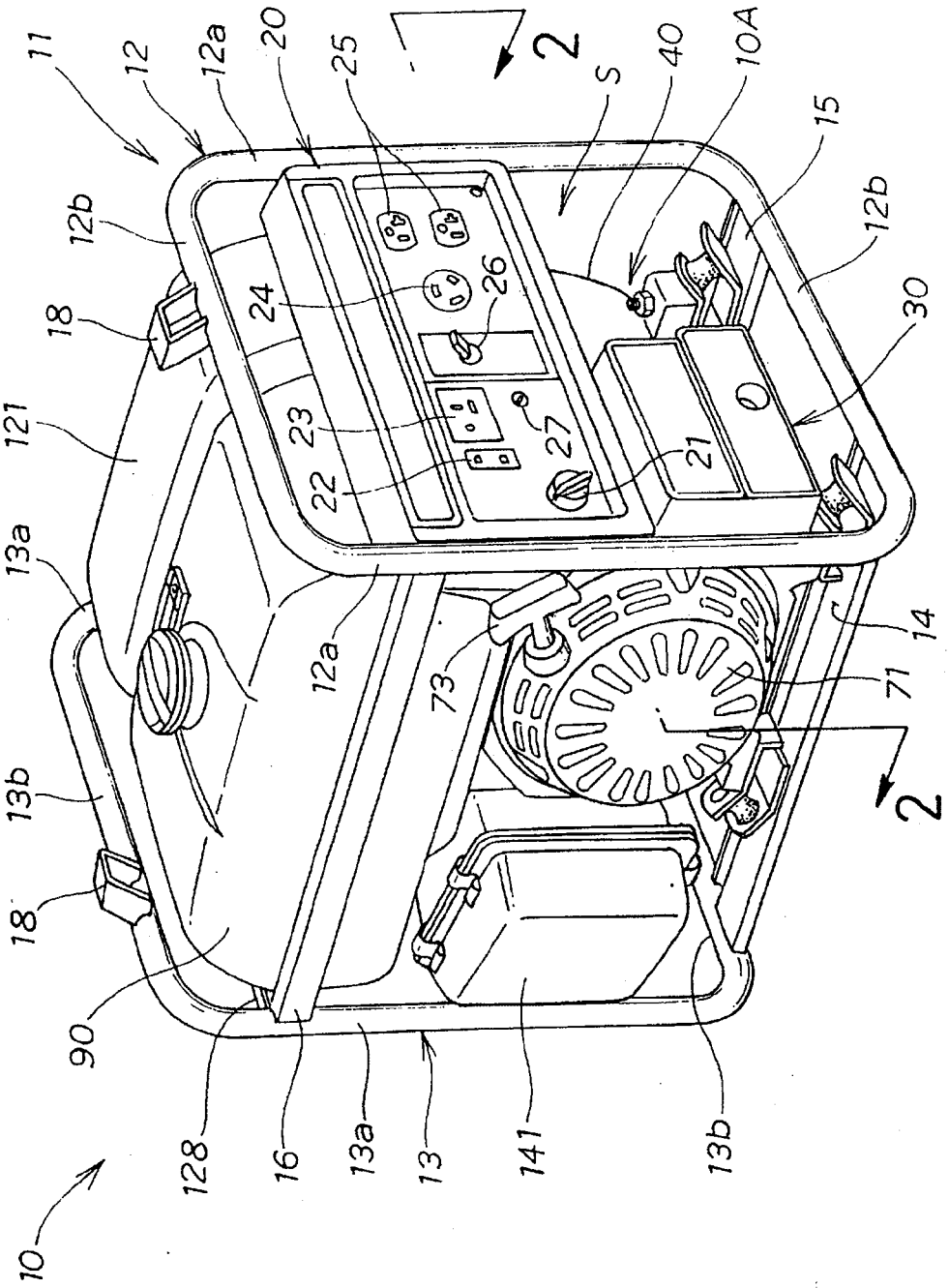

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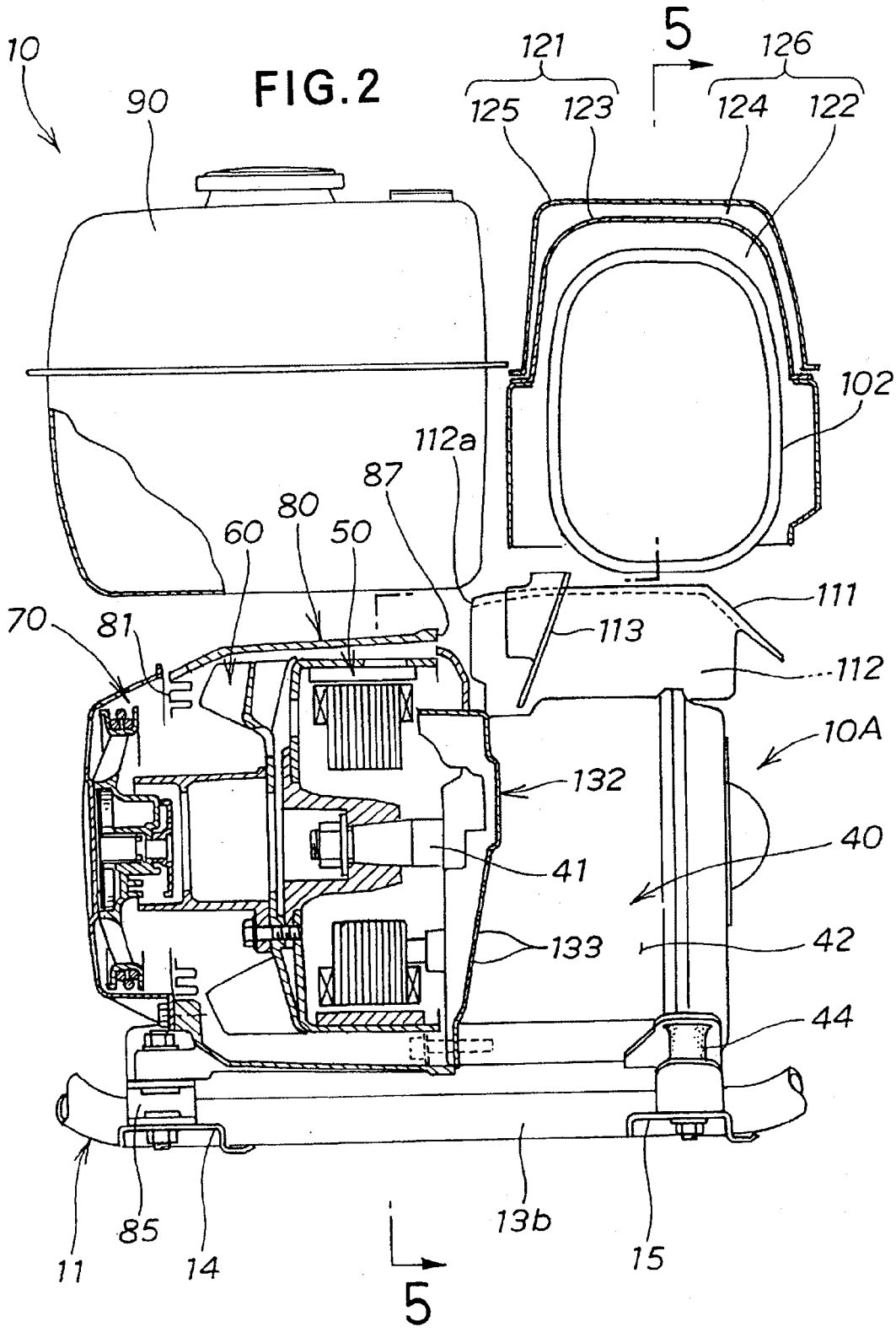
FIG. 1

FIG. 2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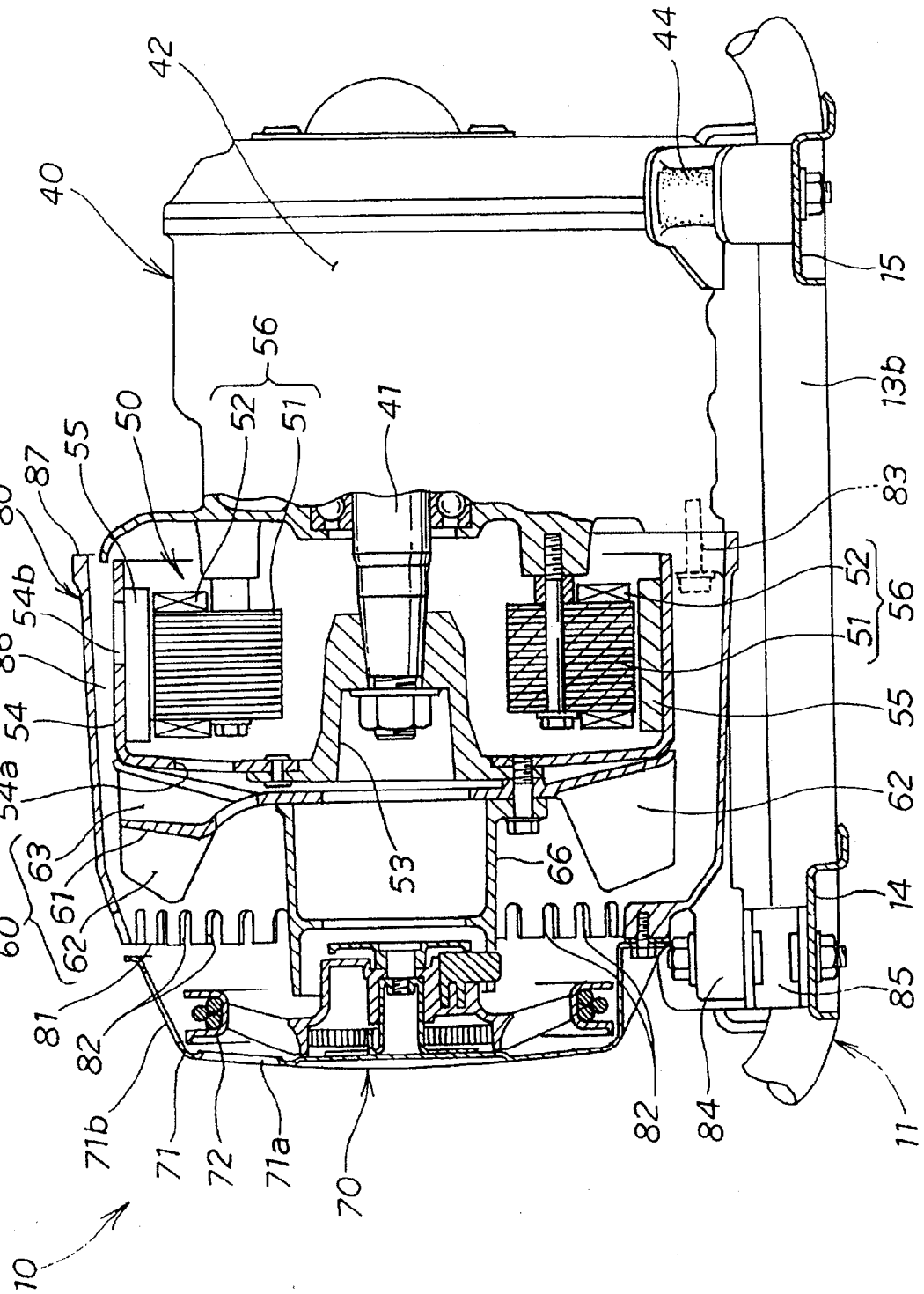
90
121
125
123
5
126
124
122
102
112a
87
80
60
50
111
113
70
81
112
10A
132
40
41
133
42
44
85
14
13b
15
11
5

FIG.3


42
44
40
15
56
52
51
41
13b
50
55
87
80
83
54b
52
56
86
51
54
55
54a
62
63
53
66
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85
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82
82
84
11
71b
71
72
71a
70
10

FIG.4

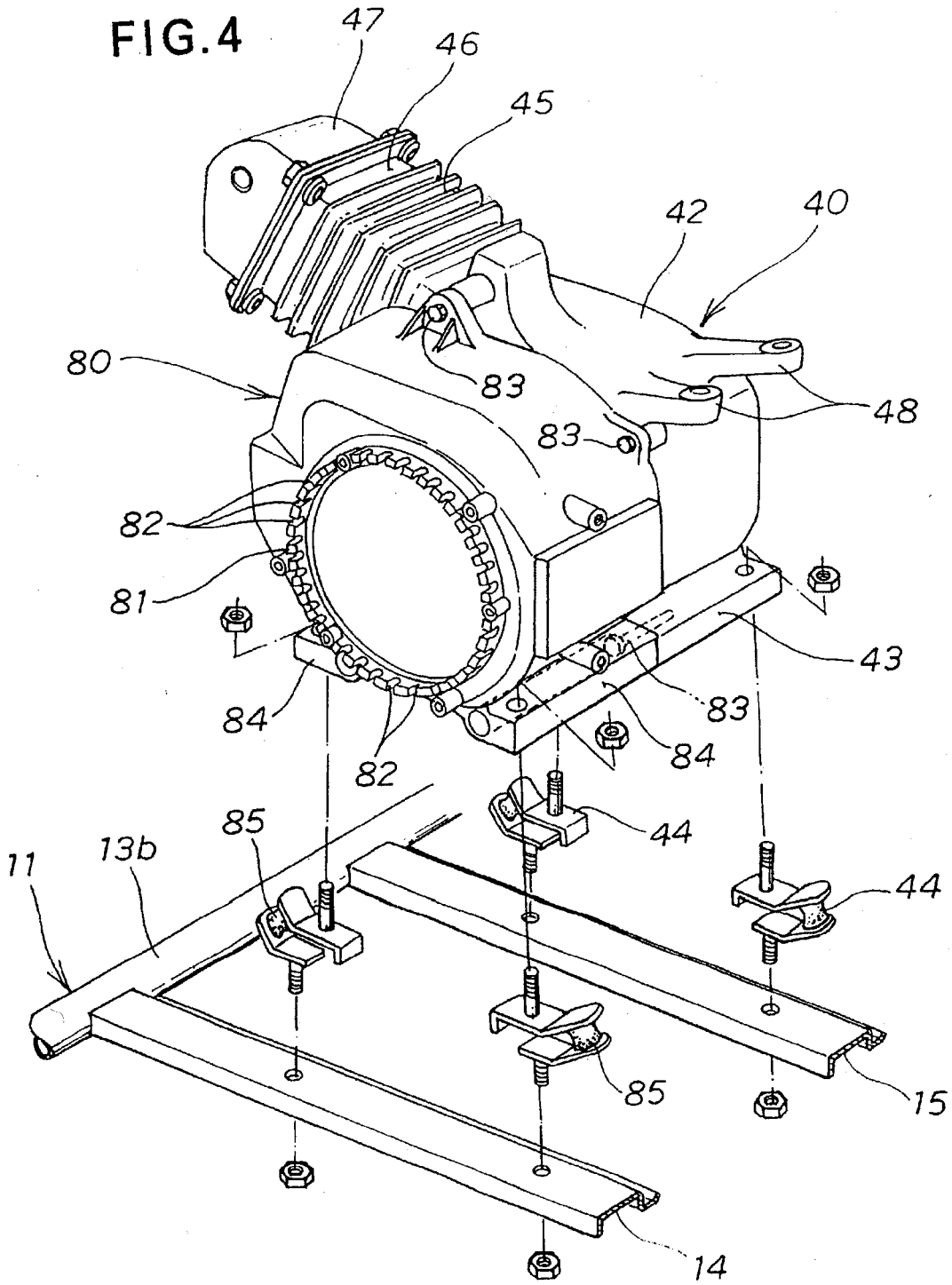


FIG.5

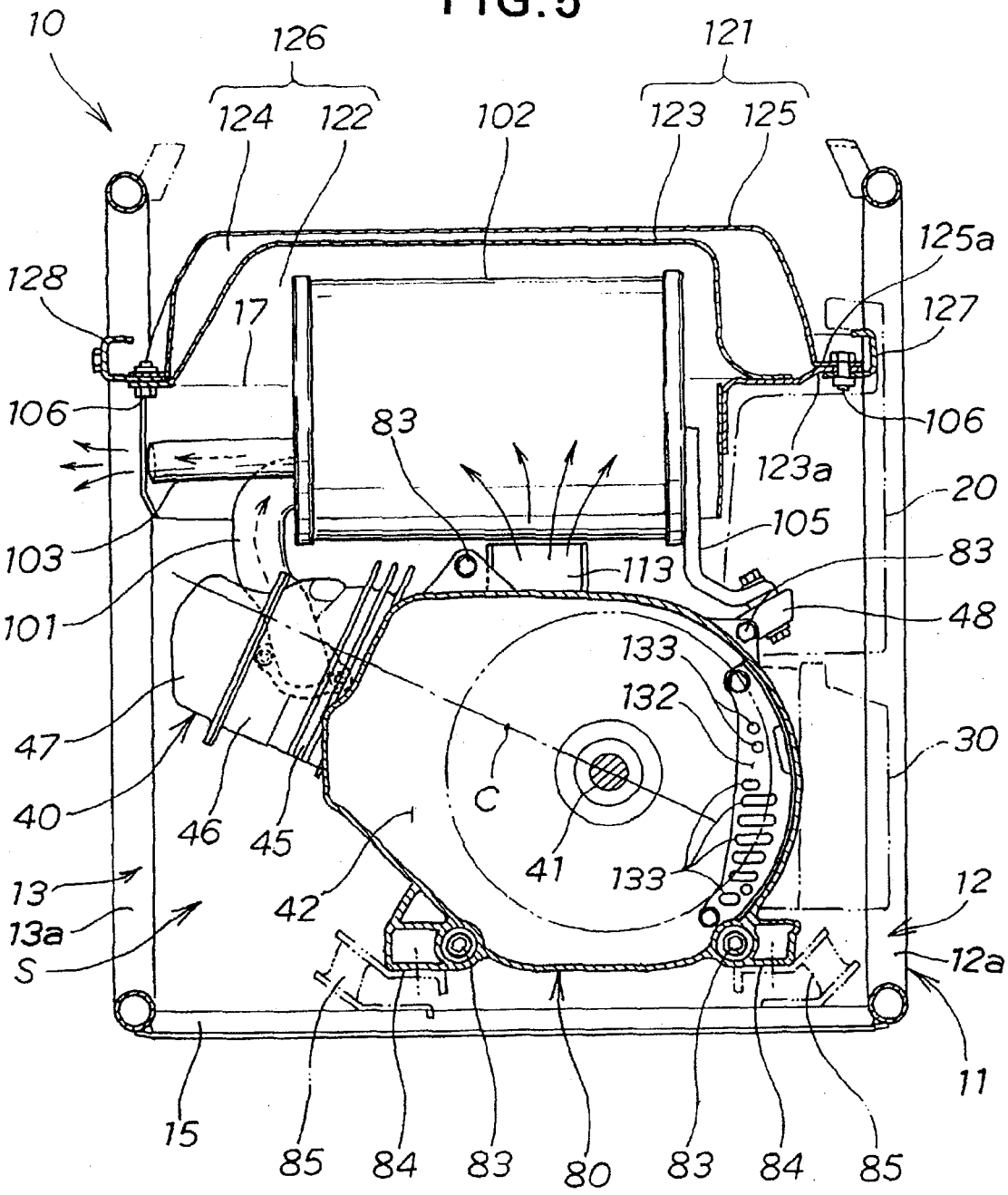

10
126
124
122
102
121
123
125
125a
128
17
127
106
83
106
123a
20
103
105
83
113
101
48
133
132
47
30
C
40
46
45
41
133
42
12
13
13a
S
12a
11
15
85
84
83
80
83
84
85

FIG.6

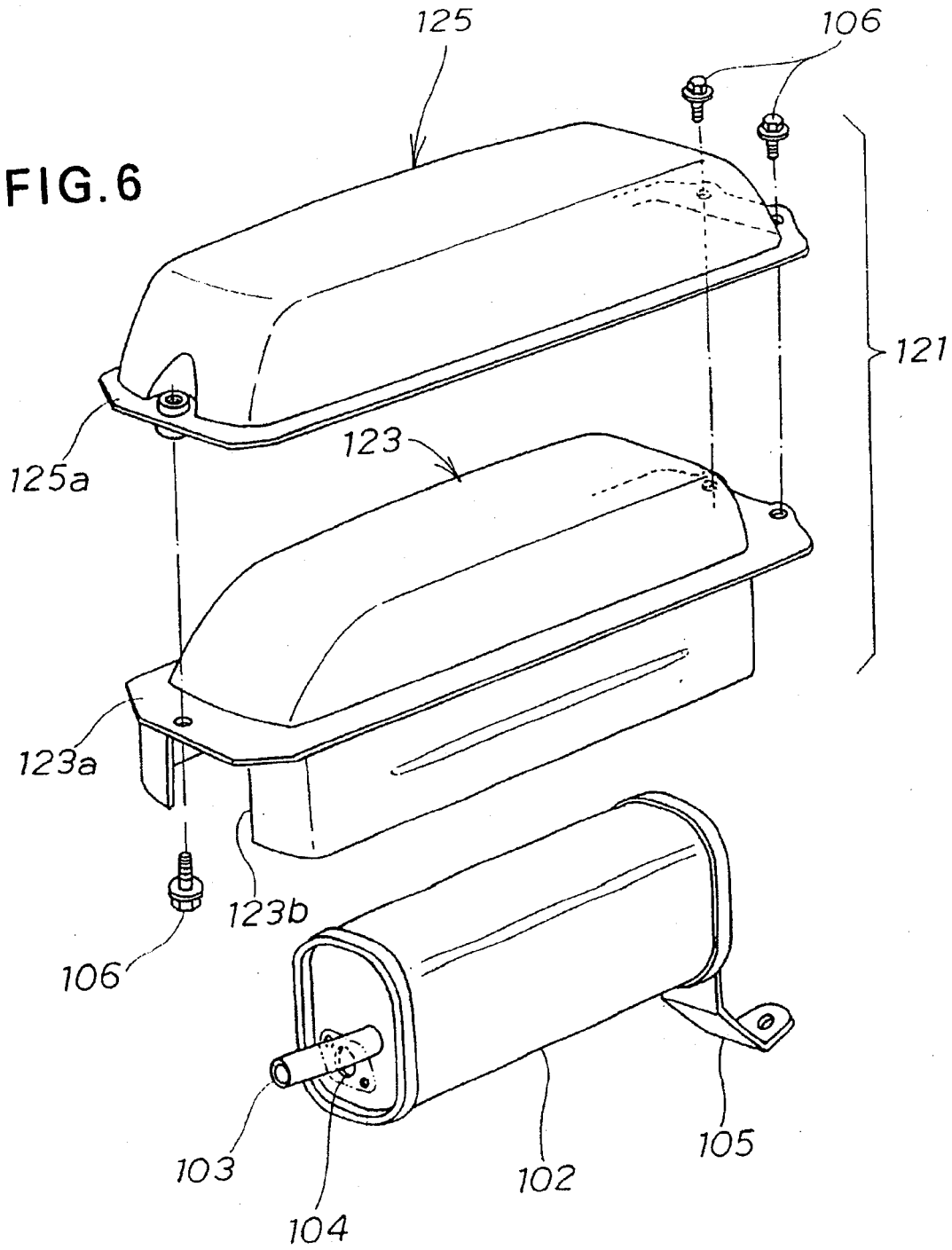
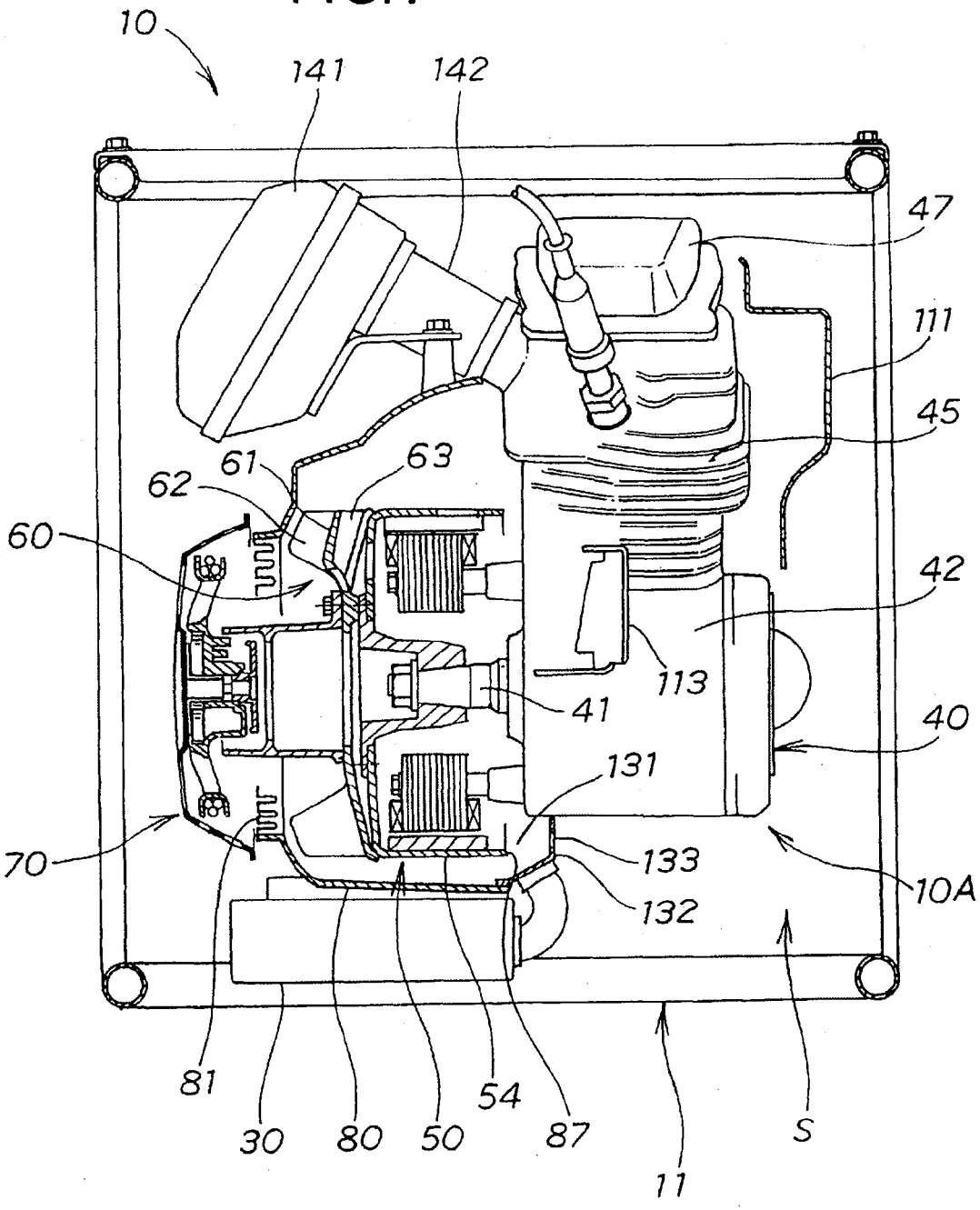


FIG. 7


10
141
142
47
111
45
61
63
62
60
42
113
41
40
131
133
132
10A
70
81
30
80
50
54
87
11
S

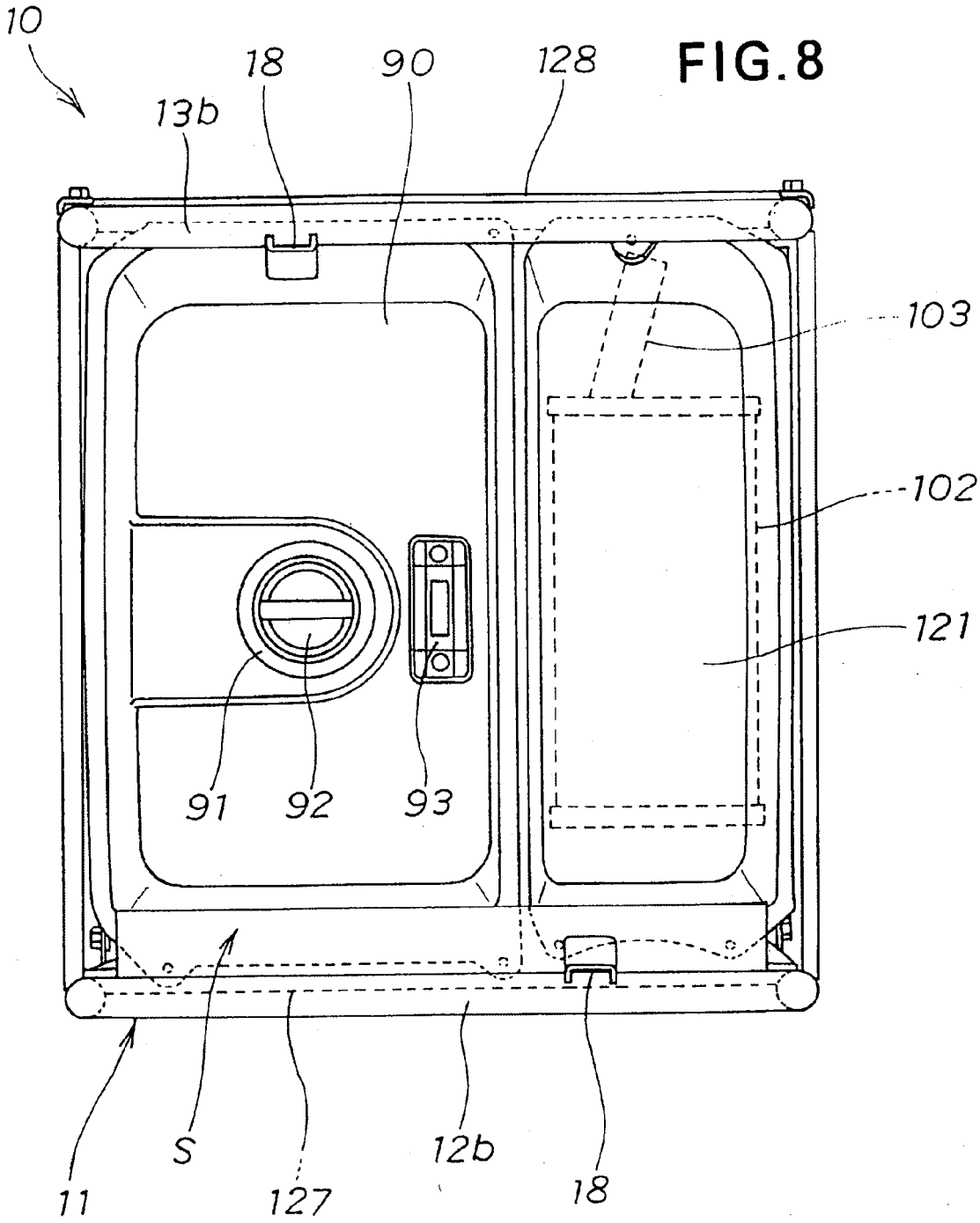
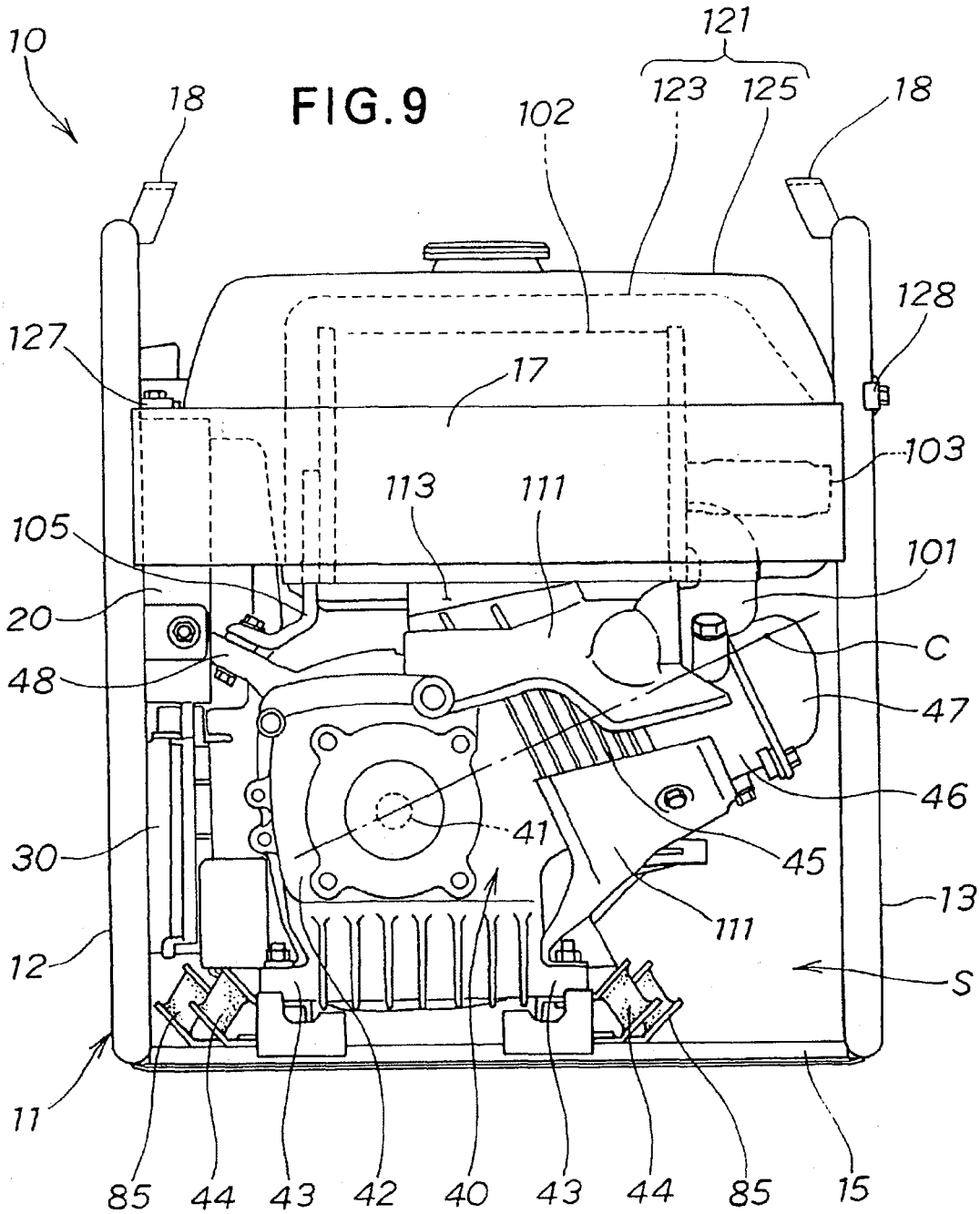


FIG.8

FIG. 9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18
121
123
125
102
18
128
127
17
103
113
111
105
101
20
C
48
47
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41
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13
111
12
S
11
85
44
43
42
40
43
44
85
15

FIG. 10

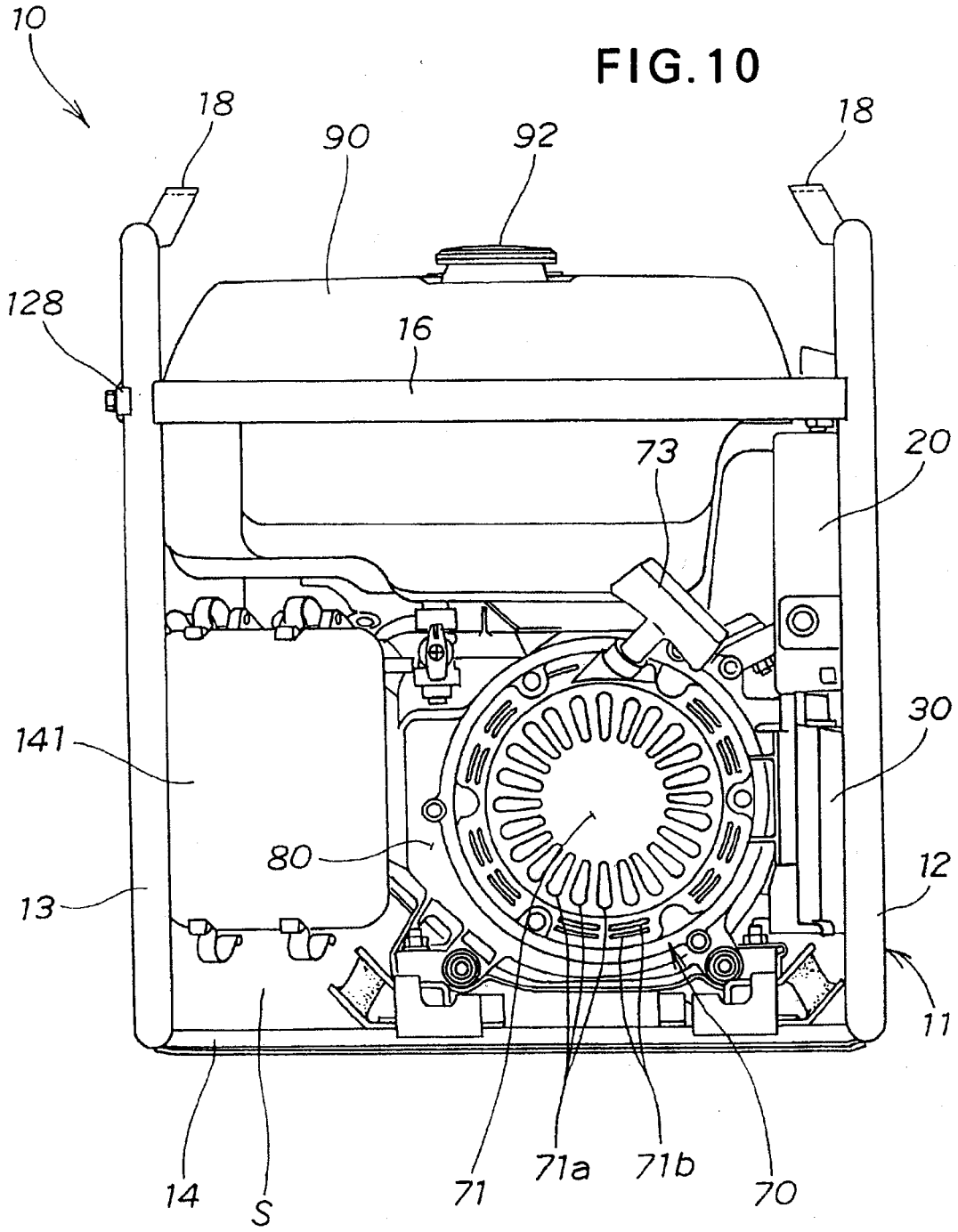


FIG. 11

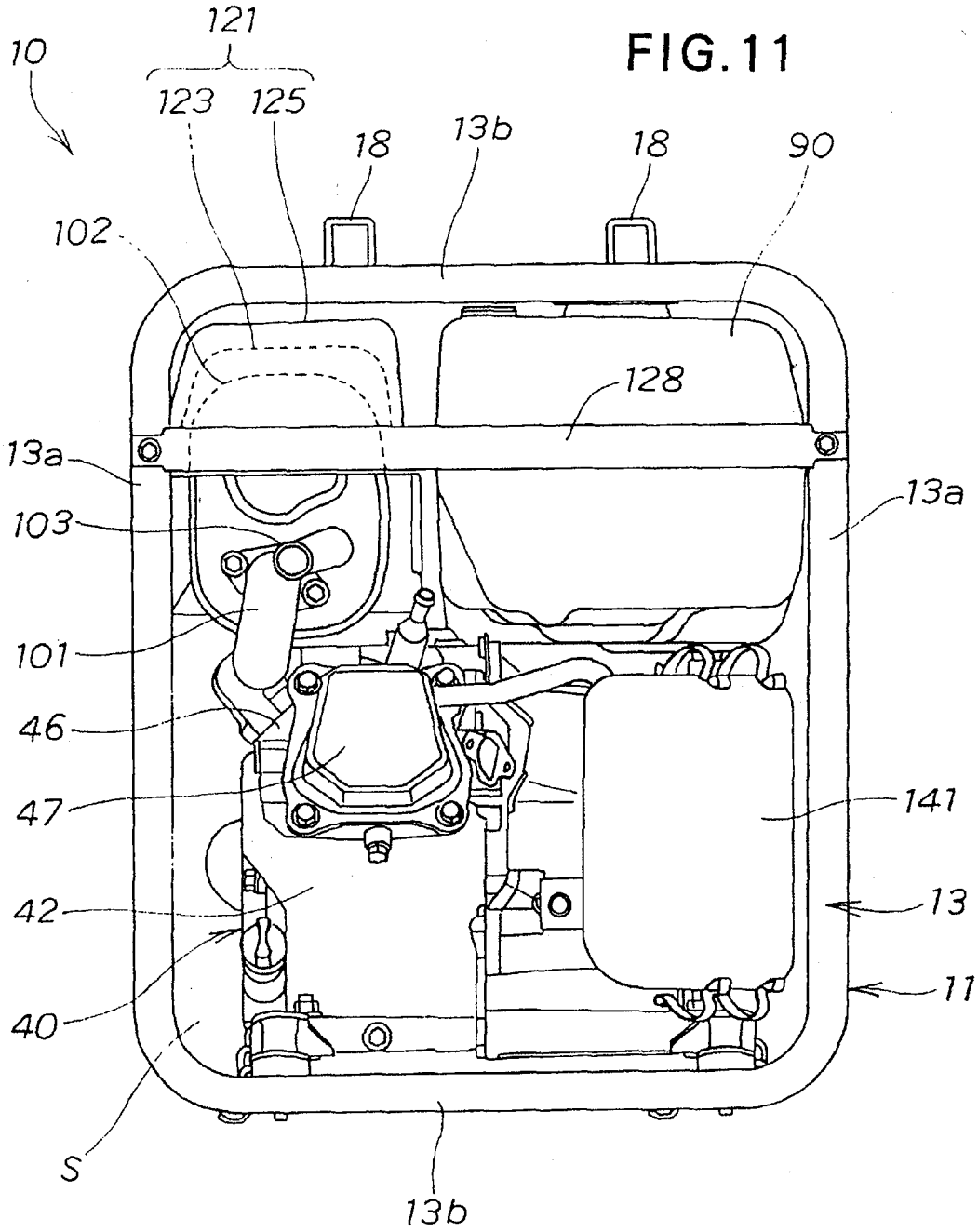
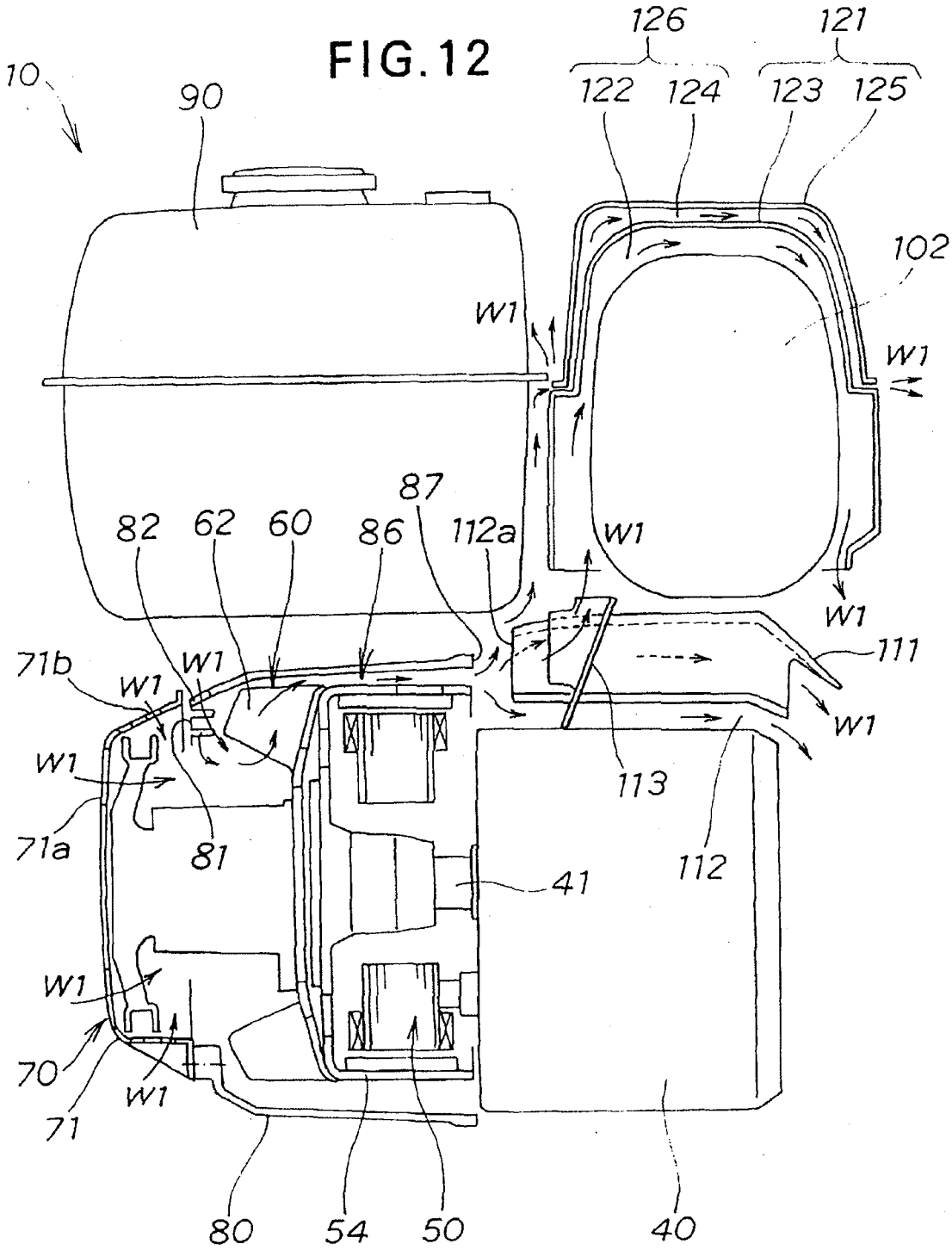

10
121
123
125
18
13b
18
90
102
128
13a
103
13a
101
46
47
141
42
13
11
40
S
13b

FIG. 12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90
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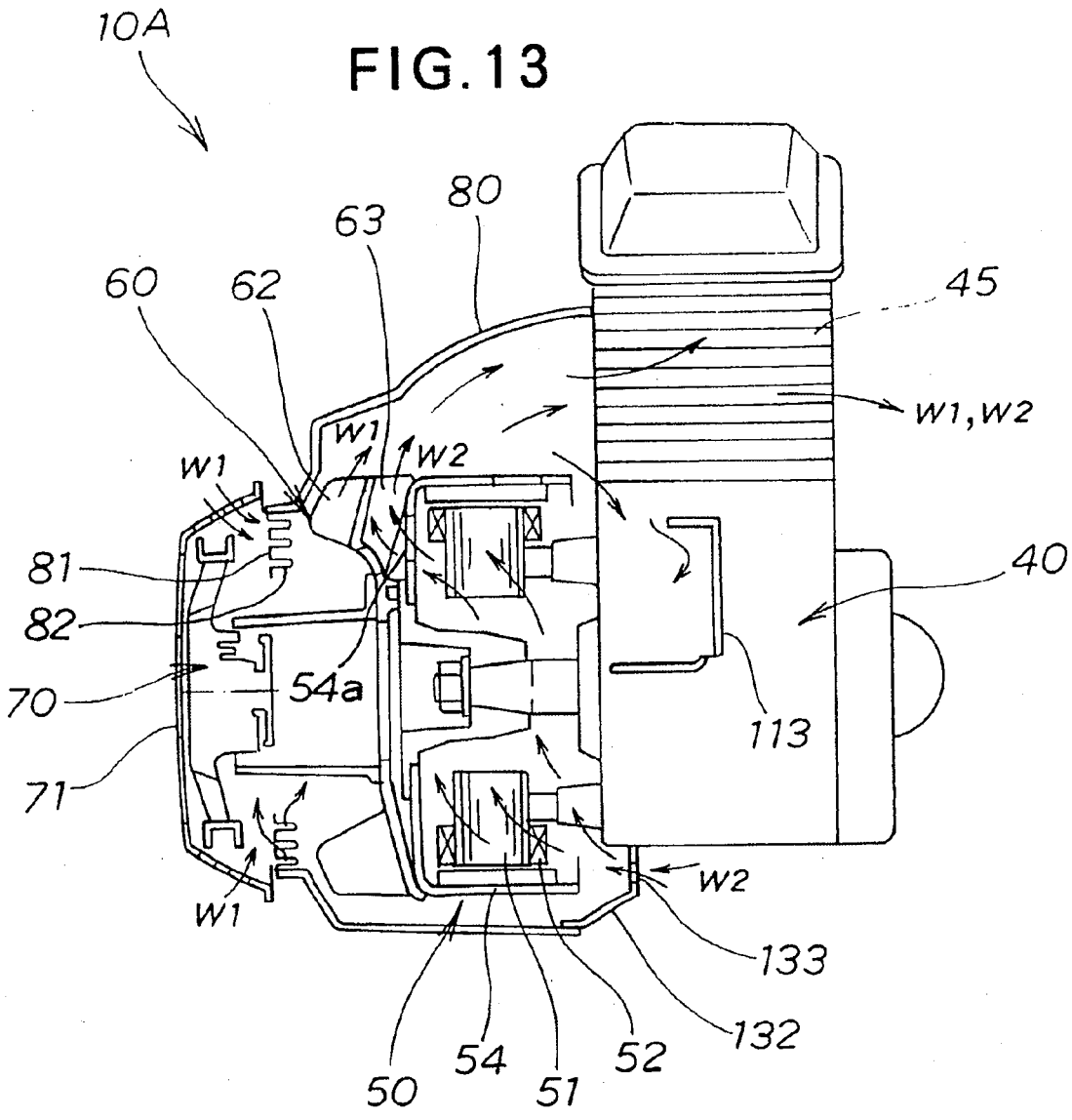
121
122
124
123
125
102
W1
87
82
62
60
86
112a
71b
111
113
71a
81
41
112
70
71
80
54
50
40

FIG. 13


10A
80
63
60
62
45
W1, W2
W1
W2
W1
81
82
70
54a
71
40
113
W2
W1
133
132
50
54
51
52

PORTABLE ENGINE GENERATOR HAVING A FAN COVER WITH HEAT RADIATING SURFACE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an engine generator unit including an engine and an electric-power generators driven by the engine.

2. Related Prior Art

Among general-purpose power supply devices suitable for outdoor use is the so-called engine generator unit which includes an engine and an electric-power generator driven by the engine. The engine and generator would vibrate strongly and become hot during operation of the unit, and thus there have been demands for techniques that can appropriately minimize adverse influences of the vibrations and heat of the engine and generator. Typical example of such an engine generator unit is shown in Japanese Utility Model Laid-Open Publication No. HEI-5-96543.

The engine generator unit disclosed in the Japanese utility model laid-open publication has a crankshaft extending horizontally (in a front-rear direction) through a crankcase of the engine, and an engine-cooling fan fixed to the front end of the crankshaft. The disclosed engine generator unit also includes a recoil starter attached to the front end of the engine-cooling fan device covered with a fan case. Also, in the disclosed engine generator unit, a casing having a stator of the generator attached thereon is connected to a rear end portion of the crankcase, and a rotor of the generator supported at its rear end via bearings is connected to the rear end of the crankshaft. Generator-cooling fan device is provided where the rotor is connected to the rear end of the crankshaft. Further, the engine and generator are supported by a common framework.

However, because both the engine and the generator are supported by the common framework in the disclosed engine generator unit, it is very important to accurately center the generator relative to the crankshaft. Further, due to the fact that the stator-attached casing is supported by the framework and connected to the crankcase, the rotor must be mounted with high positional accuracy relative to such a casing. Furthermore, the provision of the two cooling fan devices, i.e., the engine-cooling fan and generator-cooling fan, would result in an increase in the necessary number of components and a complicated structure.

SUMMARY OF THE INVENTION

It is accordingly an object of the present invention to provide an improved engine generator unit which allows the engine and generator to be reliably mounted to a framework with great facility and can effectively cool the engine and generator using a simple structure.

To accomplish the above-mentioned object, the,present invention provides an engine generator unit which comprises: an engine; an electric-power generator to be driven by the engine, the engine and the electric-power generator being provided coaxially in a direction of an engine output shaft, the electric-power generator being an outer-rotor/magnet type generator having a cantilevered outer rotor functioning also as a substitute for an engine fly wheel; a cooling fan device attached to the outer rotor; a fan cover covering the electric-power generator and the cooling fan device, the fan cover being generally in a cylindrical shape and made of die-cast aluminum alloy, the fan cover having, at one end thereof remote from the engine, a cooling-air inlet portion for introducing cooling air from outside the engine generator unit via the cooling fan device, a recoil starter being attached to the cooling-air inlet portion, the fan cover being secured at another end thereof to the engine and having, at the other end, a cooling-air outlet portion for blowing the cooling air onto an outer peripheral surface of the engine; and supporting leg members secured to the fan cover and the engine, the supporting leg member being mounted to a framework via shock-absorbing members.

In the engine generator unit of the present invention, the electric-power generator is supported by the engine in a cantilever fashion, so that both the stator and the rotor of the generator will vibrate together with the engine during operation. Because the electric-power generator is fixed to the framework via the engine and rugged fan cover secured to the engine, it can be supported with sufficient firmness. Even where the engine and fan cover are mounted with some positional error therebetween, as is often the case with this type of engine generator unit, such error can be well accommodated by a gap present between the inner surface of the fan cover and the outer rotor.

Further, the fan cover is made of die-cast aluminum alloy having a high thermal conductivity, and the cooling air drawn in from the outside via the cooling fan continues to be blown onto the inner surface of the fan cover. Because such a fan cover is attached directly to the engine, the fan cover can function as a very efficient heat radiator through which the heat accumulated in the outer wall of the engine can be efficiently radiated to the outside. As a result, the generator and engine can be cooled with increased efficiency and the oil temperature and the like in the engine, can be constantly kept low.

In a preferred implementation of the present invention, the fan cover has a plurality of axial slits formed in an end surface of the cooling-air inlet portion, and the plurality of axial slits of the fan cover and an end surface of the recoil starter together constitute a plurality of air-sucking slits. The plurality of axial slits can be formed with ease simultaneously with formation of the fan cover.

Preferably, the cooling fan device is a centrifugal cooling fan device that forces the cooling air from the outside into between the outer rotor and the fan cover so as to send the cooling air to the engine and a vicinity thereof. The cooling air forced into between the outer rotor and the fan cover can also effectively cool the inner peripheral surface of the fan cover.

BRIEF DESCRIPTION OF THE DRAWINGS

Certain preferred embodiments of the present invention will be described in greater detail with reference to the accompanying sheets of drawings, in which:

FIG. **1** is a perspective view showing a general construction of an engine generator unit in accordance with a preferred embodiment of the present invention;

FIG. **2** is a vertical sectional view taken along the **2—2** line of FIG. **1**;

FIG. **3** is a partly-sectional front view of the engine-operated generator unit shown in FIG. **1**;

FIG. **4** is a perspective view showing a fan cover attached directly to an engine shown in FIG. **1**;

FIG. **5** is a vertical sectional view taken along the **5—5** line of FIG. **2**;

FIG. **6** is an exploded perspective view showing a muffler and a heat blocking cover in the preferred embodiment;

FIG. **7** is a sectional top plan view of the engine generator unit in accordance with the preferred embodiment of the present invention, which particularly shows the engine and generator;

FIG. **8** is a top plan view of the engine generator unit in accordance with the preferred embodiment of the present invention;

FIG. **9** is a right side view of the engine generator unit in accordance with the preferred embodiment of the present invention;

FIG. **10** is a left side view of the engine generator unit in accordance with the preferred embodiment of the present invention;

FIG. **11** is a rear view of the engine generator unit in accordance with the preferred embodiment of the present invention;

FIG. **12** is a view explanatory of behavior of the inventive engine generator unit; and

FIG. **13** is also a view explanatory of the behavior of the inventive engine generator unit.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following description is merely exemplary in nature and is in no way intended to limit the invention, its application or uses.

FIG. **1** is a perspective view showing a general construction of an engine generator unit in accordance with a preferred embodiment of the present invention. As shown, this generator unit **10** is an open-type engine generator unit which includes a framework **11** that, in the illustrated example, is generally formed into a hollow cubic shape and composed of front and rear generally-square or rectangular pipe-shaped frames **12** and **13**. The generator unit **10** has a control panel **20** fixed to the front frame in an upper hollow region defined by the rectangular front frame, and an electric power controller **30** is disposed in a lower hollow region defined by the front frame. The engine generator unit **10** also includes, within an inner space between the front and rear frames **12** and **13**, an engine **40**, a fuel tank **90**, an air cleaner **141**, an electric power generator **50** (FIG. **2**) and a muffler **102** (FIG. **2**).

The rectangular front and rear frames **12** and **13** of the framework **11** are interconnected by a pair of left and right lower beams **14** and **15** and a pair of left and right upper beams **16** and **17** (the right upper beam **17** is not visible in FIG. **1** and shown in FIG. **9**). The rectangular front frame **12** consists of a pair of left and right vertical frame portions **12***a* and a pair of horizontal frame portions **12***b*, and similarly the rectangular rear frame **13** consists of a pair of left and right vertical frame portions **13***a* and a pair of horizontal frame portions **13***b*. Thus, the framework **11** has the vertical frame portions **12***a* and **13***a* at its four corners as viewed in plan.

On corresponding positions of the opposed upper horizontal frame portions **12***b* and **13***b*, the framework **11** includes a pair of positioning supports **18** that are used when another engine-operated generator unit (not shown) of the same construction is to be superposed on the engine generator unit **10**. More specifically, the positioning supports **18** are provided on the horizontal frame portions **12***b* and **13***b* so that they can engage the other engine generator unit against displacement in the front-rear and left-right directions.

The control panel **20** includes various electrical components that constitute an engine control, an electric-power take-out section, etc. More specifically, on the control panel **20**, there are provided an engine switch **21** for turning on an engine ignition system, an ignition controller **22** for controlling the engine ignition, a battery charger socket **23** for charging an external battery, a first take-out socket **24** for taking out a high-level A.C. current, and two second take-out sockets **25** each for taking a current lower in level than that taken out by the first take-out socket **24**. Also provided on the control panel **20** are a circuit breaker **26** for breaking the electric circuit when the output current from any one of the sockets **24** and **25** exceeds a predetermined threshold value, and a frequency changing switch **27** for changing the frequency of the output current from the sockets **24** and **25**. The electric power controller **30** converts the output frequency of the generator **50** into a predetermined frequency and may comprise, for example, a cycloconverter.

FIG. **2** is a vertical sectional view taken along the line **2**—**2** of FIG. **1**, which shows the engine **40**, generator **50**, fuel tank **90** and muffler **102** as viewed from the front of the engine generator unit **10**; note that only a lower end portion of the framework **11** is shown in this figure for simplicity of illustration.

Within the space surrounded by the framework **11**, as seen in FIG. **2**, the engine **40** and generator **50** capable of being driven by the engine **40** are positioned side by side in an axial direction of an engine output shaft **41**, and the fuel tank **90** and muffler **102** are disposed above the generator **50** and engine **40**. When the engine generator unit **10** is viewed from its front as in FIG. **2**, the engine **40** is located in the lower right of the generator unit **10**, the generator **50** located in the lower left of the generator unit **10**, the fuel tank **90** located above the generator **50**, and the muffler **102** located above the engine **40** that has an overall height significantly reduced by placing the engine cylinder in a downwardly tilted posture with respect to a general vertical axis of the generator unit **10** as will be later described. The fuel tank **90** and muffler **102** are placed substantially horizontally in a side-by-side relation to each other. Because the fuel tank **90** and muffler **102** are thus mounted side by side right above the generator **50** and engine **40**, the engine-operated generator unit **10** can be constructed compactly into a generally-cubic overall configuration, so that it can be appropriately installed even in a relatively small space with its center of gravity significantly lowered.

FIG. **3** is a partly-sectional front view of the engine-operated generator unit **10** with principal components of the generator unit **10** of FIG. **2** depicted on an enlarged scale. To the framework **11** of the generator unit **10**, there are fixed the engine **40**, the generator **50** operatively connected the engine **40**, a centrifugal cooling fan device **60** disposed on one side of the generator **50** opposite or remote from the engine **40** for introducing or sucking in outside air for cooling purposes to be described later, a recoil starter **70** connected to the cooling fan device **60** via a connecting cylinder **66**, and a fan cover **80** enclosing the generator **50** and cooling fan device **60**. Outer rotor **54**, cooling fan device **60** and recoil starter **70** are mounted coaxially relatively to the engine output shaft **41**.

The electric-power generator **50** in the preferred embodiment is an outer-rotor type generator based on multipolar magnets that are supported by the engine output shaft **41** in a cantilever fashion. More specifically, the generator **50** is made up of an inner stator **56** including a stator core **51** in the form of axially-stacked rings fixed to a side wall of the crankcase **42** and a plurality of coils **52** wound on the stator core **51**, the outer rotor **54** generally in the shape of a cup and mounted on the engine output shaft **41** by means of a hub **53**,

and a plurality of magnets **55** secured to the inner surface of the outer rotor **54**.

The cup-shaped outer rotor **54** surrounds the inner stator **56** (i.e., the stator core **51** and coils **52**) and has its one end (cup bottom portion) coupled with the centrifugal cooling fan device **60**; thus, the centrifugal cooling fan device **60** having a relatively large diameter can be mounted reliably in a simple manner. The large diameter of the centrifugal cooling fan device **60** can suck in a sufficient amount of air for cooling the engine **40** and generator **50**.

The outer rotor **54** in the preferred embodiment also functions as a cantilevered flywheel, which can eliminate a need for a separate flywheel. Thus, the dimension of the generator unit **10** in the axial direction of the engine output shaft **41** can be reduced accordingly to permit downsizing of the framework **11**, so that the generator unit **10** can be reduced in overall size. The cup-shaped outer rotor **54** also has air holes **54***a* and **54***b* in the cup bottom portion and cylindrical side wall.

Mounting accuracy of the fan cover **80** relative to the engine output shaft **41** need not be very high because it only has to enclose the outer-rotor-type generator **50** and the cooling fan device **60** attached to the outer rotor **54**.

The fan cover **80** is generally in the form of a cylinder extending horizontally along the engine output shaft **41** close to the engine **40**. Specifically, the fan cover **80** has a cooling-air inlet portion **81** at its outer end remote from the engine **40**, through which the outside air is introduced into the generator unit **10** by means of the cooling fan device **60** generally located inwardly of the cooling-air inlet portion **81**. More specifically, the cooling-air inlet portion **81** has at its outer end a plurality of parallel air sucking-in slits **82** extending along the longitudinal direction of the fan cover **80**, and a recoil starter cover **71** is attached to the cooling-air inlet portion **81** outwardly of the cooling-air inlet portion **81**.

By means of the recoil starter cover **71**, the recoil starter **70** supports a pulley **72** for rotation about an axis lying in horizontal alignment with the engine output shaft **41** and operatively connects the pulley **72** with the cooling fan device **60**. The recoil starter cover **71** has a plurality of air holes **71***a*.

At the other or inner end adjacent the engine **40**, on the other hand, the cooling fan cover **80** is secured to the engine crankcase **42** by means of bolts **83** (only one of which is shown in FIG. **3**) while forming a cooling-air outlet portion **87** for blowing the cooling air onto the outer peripheral surface of the engine **40**.

FIG. **4** is a perspective view showing the cooling fan cover **80** secured directly to the engine crankcase **42**. The cooling fan cover **80** is made of die-cast aluminum alloy that has a high thermal conductivity and thus achieves a superior heat-radiating performance. By being made of such die-cast aluminum alloy and directly secured to the engine **40**, the cooling fan cover **80** can function as a very efficient heat radiator. Namely, the heat accumulated in the outer wall of the engine crankcase **42** can be readily transferred, to the directly-secured fan cover **80**. This way, in the preferred embodiment, the outer surface of the engine **40** and the entire area of the cooling fan cover **80** can together provide an increased heat-radiating surface for the engine **40**. With such an increase in the heat radiating surface, the engine **40** can be cooled with increased efficiency, as a result of which the oil temperature and the like in the engine **40** can also be kept low with efficiency.

Further, as shown in FIG. **4**, a pair of supporting leg members **43** (only one of which is visible here) are secured to opposite (front and rear) end portions of the underside of the engine **40**. Similarly, a pair of supporting leg portions **84** are secured to opposite ends of the underside of the cooling fan cover **80**. These supporting leg members **43** and **84** of the engine **40** and cooling fan cover **80** are placed transversely on the above-mentioned left and right lower beams **14** and **15** and bolted to the beams **14** and **15** with shock absorbing members (vibration-isolating mounts) **44** and **85** interposed therebetween.

Because the cooling fan cover **80** made of the die-cast aluminum alloy has relatively great rigidity and ruggedness and such a rugged cooling fan cover **80** is firmly secured to the engine **40** that is also rugged enough in general, the engine generator unit **10** of the present invention can provide a rugged assembly of the fan cover **80** and engine **40** which can be reliably retained on the framework **11** with an appropriate shock absorbing or cushioning capability.

Referring back to FIG. **2**, at least part of the engine **40** is covered with an engine shroud **111** with a relatively large empty space **112** left therebetween, and the empty space **112** serves as an air passage through which air is allowed to pass to cool the engine **40** (hereinafter referred to as an "engine-cooling air passage" **112**). Inlet portion **112***a* to the interior of the engine-cooling air passage **112** faces the cooling-air outlet portion **87** of the fan cover **80**.

The muffler **102** is covered or closed at least at its top end portion with a heat blocking cover **121** which is a dual-cover structure including an inner cover **123** covering the muffler **102** with a predetermined first gap **122** formed therebetween and an outer cover **125** covering the outer surface of the inner cover **123** with a predetermined second gap **124**. The inner cover **123** of the dual heat blocking cover structure **121** is generally in the shape of a halved cylinder opening downward to cover an almost entire outer surface of the muffler **102** except for a lower end surface of the muffler **102**. The outer cover **125** is also generally in the shape of a halved cylinder opening downward to cover an upper surface of the inner cover **123**.

The first gap **122** between the inner cover **123** and the muffler **102** functions as a first cooling-air path, while the second gap **124** between the inner cover **123** and the outer cover **125** functions as a second cooling-air path. Thus, these first and second cooling-air paths **122** and **124** together constitute a divided muffler-cooling air passage **126** separate from the engine-cooling air passage **112**.

As further shown in FIG. **2**, the engine shroud **111** has an air guide **113** integrally formed thereon for diverting a proportion of the cooling air from the engine-cooling air passage **112** upwardly into the muffler-cooling air passage **126**. With this air-diverting guide **113**, the cooling air drawn in from the outside via the cooling fan device **60** having cooled the generator **50** is allowed to flow into both the engine-cooling air passage **112** and the muffler-cooling air passage **126**, so that the engine **40** and muffler **102** can be cooled by the same cooling air having cooled and passed the upstream generator **50**. Because the air guide **113** is used only to divert a proportion of the cooling air within the engine shroud **111**, it can be of simple structure.

FIG. **5** is a vertical sectional view taken along the **5**—**5** line of FIG. **2**, which shows the left side of the framework **11**, engine **40** and muffler **102** and where illustration of the generator **50** is omitted for simplicity. In the preferred embodiment, as shown in FIG. **5**, the engine **40** is constructed to have a lower profile, i.e., a smaller height, than the conventional counterparts by tilting the cylinder **45**, cylinder head **46** and head cover **4**, i.e., the longitudinal axis

of the engine **40**, rearwardly downward about the engine output shaft **41** with respect to the general vertical axis of the unit **10**, so as to be located obliquely upward of the engine output shaft **41**.

As further shown in FIG. **5**, the muffler **102** is connected via an exhaust pipe **101** to an exhaust port of the engine **40**.

As also seen from FIG. **5**, the horizontal muffler **102** extends to cross the engine output shaft **41**, substantially at right angles thereto, above the engine cylinder **45**, and is secured to an engine bracket **48**. More specifically, tilting the cylinder **45** as above can lower the overall height or profile of the engine **40** and leaves a relatively large empty space above the thus-lowered cylinder **45**. This relatively large empty space is utilized to position the horizontal muffler **102** to cross the engine output shaft **41** substantially at right angles thereto; this arrangement can further increase the capacity of the muffler **102**.

Further, an exhaust port (tailpipe) **103** is positioned to extend in the same rearward direction as the cylinder **41** extends from the engine output shaft **41**, and the control panel **20** is positioned on the front of the generator unit **10** remotely from the exhaust port **103**, as denoted by phantom line.

In the preferred embodiment thus arranged, the exhaust from the muffler **102** is prevented from flowing toward the control panel **20**, which is therefore not thermally influenced by the muffler exhaust and can be constantly maintained in a suitable operating condition for a human operator to appropriately manipulate the panel **20** as necessary.

The inner and outer covers **123** and **125** of the dual heat blocking cover structure **121** are elongate covers spanning between the front and rear frames **12** and **13** and secured to the frames **12** and **13** with their opposite end flanges **123***a* and **125***a* superposed on each other. Further, a front support member **127** is provided between the vertical frame portions **12***a*of the front frame **12** while a rear support member **128** is provided between the vertical frame portions **13***a* of the rear frame **13**. Two pairs of the superposed end flanges **123***a* and **125***a* are bolted to the front and rear support members **127** and **128**, respectively, by which the dual heat blocking cover structure **121** is secured between the front and rear frames **12** and **13** above the muffler **102**.

FIG. **6** is an exploded perspective view showing the muffler **102** and heat blocking cover **121** and is particularly explanatory of a relationship between the muffler **102** and the inner and outer covers **123**, **125** in the preferred embodiment. As shown, the inner cover **123** has an opening **123***b* in its rear wall to avoid mechanical interference with the tailpipe **103** of the muffler **102**. The muffler **102** also has an exhaust inlet and a stay **105**, and reference numeral **106** is a bolt for insertion through the end flanges of the inner and outer covers **123** and **125**.

FIG. **7** is a sectional top plan view of the engine generator unit **10** in accordance with the preferred embodiment of the present invention, which particularly shows the engine **40** and generator **50** with the fuel tank **90**, muffler **102** and control panel **20** removed for clarity. As shown in the figure, a set of the engine **40**, generator **50**, electric power controller **30**, engine shroud **111**, air cleaner **141** and carburetor **142** is mounted snugly within a square space defined by the framework **11**, and the air guide **113** of the engine shroud **111** has a generally U-shape opening toward the cooling fan cover **80** as viewed in top plan.

As viewed in top plan, the cooling fan cover **80** bulges greatly along the engine cylinder **45**, and thereby allows the cooling air to be readily introduced into the space within the engine shroud **111**. The cooling fan device **60** is a double-side fan which includes a main fan **62** formed integrally on the rear surface of a base **61** and an auxiliary fan **63** formed integrally on the front surface of the base **61**. The main fan **62** functions to direct the outside air, introduced through the main cooling-air inlet portion **81**, toward the engine **40**, while the auxiliary fan **63** functions to direct the outside air, introduced through a plurality of auxiliary cooling-air inlets **133** and passed through the generator **50**, toward the engine **40**.

The cooling fan cover **80** has a predetermined gap **131** adjacent the engine **40** so that the gap **131** serves as the auxiliary cooling-air inlets **133** for drawing in the outside air to cool the interior of the generator **50**. Namely, the gap **131** having a relatively large size is formed between one end of the fan cover **80** and one side of the crankcase **52** remotely from the engine cylinder **45**, and this gap **131** is closed by a plate **132** having the auxiliary cooling-air inlets **133** formed therein. The auxiliary air inlets **133** are formed in the plate **132** inwardly of the outer rotor **54** so as to be close to the center of the centrifugal cooling fan **60**. Because the central area of the centrifugal cooling fan **60** is subject to a greater negative pressure, the outside air can be efficiently sucked in through the auxiliary cooling-air inlets **133** located close to the center of the cooling fan **60** and then directed through the interior space of the generator **50** to the auxiliary fan **63**. The closing plate **132** bolted to the engine **40** and the auxiliary cooling-air inlets **133** formed in the closing plate **132** are illustratively shown in FIG. **5**.

FIG. **8** is a top plan view of the engine generator unit **10** in accordance with the preferred embodiment of the present invention. As shown, the muffler **102** is disposed adjacent the fuel tank **90** in a side-by-side relation thereto and covered at its top with the heat blocking cover **121**. Further, the fuel tank **90** and heat blocking cover **121** span horizontally between and secured to the front and rear support members **127** and **128**, so that the entire top region of an inner area defined by the pipe-shaped framework **11** is substantially closed by the fuel tank **90** and heat blocking cover **121**. In this figure, reference numeral **91** represents an oil filler hole, **92** an oil filler cap, and **93** an oil surface gauge.

FIG. **9** is a right side view of the engine generator unit **10** in accordance with the preferred embodiment of the present invention, which particularly shows that the muffler, **102** is supported by the engine **40** via the above-mentioned exhaust pipe **101** and stay **105** and that the cylinder **45** and cylinder head **46** of the engine **40** are covered with a pair of upper and lower engine shroud members **111**.

FIG. **10** is a left side view of the engine generator unit **10** in accordance with the preferred embodiment of the present invention, which particularly shows that an actuating handle **73** of the recoil starter **70** is provided on a front left portion of the engine generator unit **10** and the air cleaner **141** is provided on a rear left portion of the unit **10**.

Further, FIG. **11** is a rear view of the engine generator unit **10** in accordance with the preferred embodiments of the present invention, which particularly shows that the muffler **102** is connected via the exhaust pipe **101** to the engine cylinder head **46** and that the rear support member **128** is bolted at its opposite ends to the vertical frame portions **13***a* of the rear frame **13**.

Now, a description will be made about exemplary behavior of the engine generator unit **10** constructed in the above-mentioned manner, with particular reference to FIGS. **12** and **13**.

FIG. **12** is a view explanatory of the behavior of the inventive engine generator unit **10**. Upon power-on, of the

engine **40**, the engine output shaft **41** causes the outer rotor **54** to start rotating, by which electric power generation by the generator **50** is initiated.

Simultaneously, the cooling fan device **60** is caused to rotate with the outer rotor **54** functioning as a magnetic rotor, so that the main fan **62** of the device **60** sucks in the outside air W1 through the air holes **71***a*, **71***b* of the recoil starter cover **71** and air sucking-in slits **82** of the fan cover **80**. The thus-introduced outside air W1 flows in the space enclosed by the fan cover **80** and is discharged radially out of the space by the centrifugal force of the main fan **62**. Then, the cooling air W1 flows through a cooling passage **86** to thereby cool the generator **50** and fan cover **80**, after which it exits via the cooling-air outlet portion **87** of the fan cover **80**. A proportion of the cooling air W1 from the cooling-air outlet portion **87** then enters the space defined by the engine shroud **111** and flows through the engine-cooling air passage **112** while cooling the outer surface of the engine **40**, after which it is discharged back to the outside. Because that proportion of the cooling air W1 flowing through the engine-cooling air passage **112** has just cooled and passed only the generator **50** and thus is still at a relatively low temperature, it can cool the engine **40** with sufficient efficiency. Further, because the air sucking-in slits **82** are formed in the cooling-air inlet portion **81** of the fan cover **80**, a sufficient amount of the outside air W1 can be introduced through these slits **82** into the engine generator unit **10** although the recoil starter **70** is provided in the inlet portion **81**.

The remaining portion of the cooling air W1 from the cooling-air outlet portion **87**, on the other hand, is diverted, via the air guide **113**, upwardly into the first and second passageways **122** and **124** of the divided muffler-cooling air passage **126**. The air guide **113** provides for positive and efficient diversion, and hence sufficient introduction, of the cooling air W1 into the muffler-cooling air passage **126**.

More specifically, the cooling air W1 diverted via the air guide **113** flows in the first cooling-air path **122** of the divided muffler-cooling air passage **126** along the inner surface of the inner cover **123**, to thereby cool the outer surface of the muffler **102**. The cooling air W1 diverted via the air guide **113** also flows in the second cooling-air path **124** of the divided muffler-cooling air passage **126** along the outer cover **125**, to thereby cool the outer surface of the inner cover **123**. The cooling air W1 flowing through the second cooling-air path **124** functions as a heat blocking air layer, namely, an air curtain, that effectively blocks the heat transfer from the inner cover **123**.

In the preferred embodiment, the outer surface temperature of the outer cover **125** can be reduced sufficiently by the cooling air W1 flowing through the two paths **122** and **124** of the divided muffler-cooling air passage **126** in the manner as described above. Further, because the proportion of the cooling air W1 flowing through the two cooling-air paths **122** and **124** has just cooled and passed only the generator **50** and thus is still at a relatively low temperature, it can cool the muffler **102** with sufficient efficiency. The cooling air W1 having thus cooled and passed the muffler **102** is discharged back to the outside.

Furthermore, the preferred embodiment can effectively reduce undesired heat radiation from the muffler **102** to the fuel tank **90**, by closing the top and side portions of the muffler **102** with the heat blocking cover **121**. Also, the cooling air W1 flowing between the fuel tank **90** and the muffler **102** can form an air curtain blocking the heat transfer between the two. Furthermore, with the cooling air W1 flowing through the muffler-cooling air passage **126**, the outer surface temperature of the heat blocking cover **121** can be kept low so that adverse thermal influences of the muffler **102** on the fuel tank **90** can be reliably avoided even where the muffler **102** is located close to the fuel tank **90**. Thus, in the preferred embodiment of the present invention, the fuel tank **90** and muffler **102** both having a great capacity can be safely positioned very close to each other, and such a great-capacity muffler **102** can reduce an undesired roar of the engine exhaust to a significant degree.

FIG. **13** is also a view explanatory of the behavior of the inventive engine generator unit **10**. The auxiliary fan **63** of the cooling fan device **60** operates to suck in the cooling air from the outside through the auxiliary cooling air inlets **133** formed in the closing plate **132**. The thus-introduced cooling air W2 flows into the space defined by the outer rotor **54** to cool the stator core **51** and coils **52** and then is directed, through the air holes **54***a* formed in the bottom wall of the outer rotor **54**, onto the auxiliary fan **63**. Then, the cooling air W2 is discharged back to the outside by the centrifugal force of the fan **63** and merges with the above-mentioned cooling air W1 discharged via the main fan **62**.

In summary, the present invention arranged in the above-described manner affords various superior benefits as follows.

The engine generator unit in accordance with the present invention is characterized primarily in that the electric-power generator is supported by the engine in a cantilever fashion so that both the stator and the rotor of the generator will vibrate together with the engine during operation, and that the generator is fixed to the framework via the engine and rugged fan cover secured to the engine so that it can be supported with sufficient firmness. Even where the engine and fan cover are mounted with some positional error therebetween, as is often the case with this type of engine generator unit, such error can be well accommodated by a gap present between the inner surface of the fan cover and the outer rotor.

Further, the fan cover is made of die-cast aluminum alloy having a high thermal conductivity, and the cooling air drawn in from the outside via the cooling fan continues to be blown onto the inner surface of the fan cover. Because such a fan cover is attached directly to the engine, the heat accumulated in the outer wall of the engine can be efficiently radiated to the outside. As a result, the generator and engine can be cooled with increased efficiency and the oil temperature and the like in the engine can be constantly kept low.

Further, with the arrangement that the fan cover has a plurality of axial slits formed in an end surface of the cooling-air inlet portion and the plurality of axial slits of the fan cover and an end surface of the recoil starter together constitute a plurality of air-sucking slits, the plurality of axial slits can be formed with ease simultaneously with formation of the fan cover.

Furthermore, with the arrangement that the cooling fan device is a centrifugal cooling fan device that forces the cooling air from the outside into between the outer rotor and the fan cover so as to send the cooling air to the engine and a vicinity thereof, the cooling air can effectively cool the inner peripheral surface of the fan cover.

What is claimed is:

1. An engine generator unit comprising: an engine; an electric-power generator driven by said engine, said engine and said electric-power generator being provided coaxially in a direction of an output shaft of the engine, said electric-power generator being an outer-rotor/magnet type generator having a cantilevered outer rotor functioning also as a

substitute for a fly wheel of the engine; a cooling fan device attached to said outer rotor; a fan cover covering said electric-power generator and said cooling fan device, said fan cover being generally in a cylindrical shape and made of die-case aluminum alloy, said fan cover having, at a first end thereof remote from said engine, a cooling-air inlet portion for introducing cooling air from outside said engine generator unit via said cooling fan device, a recoil starter being attached to the cooling-air inlet portion, said fan cover being directly attached at a second end thereof opposite the first end to said engine so that the fan cover serves as a heat radiating member for radiating heat produced by the engine and having, at the second end, a cooling-air outlet portion for blowing the cooling air onto an outer peripheral surface of said engine; and supporting leg members secured to said fan cover and said engine, said supporting leg members being mounted to a frame via shock-absorbing members; wherein the cooling fan device comprises a centrifugal cooling fan device that forces the cooling air between the outer rotor and the fan cover so as to send the cooling air to the outer peripheral surface of the engine through the cooling-air outlet portion.

2. An engine generator unit according to claim **1**; wherein the fan cover has a plurality of axial slits formed in an end surface of the cooling-air inlet portion, and the plurality of axial slits of said fan cover and an end surface of the recoil starter together constitute a plurality of air-sucking slits.

3. An engine generator unit according to claim **1**; wherein the fan cover has an opening at the second end proximate the engine, and the cooling fan device has a first rotary blade member for drawing outside air into the inlet portion and blowing the air out the outlet portion to cool the engine and a second rotary blade member facing in a different direction from the first rotary blade member for drawing outside air into the opening and blowing the air onto the electric power generator.

4. An engine generator unit according to claim **1**; wherein the cooling fan device is provided proximate the inlet portion of the fan cover and provided integrally with the outer-rotor.

5. An engine generator unit according to claim **1**; wherein the electric power generator is a multipolar generator having a magnet rotor and a control circuit for converting an output of the multipolar generator into an alternating current of a predetermined frequency.

6. An engine generator unit according to claim **1**; wherein the engine has a cylinder inclined sideways obliquely and a muffler disposed in a space above the cylinder.

7. An engine generator unit according to claim **6**; further comprising an engine shroud covering a portion of the engine and having one end disposed proximate the outlet portion of the fan cover so that air blown out of the outlet portion of the fan cover passes between the engine shroud and the engine to cool the engine, the engine shroud having an air deflecting plate for deflecting a portion of the air introduced from the outlet portion of the fan cover toward the muffler.

8. An engine generator unit according to claim **6**; wherein the muffler is substantially cylindrical and elongated in a direction perpendicular to the output shaft of the engine.

9. An engine generator unit comprising: an engine; an electric power generator driven by an output shaft of the engine and coaxially arranged with respect to the output shaft; a cooling fan unit driven by the electric power generator; a fan cover covering the electric power generator and the cooling fan device and having a generally cylindrical shape, the fan cover having an air inlet portion for introducing external air at a first end remote from the engine, a duct extending from the air inlet portion to an air outlet portion at a second end of the fan cover proximate the engine so that the cooling fan unit draws in external air through the inlet portion and blows out air from the outlet portion onto the engine; a recoil starter attached to the air inlet portion of the fan cover; a muffler disposed above the engine and supported by an exhaust pipe of the engine; and an engine shroud covering a portion of the engine and having one end disposed proximate the outlet portion of the fan cover so that air blown out of the outlet portion passes into the engine shroud to cool the engine, the engine shroud having an air deflecting plate for deflecting a portion of the air introduced from the outlet portion of the fan cover toward the muffler; wherein the fan cover is formed of a die-cast aluminum alloy and is directly attached at the second end thereof to the engine so that the fan cover serves as a heat radiating member for radiating heat produced by the engine.

10. An engine generator unit comprising: an engine; an electric power generator driven by an output shaft of the engine and coaxially arranged with respect to the output shaft; a cooling fan unit driven by the electric power generator; a fan cover covering the electric power generator and the cooling fan device and having a generally cylindrical shape, the fan cover having an air inlet portion for introducing external air at a first end remote from the engine, a duct extending from the air inlet portion to an air outlet portion at a second end of the fan cover proximate the engine so that the cooling fan unit draws in external air through the inlet portion and blows out air from the outlet portion onto the engine; a recoil starter attached to the air inlet portion of the fan cover; a muffler disposed above the engine and supported by an exhaust pipe of the engine; and an engine shroud covering a portion of the engine and having one end disposed proximate the outlet portion of the fan cover so that air blown out of the outlet portion passes into the engine shroud to cool the engine, the engine shroud having an air deflecting plate for deflecting a portion of the air introduced from the outlet portion of the fan cover toward the muffler; wherein the fan cover has an opening at the second end proximate the engine, and the cooling fan unit has a first rotary blade member for drawing outside air into the inlet portion and blowing the air out the outlet portion to cool the engine and a second rotary blade member facing in a different direction from the first rotary blade member for drawing outside air into the opening and blowing the air onto the electric power generator.

* * * * *

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(12) **United States Patent**
Morohoshi et al.

(10) **Patent No.: US 6,331,740 B1**
(45) **Date of Patent: Dec. 18, 2001**

(54) **ENGINE GENERATOR UNIT**

(75) Inventors: **Shinichi Morohoshi**; **Ryuji Tsuru**, both of Wako (JP)

(73) Assignee: **Honda Giken Kogyo Kabushiki Kaisha** (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/572,746**

(22) Filed: **May 16, 2000**

(30) **Foreign Application Priority Data**

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(52) **U.S. Cl.** ..... **290/1 A**; 322/1; 123/41.56
(58) **Field of Search** ..... 290/1 A, 40 R, 290/40 C; 322/1; 123/2, 3, 41.56

(56) **References Cited**

U.S. PATENT DOCUMENTS

D. 441,714	*	5/2001	Yuzuriha	D13/116
3,714,449	*	1/1973	De Bella	290/1
4,595,841	*	6/1986	Yaguchi	290/1 A
4,647,835	*	3/1987	Fujikawa et al.	322/1
4,907,546	*	3/1990	Ishii et al.	123/41.56
5,086,748	*	2/1992	Yokoyama	123/549
5,121,715	*	6/1992	Nogami et al.	123/41.7
5,212,952	*	5/1993	Yokoyama et al.	60/721
5,977,667	*	11/1999	Hirose	310/51
6,084,313	*	7/2000	Frank	290/40 C

FOREIGN PATENT DOCUMENTS

3-6831	2/1991	(JP) .
3-79532	12/1991	(JP) .
4-42494	10/1992	(JP) .

OTHER PUBLICATIONS

Coleman POWERMATE Generators. Product Catalog 1997.*

Coleman POWERMATE Maxa ER series electric generators. Product catalog 1995.*

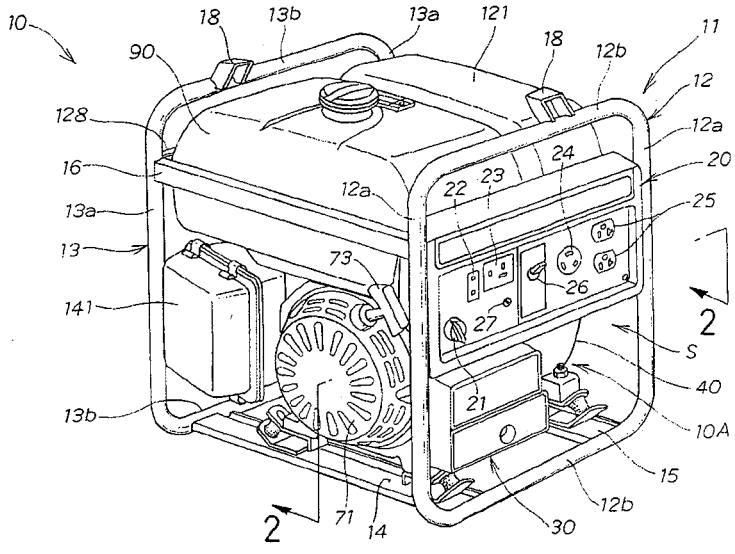
* cited by examiner

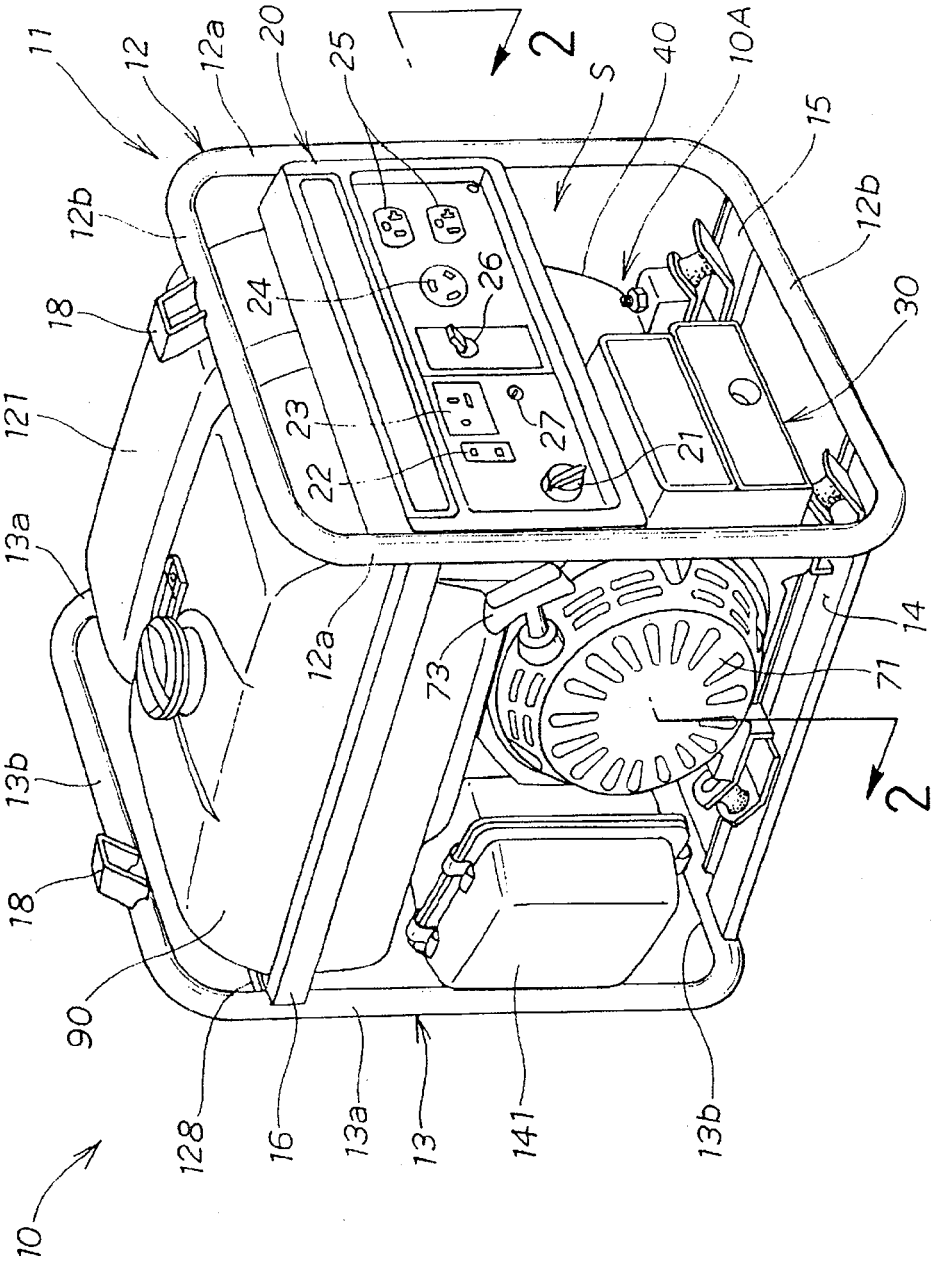
Primary Examiner—Nicholas Ponomarenko
(74) *Attorney, Agent, or Firm*—Adams & Wilks

(57) **ABSTRACT**

Muffler connected to the exhaust-discharging end of an engine is positioned above the engine adjacent a fuel tank. Heat blocking cover covers top and side portions of the muffler, and a fan cover, generally in the shape of a cylinder and extending close to the engine, covers an electric-power generator. Cooling fan device is provided in a cooling-air inlet portion of the fan cover for introducing cooling air from the outside to the electric-power generator covered with the fan cover. Engine-cooling air passage having a cooling-air inlet portion that faces a cooling-air outlet portion of the fan cover is provided to cool an outer surface of the engine by the cooling air flowing out through the cooling-air outlet portion of the fan cover. The engine-cooling air passage is branched upward to provide a separate muffler-cooling air passage extending between the muffler and the heat blocking cover above the engine. Thus, the cooling air introduced from the outside is allowed to cool both the engine and the muffler after having cooled the electric-power generator. With such arrangements, the engine, generator and muffler can be cooled with enhanced efficiency in a very simple manner.

4 Claims, 13 Drawing Sheets

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18
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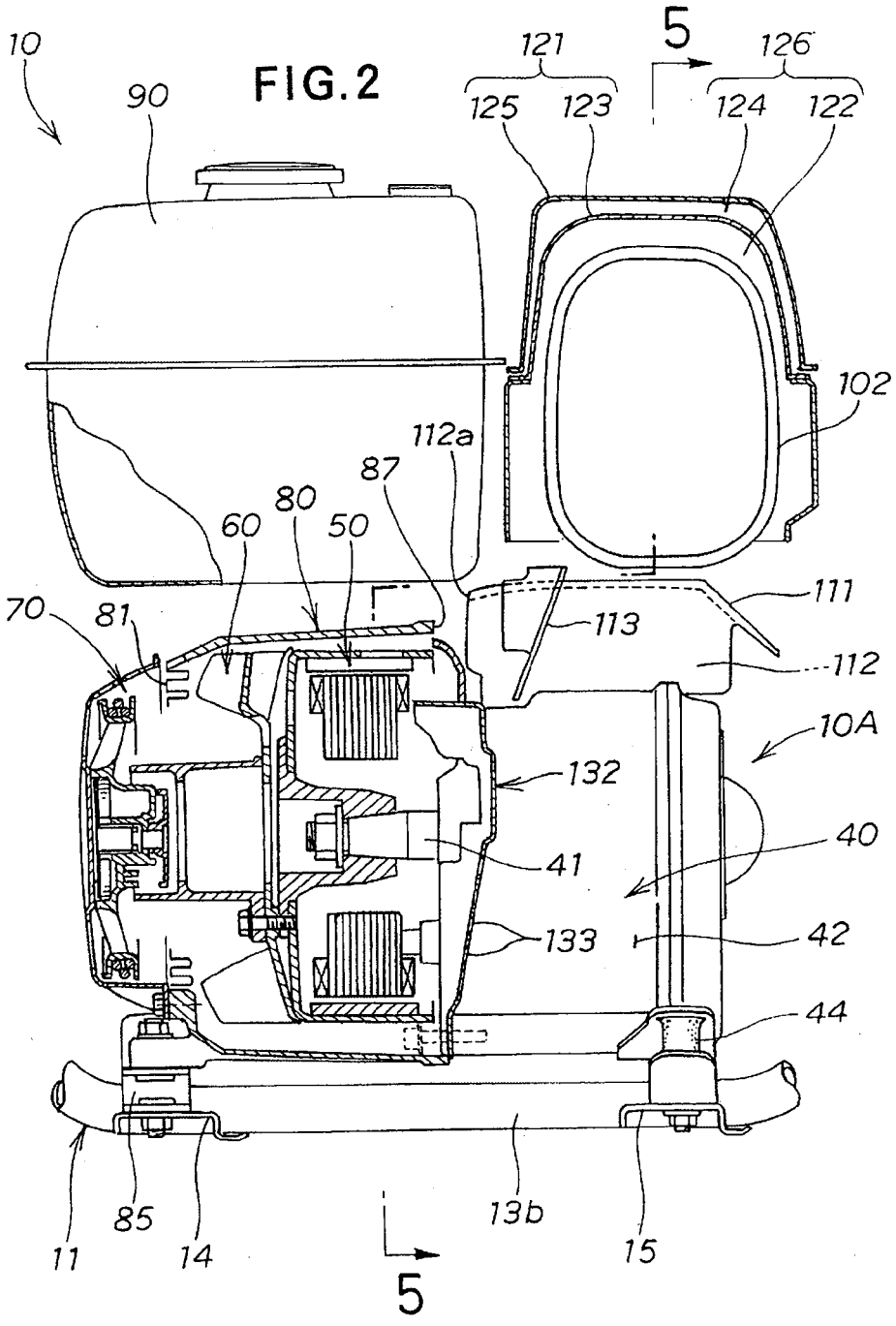
141
13b
10

FIG. 1

FIG. 2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112a
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132
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41
133
42
44
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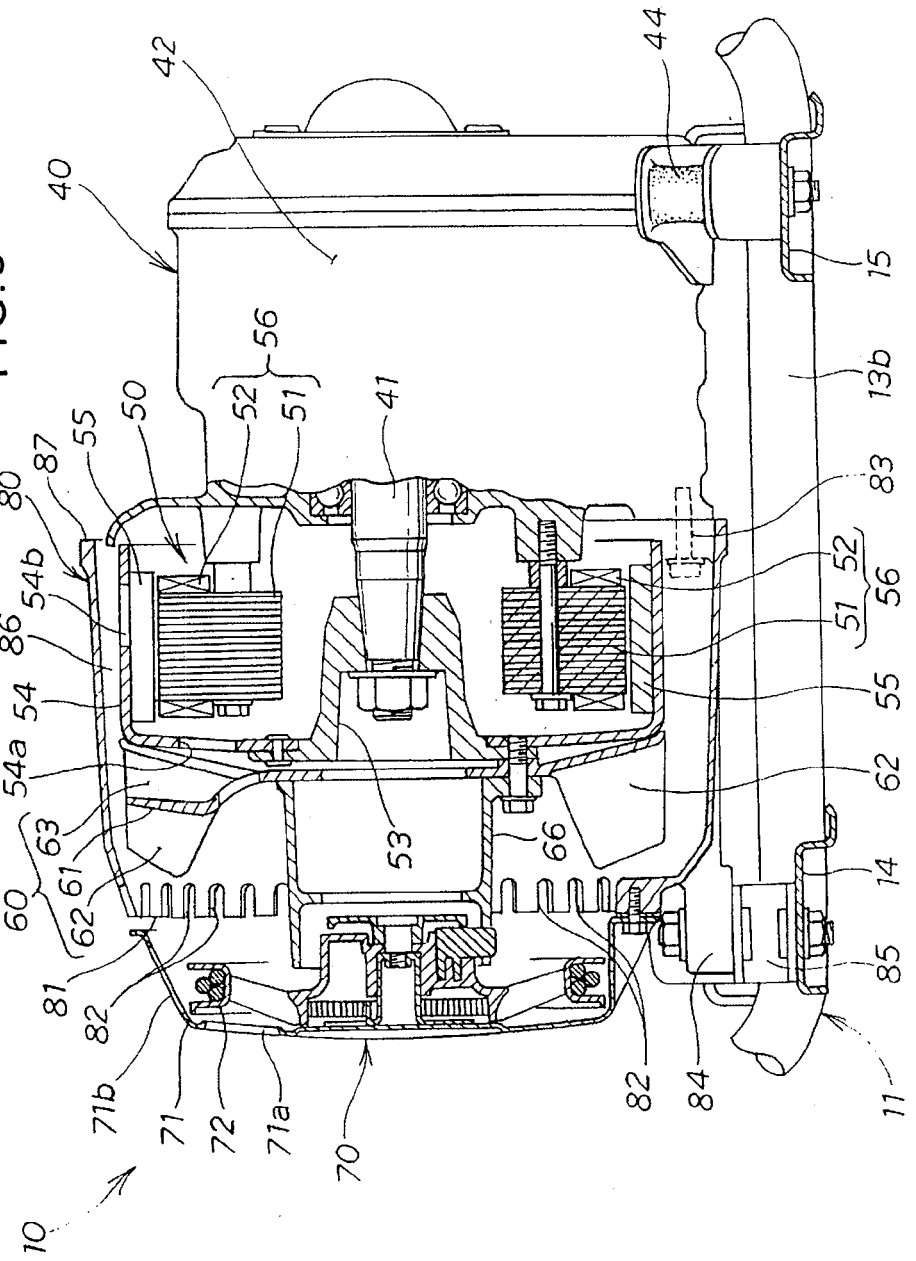
85
14
13b
15
5

FIG.3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60
81
82
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11

FIG. 4

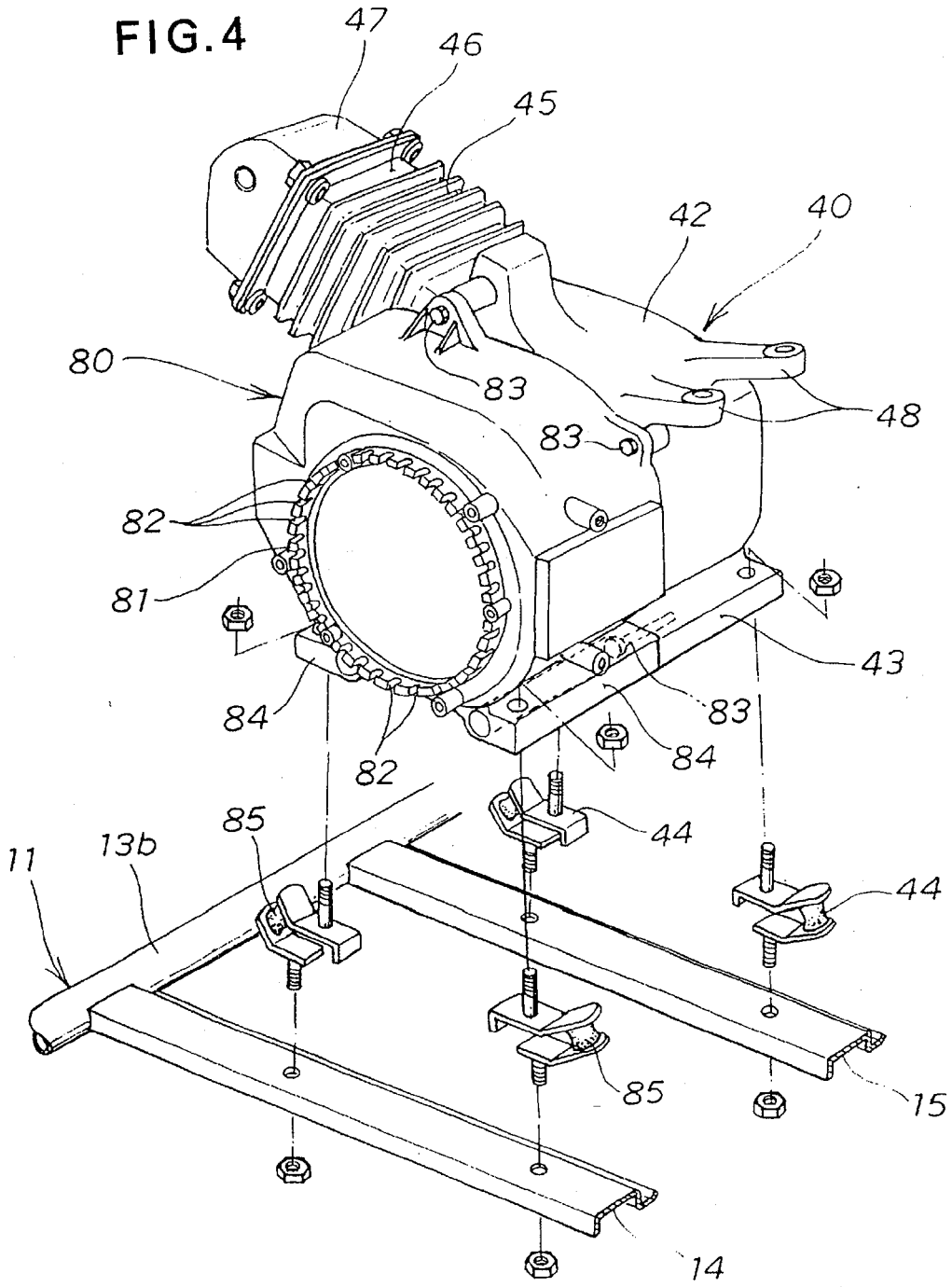
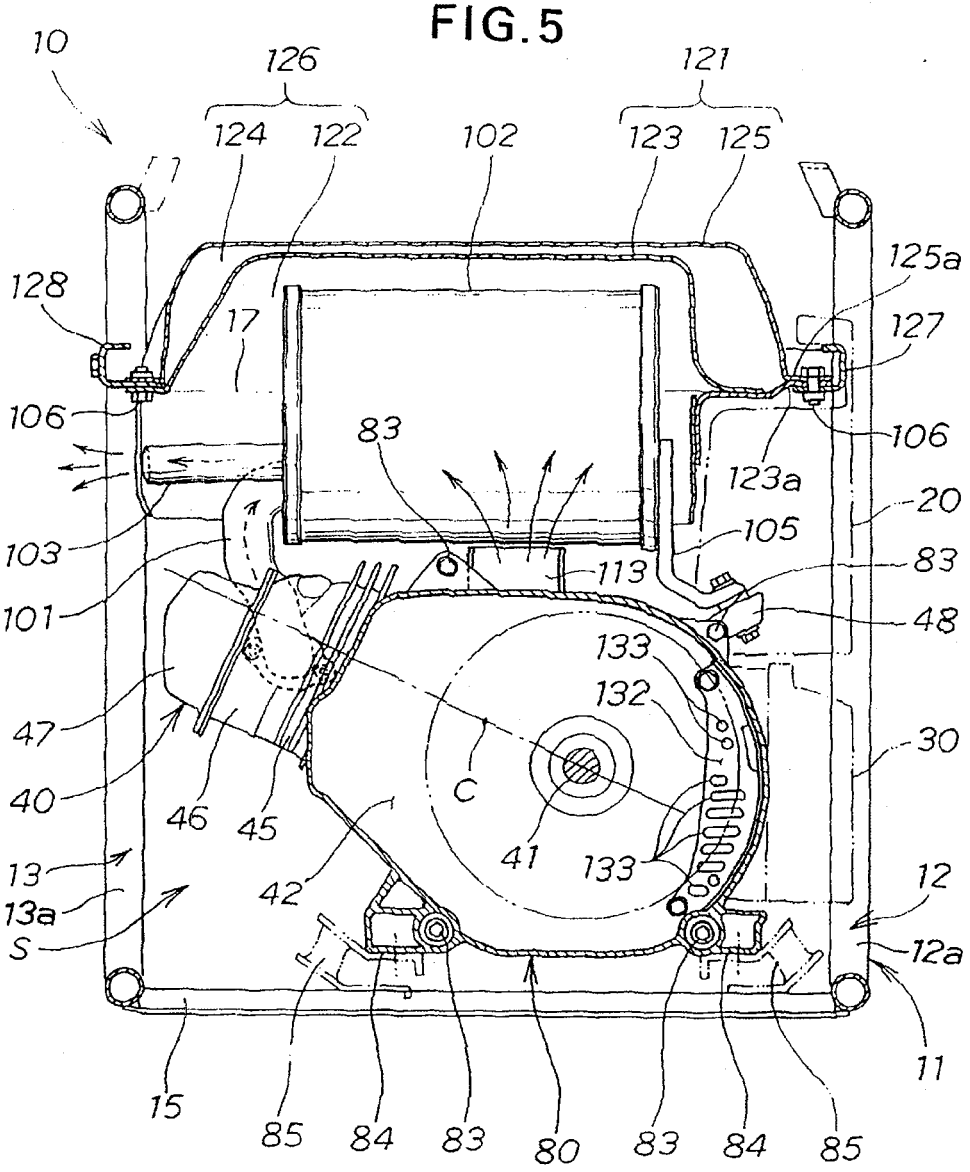


FIG. 5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83
48
133
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30
40
C
46
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FIG. 6

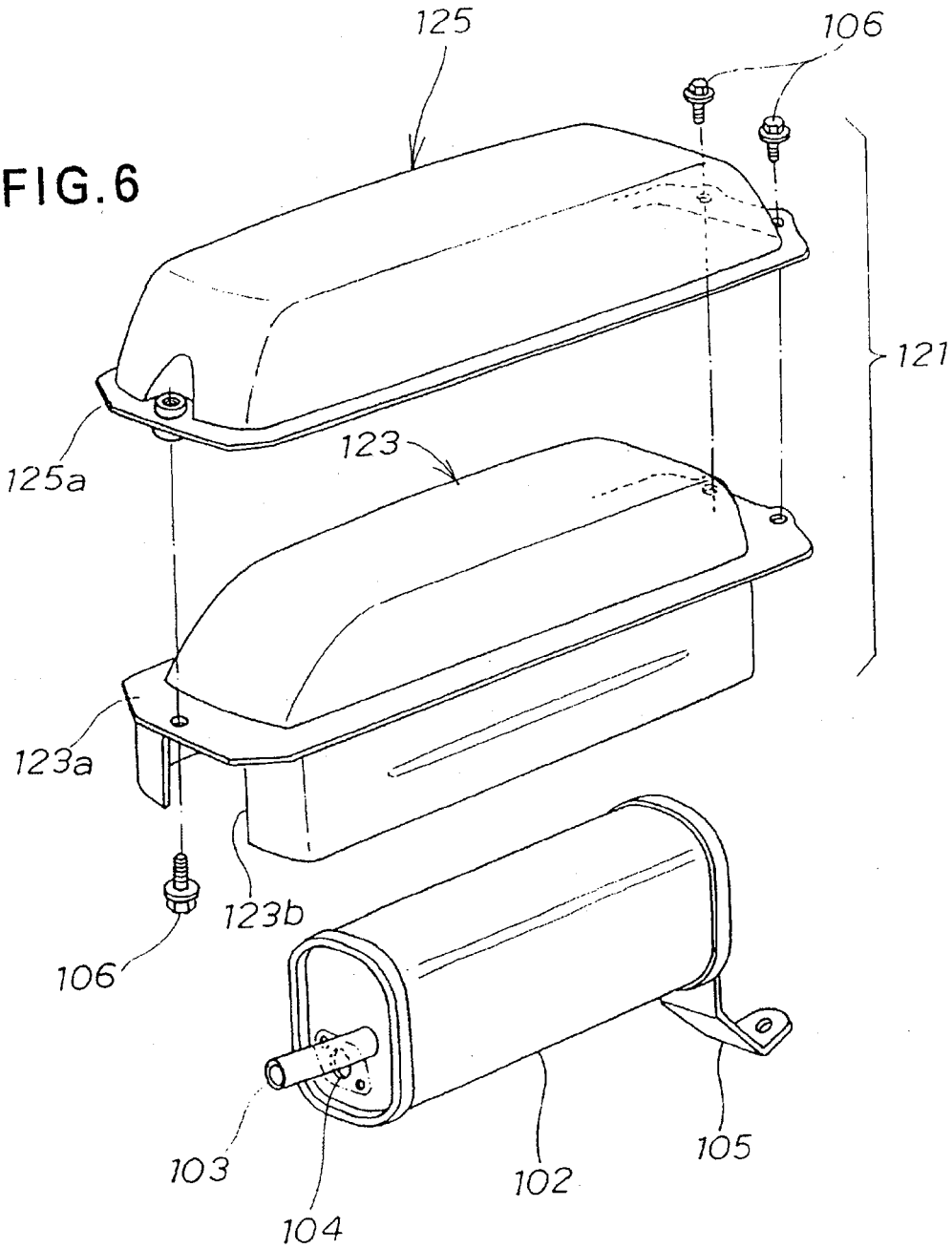
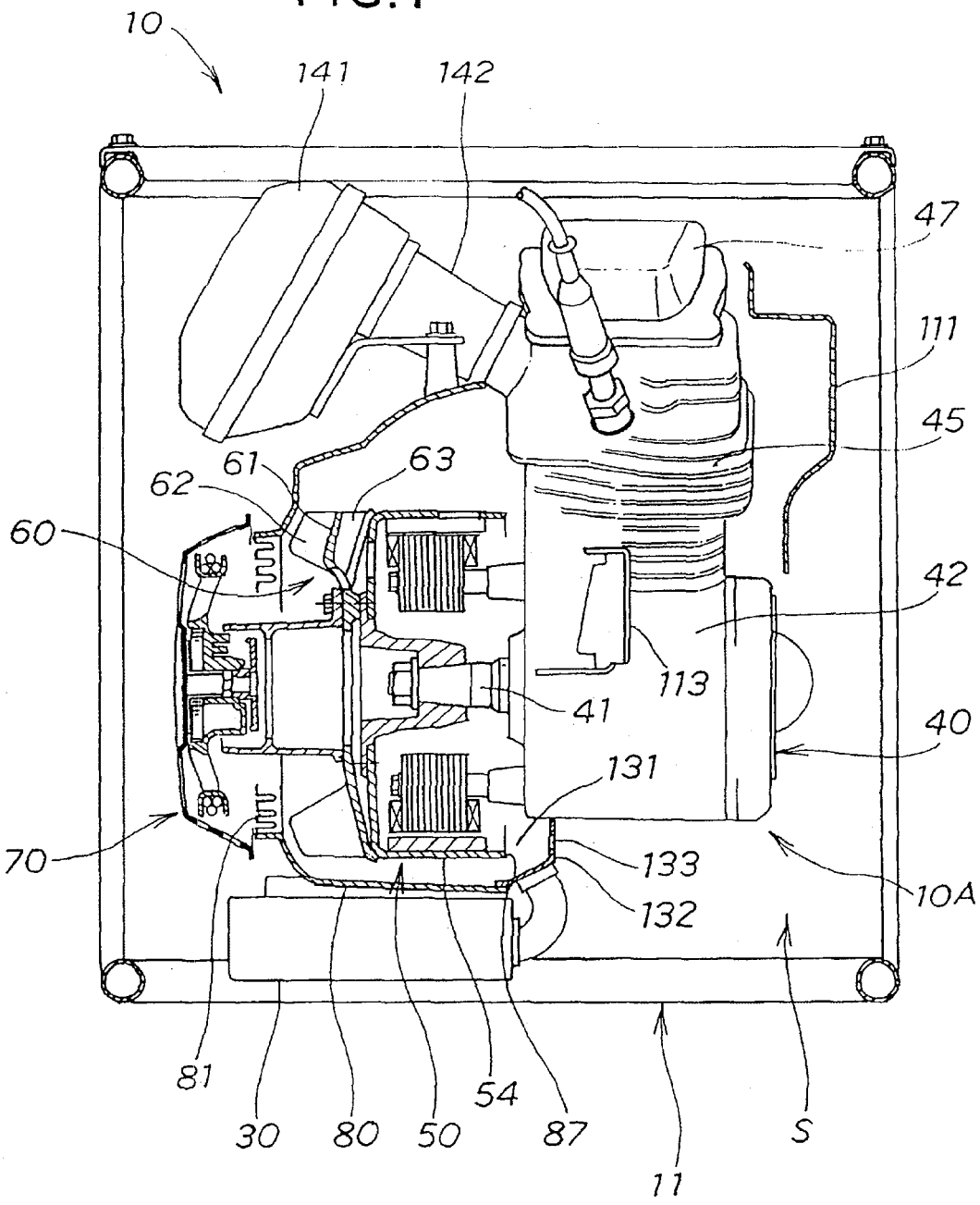


FIG. 7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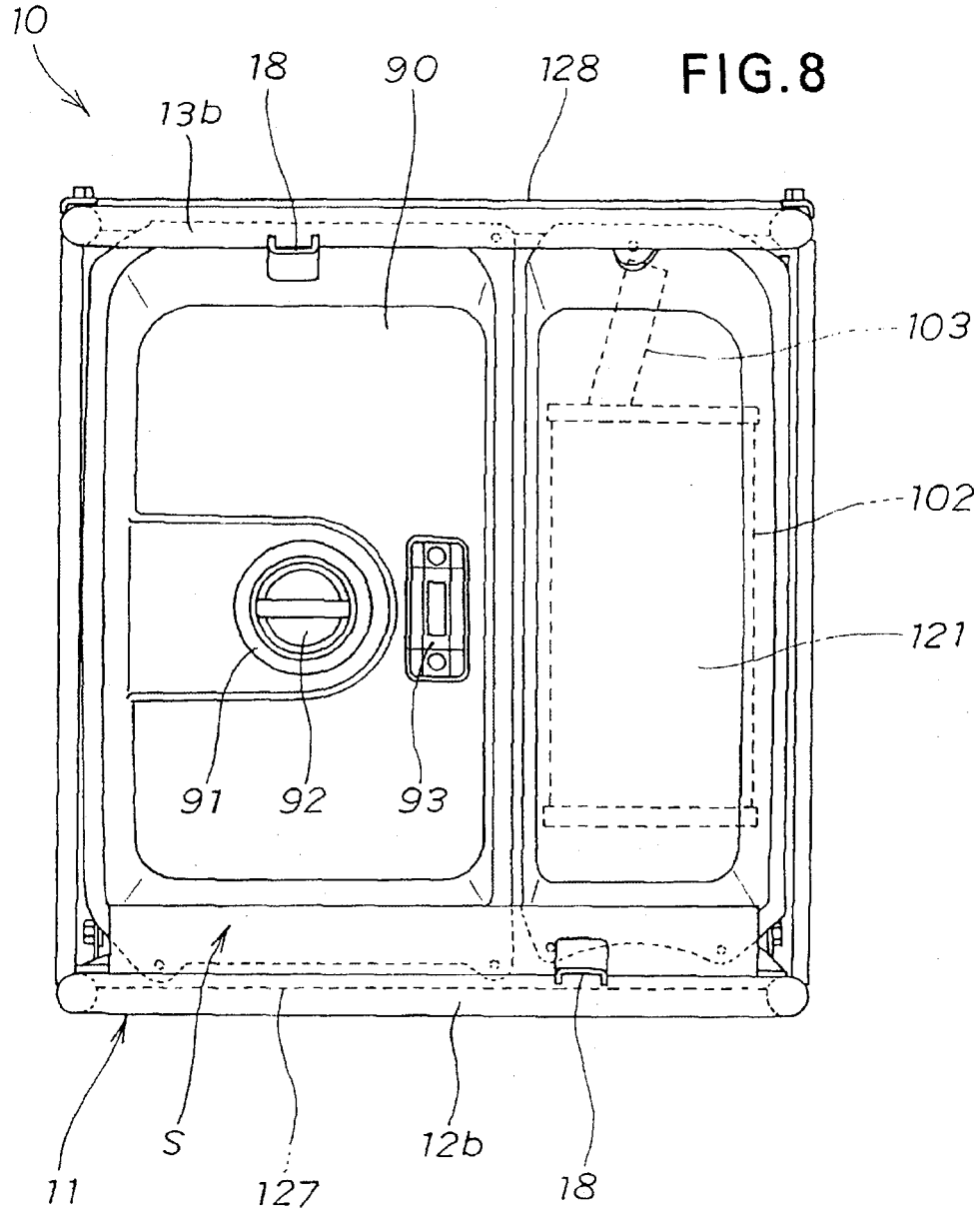

FIG.8

FIG. 9

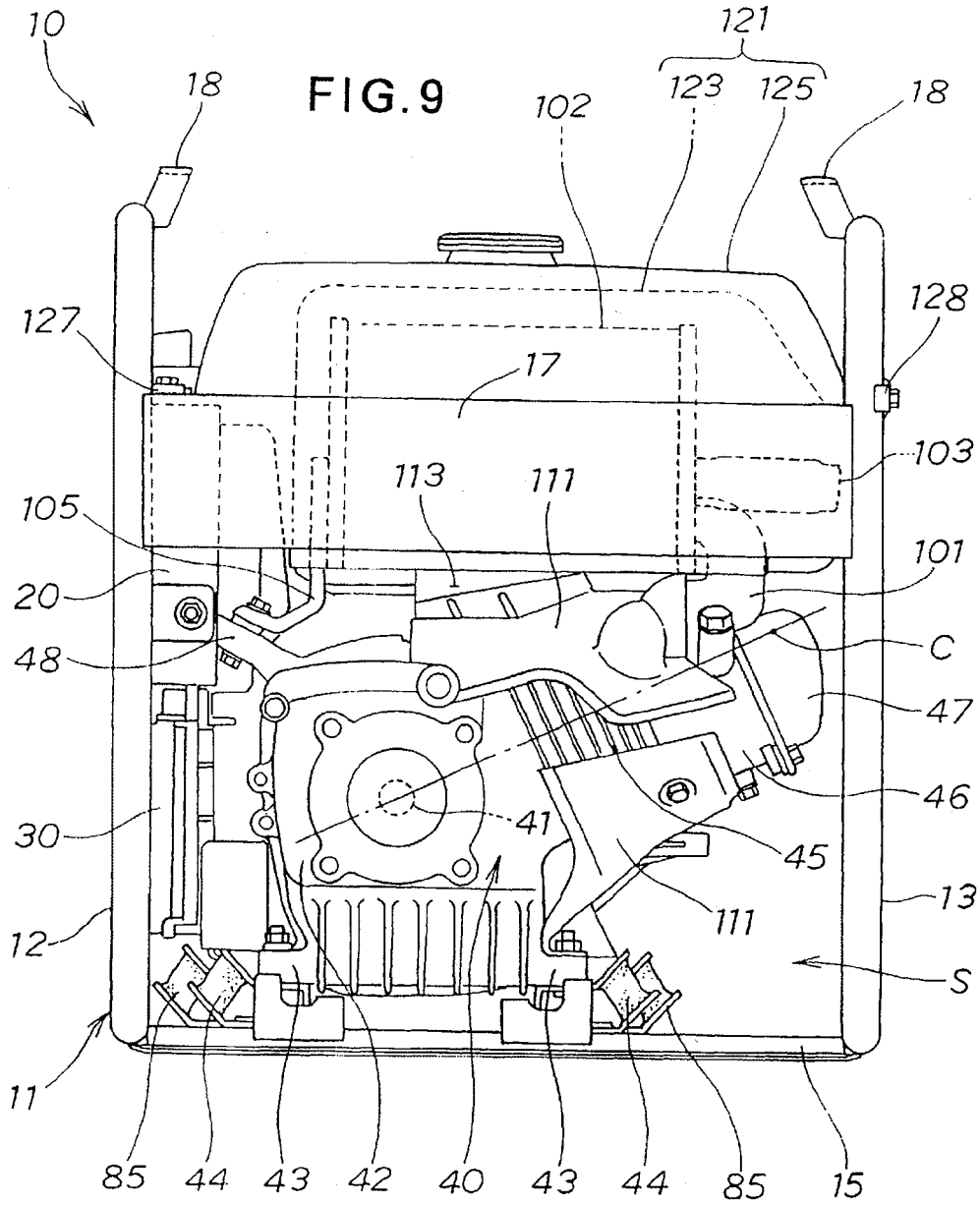
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FIG. 10

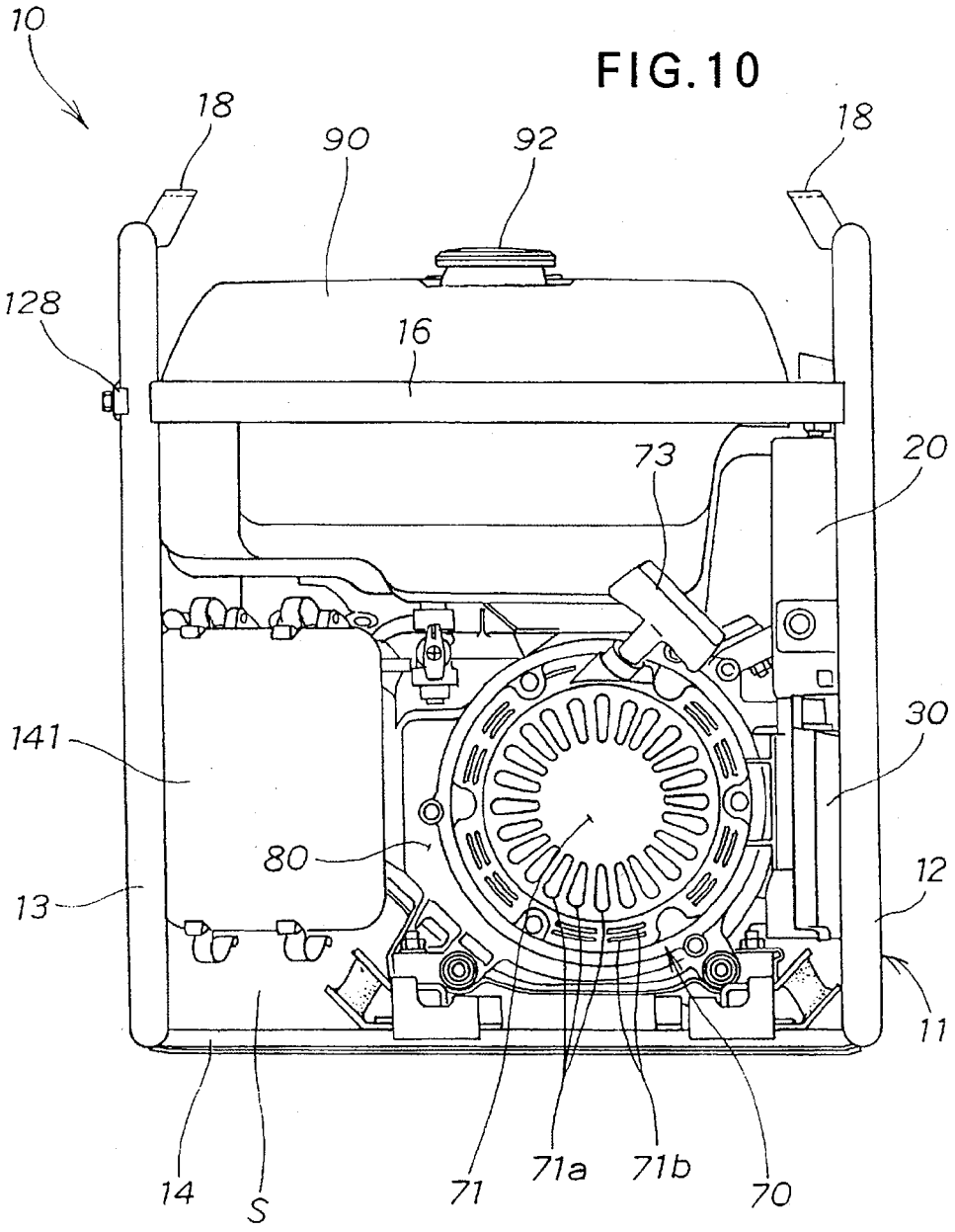
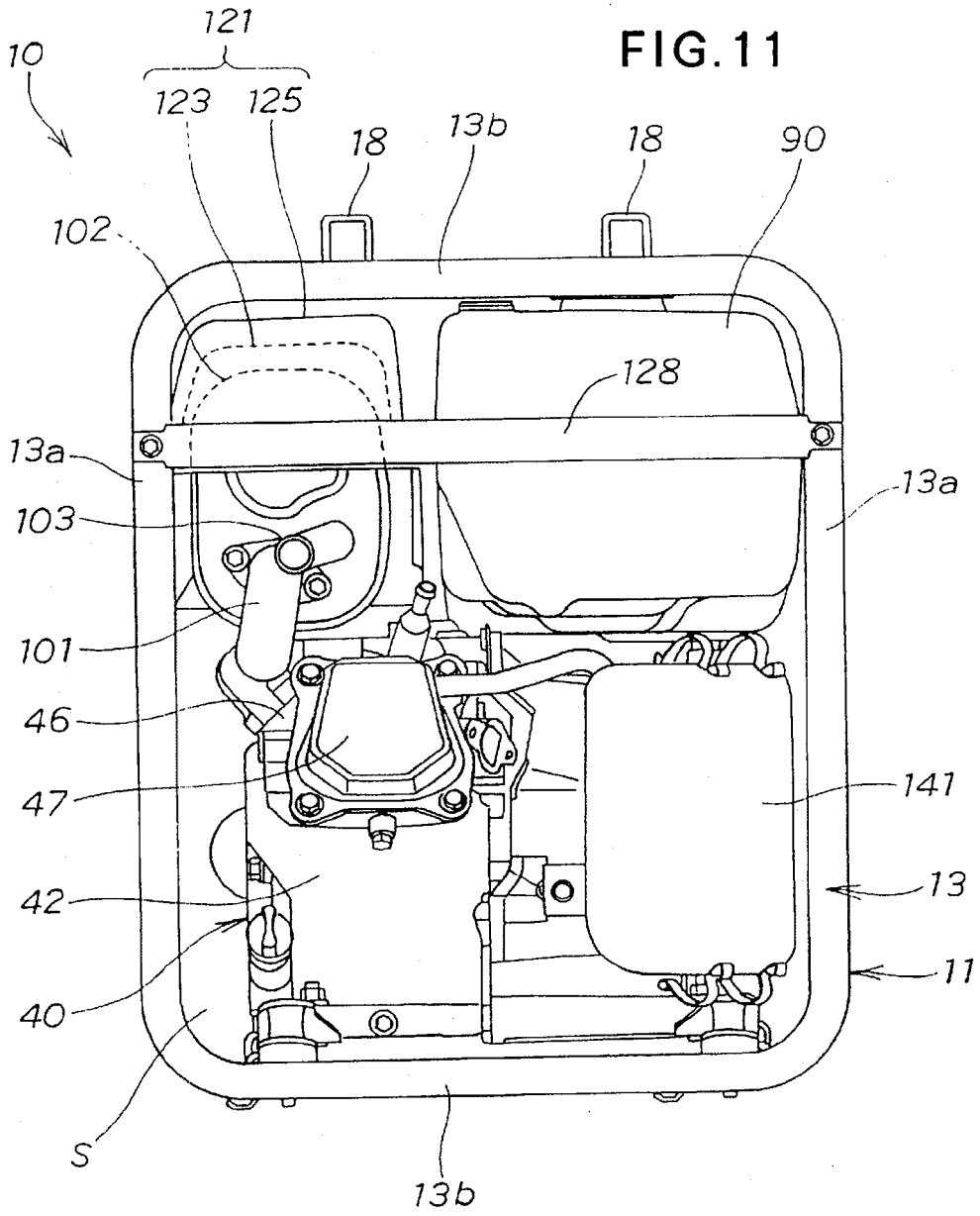


FIG. 11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125
18
13b
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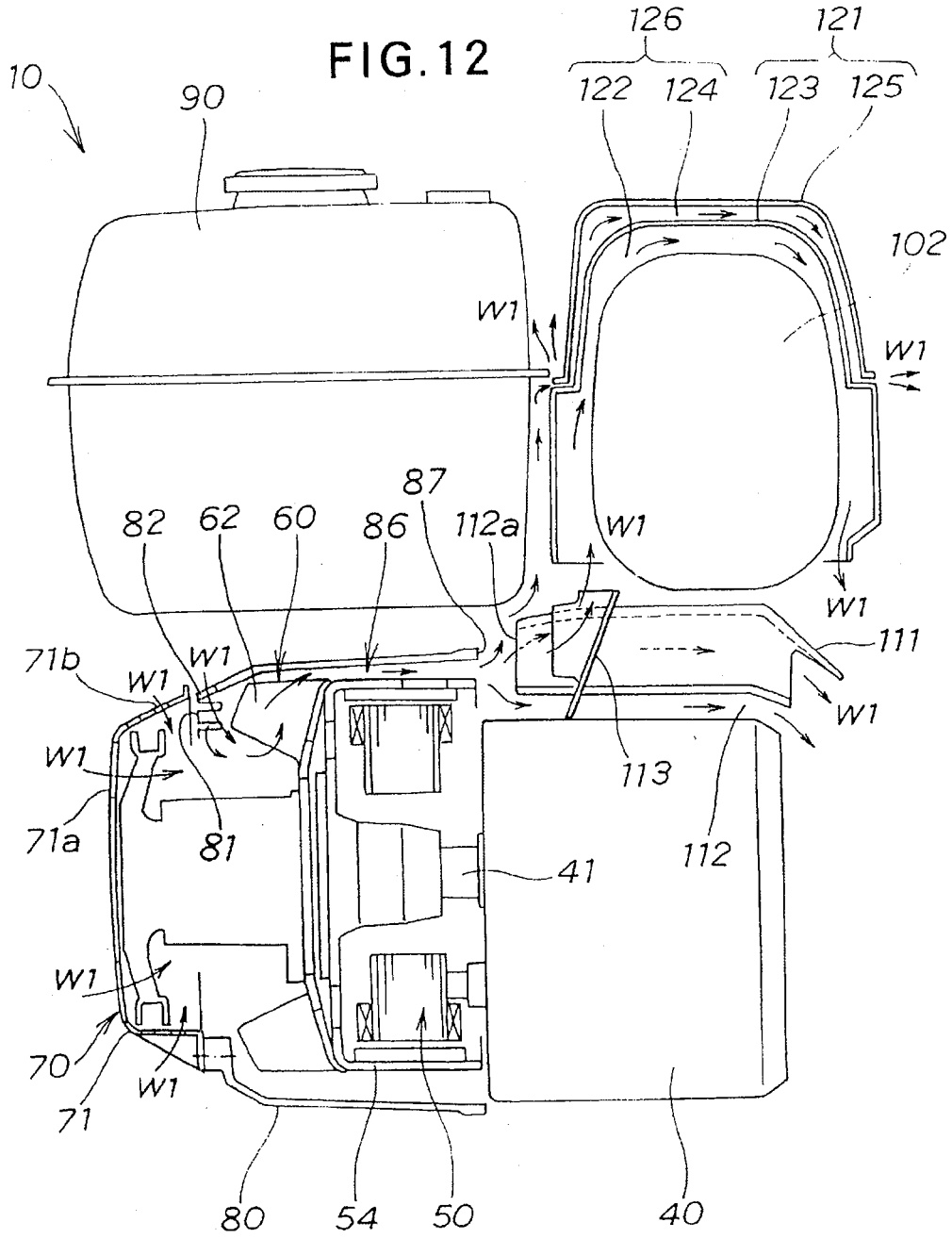
S
13b

FIG. 12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W1
87
82
62
60
86
112a
111
71b
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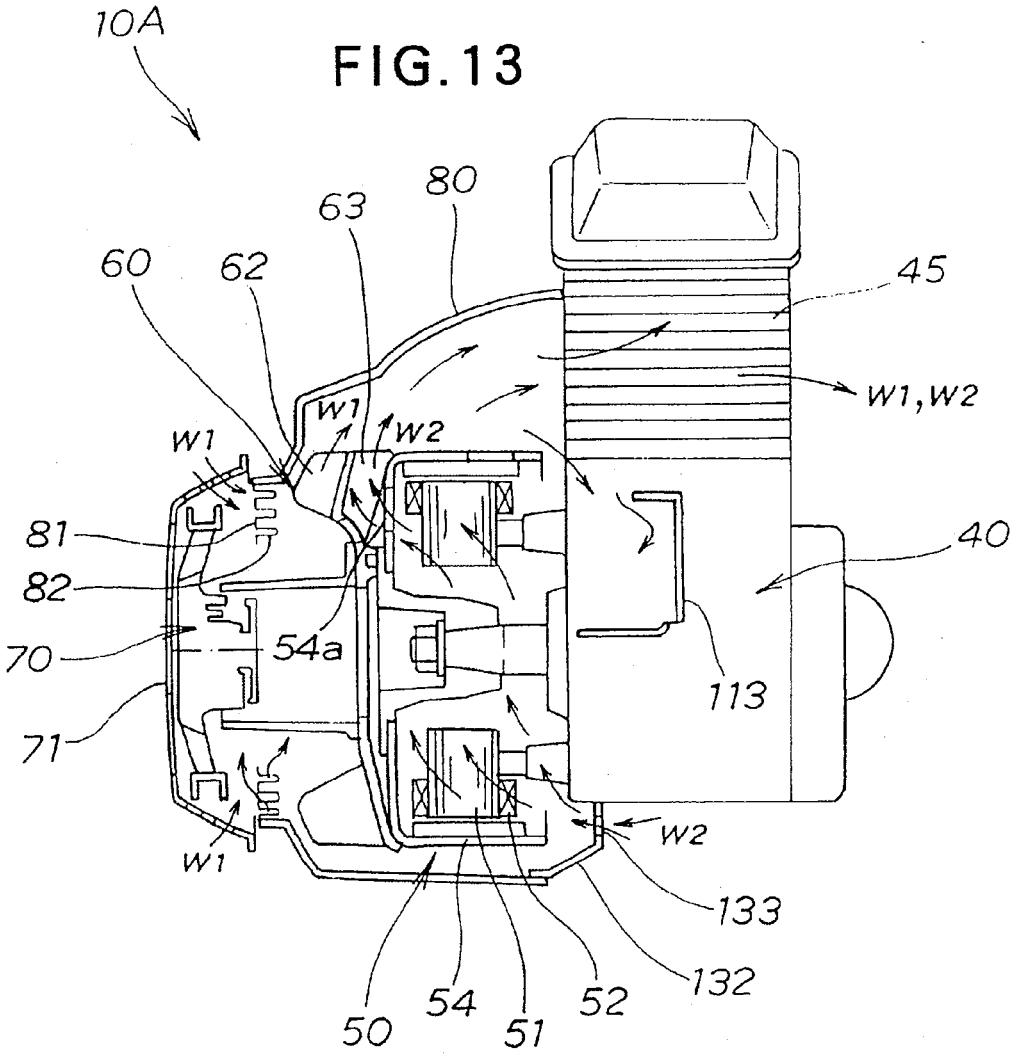
71a
81
41
112
70
71
80
54
50
40

FIG. 13


10A
60
62
63
80
45
W1,W2
W1
W1
W2
81
82
70
54a
71
40
113
W1
W2
133
132
50
54
51
52

ENGINE GENERATOR UNIT

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an engine generator unit including an engine and an electric-power generator driven by the engine.

2. Related Prior Art

Among general-purpose power supply devices suitable for use outdoors is the so-called engine generator unit which includes an engine and an electric-power generator driven by the engine. During operation, the engine, generator and muffler in the engine generator unit tend to become hot and thus are normally cooled via a cooling fan device. Typical examples of such an engine generator unit are shown in Japanese Utility Model Publication Nos. HEI-3-6831 and HEI-4-42494 and Japanese Patent Publication No. HEI-3-79532.

In the engine generator unit disclosed in Japanese Utility Model Publication No. HEI-3-6831, outside air is introduced into a space defined by the engine shroud, by means of a cooling fan device attached to the engine, in order to cool the engine cylinder and its vicinity. The outside or cooling air having cooled the engine cylinder is then passed through an exhaust air guide and blown onto the muffler while cooling an exhaust manifold, to thereby lower the temperature of the muffler. On the other hand, the outside air is also introduced into the generator by means of another cooling fan device attached thereto in order to cool the interior of the generator.

The engine generator unit disclosed in the No. HEI-4-42494 publication has a cooling fan device fixed to the engine, via which outside air is introduced into first and second cooling-air passages so that the engine cylinder is cooled by the air passing through the first cooling-air passage while the crankcase is cooled by the air passing through the second cooling-air passage. The air having cooled and passed the crankcase is then directed to cool the muffler.

Further, in the engine generator unit disclosed in the No. HEI-3-79532 publication, outside air is introduced, by means of a cooling fan device fixed to the engine, to cool both the engine and the generator, and the air having cooled and passed the engine and generator is directed to an exhaust air duct so as to cool the muffler provided within the exhaust air duct.

However, the first-mentioned prior engine generator unit disclosed in the No. HEI-3-6831 publication would require a great amount of cooling air in order to effectively cool the muffler because the muffler is cooled here by the cooling air after having passed the engine and hence having got relatively hot. Thus, arrangements must be made, in this unit, for directing as much cooling air as possible to the muffler with minimum leakage and for causing the cooling air to efficiently contact the muffler over the entire outer surface thereof. This is also the case with the second-mentioned prior engine generator unit. Further, the last-mentioned prior engine generator unit disclosed in the No. HEI-3-79532 publication would require a complicated cooling-air passage structure because of the arrangement that a great amount of the cooling air having passed the engine and generator is collected together and then directed to flow through the exhaust air duct.

SUMMARY OF THE INVENTION

It is accordingly an object of the present invention to provide an improved engine generator unit which can cool the engine, generator and muffler with greatly increased efficiency by use of simple structure.

To accomplish the above-mentioned object, the present invention provides an engine generator unit which comprises: an engine; an electric-power generator to be driven by the engine, the engine and the electric-power generator being provided coaxially in a direction of an engine output shaft; a fuel tank disposed above the engine and electric-power generator; a muffler connected to an exhaust-discharging end of the engine and positioned above the engine adjacent the fuel tank; a heat blocking cover covering top and side portions of the muffler; a fan cover having a generally cylindrical shape, the fan cover covering the electric-power generator and extending close to the engine; and a cooling fan device disposed in a cooling-air inlet portion of the fan cover for introducing cooling air, from outside the engine generator unit, to the electric-power generator covered with the fan cover, an engine-cooling air passage having a cooling-air inlet portion that faces a cooling-air outlet portion of the fan cover being provided to cool an outer surface of the engine by the cooling air flowing out through the cooling-air outlet portion of the fan cover. In this inventive engine generator unit, the engine-cooling air passage is branched to provide a separate muffler-cooling air passage extending between the muffler and the heat blocking cover; thus, the cooling air introduced from the outside is allowed to cool both the engine and the muffler after having cooled the electric-power generator.

In the present invention, the cooling air introduced or sucked in via the cooling fan device first cools the generator within the fan cover, and then enters the engine-cooling air passage to cool the outer surface of the engine. By the engine-cooling air passage being branched upwardly to provide the separate muffler-cooling air passage as mentioned above, a proportion of the cooling air flowing out of the fan cover toward the engine-cooling air passage can be positively diverted into the muffler-cooling air passage between the muffler and the heat blocking cover and thereby can effectively cool the outer surface of the muffler. Because that proportion of the cooling air thus diverted into the muffler-cooling air passage has just cooled and passed only the electric-power generator and thus is still at a relatively low temperature, it can cool the muffler with sufficient efficiency. Namely, in the present invention, the cooling air introduced from the outside is allowed to first cool the electric-power generator and then both the engine and the muffler efficiently while still maintaining a low temperature.

In one preferred implementation, the engine-cooling air passage is provided, between the engine and an engine shroud covering at least a part of the engine, for passing therethrough the cooling air having cooled the electric-power generator, and the engine-cooling air passage is branched into the muffler-cooling air passage by means of an air guide provided on the engine shroud. Because the cooling air is directed to flow between the engine and the engine shroud, the engine can be cooled even more effectively. Further, with the air guide positively diverting a proportion of the cooling air flowing out of the fan cover, the cooling air can be directed into the muffler-cooling air passage with increased efficiency. Such an air guide can be of simple structure since it is only necessary for the air guide to divert the proportion of the cooling air within the engine shroud.

In a preferred embodiment of the present invention, the heat blocking cover is a dual-cover structure that comprises an inner cover covering the muffler with a predetermined first gap left therebetween and an outer cover covering the

inner cover with a predetermined second gap left therebetween. The muffler-cooling air passage is made up of a first cooling-air path provided by the first gap and a second cooling-air path provided by the second gap and the second cooling-air path extends between the inner cover and the fuel tank. The diverted cooling air flows in the first cooling-air path of the muffler-cooling air passage along the inner surface of the inner cover, to thereby cool the outer surface of the muffler. The diverted cooling air also flows in the second cooling-air path of the muffler-cooling air passage along the outer cover, to thereby cool the outer surface of the inner cover. The cooling air flowing through the second cooling-air path functions as a heat blocking air layer, namely, an air curtain, that blocks the heat transfer from the inner cover. By the diverted cooling air thus flowing through the two cooling-air paths of the muffler-cooling air passage, the outer surface temperature of the outer cover can be lowered even further.

Furthermore, in one preferred embodiment of the present invention, the engine, electric-power generator, fuel tank and muffler are mounted together within a space defined by a framework preferably in the shape of a pipe. Also, the cylinder of the engine is mounted in a downwardly tilted posture with respect to a general vertical axis of the engine generator unit, and the fuel tank and the muffler are mounted above the cylinder of the engine in such a way that respective longitudinal axes of the tank and the muffler lie substantially horizontally and cross the engine output shaft at right angles thereto. Thus tilting the engine cylinder can lower the overall height or profile of the engine and create a relatively large empty space above the thus-lowered engine cylinder within the space surrounded by the pipe-shaped framework. The relatively large empty space can be utilized to position the horizontal muffler to cross the engine output shaft substantially at right angles thereto; this arrangement can increase the capacity of the muffler and thus significantly reduce an undesired roar of the engine exhaust.

BRIEF DESCRIPTION OF THE DRAWINGS

Certain preferred embodiments of the present invention will be described in greater detail with reference to the accompanying sheets of drawings, in which:

FIG. **1** is a perspective view showing a general construction of an engine generator unit in accordance with a preferred embodiment of the present invention;

FIG. **2** is a vertical sectional view taken along the **2**—**2** line of FIG. **1**;

FIG. **3** is a partly-sectional front view of the engine-operated generator unit shown in FIG. 1;

FIG. **4** is a perspective view showing a fan cover attached directly to an engine shown in FIG. 1;

FIG. **5** is a vertical sectional view taken along the **5**—**5** line of FIG. **2**;

FIG. **6** is an exploded perspective view showing a muffler and a heat blocking cover in the preferred embodiment;

FIG. **7** is a sectional top plan view of the engine generator unit in accordance with the preferred embodiment of the present invention, which particularly shows the engine and generator;

FIG. **8** is a top plan view of the engine generator unit in accordance with the preferred embodiment of the present invention;

FIG. **9** is a right side view of the engine generator unit in accordance with the preferred embodiment of the present invention;

FIG. **10** is a left side view of the engine generator unit in accordance with the preferred embodiment of the present invention;

FIG. **11** is a rear view of the engine generator unit in accordance with the preferred embodiment of the present invention;

FIG. **12** is a view explanatory of behavior of the inventive engine generator unit; and

FIG. **13** is also a view explanatory of the behavior of the inventive engine generator unit.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following description is merely exemplary in nature and is in no way intended to limit the invention, its application or uses.

FIG. **1** is a perspective view showing a general construction of an engine generator unit in accordance with a preferred embodiment of the present invention. As shown, this generator unit **10** is an open-type engine generator unit which includes a framework **11** that, in the illustrated example, is generally formed into a hollow cubic shape and composed of front and rear generally-square or rectangular pipe-shaped frames **12** and **13**. The generator unit **10** has a control panel **20** fixed to the front frame in an upper hollow region defined by the rectangular front frame, and an electric power controller **30** is disposed in a lower hollow region defined by the front frame. The engine generator unit **10** also includes, within an inner space between the front and rear frames **12** and **13**, an engine **40**, a fuel tank **90**, an air cleaner **141**, an electric power generator **50** (FIG. **2**) and a muffler **102** (FIG. **2**).

The rectangular front and rear frames **12** and **13** of the framework **11** are interconnected by a pair of left and right lower beams **14** and **15** and a pair of left and right upper beams **16** and **17** (the right upper beam **17** is not visible in FIG. 1 and shown in FIG. **9**). The rectangular front frame **12** consists of a pair of left and right vertical frame portions **12***a* and a pair of horizontal frame portions **12***b*, and similarly the rectangular rear frame **13** consists of a pair of left and right vertical frame portions **13***a* and a pair of horizontal frame portions **13***b*. Thus, the framework **11** has the vertical frame portions **12***a* and **13***a* at its four corners as viewed in plan.

On corresponding positions of the opposed upper horizontal frame portions **12***b* and **13***b*, the framework **11** includes a pair of positioning supports **18** that are used when another engine-operated generator unit (not shown) of the same construction is to be superposed on the engine generator unit **10**. More specifically, the positioning supports **18** are provided on the horizontal frame portions **12***b* and **13***b* so that they can engage the other engine generator unit against displacement in the front-rear and left-right directions.

The control panel **20** includes various electrical components that constitute an engine control, an electric-power take-out section, etc. More specifically, on the control panel **20**, there are provided an engine switch **21** for turning on an engine ignition system, an ignition controller **22** for controlling the engine ignition, a battery charger socket **23** for charging an external battery, a first take-out socket **24** for taking out a high-level A.C. current, and two second take-out sockets **25** each for taking a current lower in level than that taken out by the first take-out socket **24**. Also provided on the control panel **20** are a circuit breaker **26** for breaking the electric circuit when the output current from any one of the sockets **24** and **25** exceeds a predetermined threshold value,

and a frequency changing switch **27** for changing the frequency of the output current from the sockets **24** and **25**. The electric power controller **30** converts the output frequency of the generator **50** into a predetermined frequency and may comprise, for example, a cycloconverter.

FIG. **2** is a vertical sectional view taken along the line **2**—**2** of FIG. **1**, which shows the engine **40**, generator **50**, fuel tank **90** and muffler **102** as viewed from the front of the engine generator unit **10**; note that only a lower end portion of the framework **11** is shown in this figure for simplicity of illustration.

Within the space surrounded by the framework **11**, as seen in FIG. **2**, the engine **40** and generator **50** capable of being driven by the engine **40** are positioned side by side in an axial direction of an engine output shaft **41**, and the fuel tank **90** and muffler **102** are disposed above the generator **50** and engine **40**. When the engine generator unit **10** is viewed from its front as in FIG. **2**, the engine **40** is located in the lower right of the generator unit **10**, the generator **50** located in the lower left of the generator unit **10**, the fuel tank **90** located above the generator **50**, and the muffler **102** located above the engine **40** that has an overall height significantly reduced by placing the engine cylinder in a downwardly tilted posture with respect to a general vertical axis of the generator unit **10** as will be later described. The fuel tank **90** and muffler **102** are placed substantially horizontally in a side-by-side relation to each other. Because the fuel tank **90** and muffler **102** are thus mounted side by side right above the generator **50** and engine **40**, the engine-operated generator unit **10** can be constructed compactly into a generally-cubic overall configuration, so that it can be appropriately installed even in a relatively small space with its center of gravity significantly lowered.

FIG. **3** is a partly-sectional front view of the engine-operated generator unit **10** with principal components of the generator unit **10** of FIG. **2** depicted on an enlarged scale. To the framework **11** of the generator unit **10**, there are fixed the engine **40**, the generator **50** operatively connected the engine **40**, a centrifugal cooling fan device **60** disposed on one side of the generator **50** remote from the engine **40** for introducing or sucking in outside air for cooling purposes to be described later, a recoil starter **70** connected to the cooling fan device **60** via a connecting cylinder **66**, and a fan cover **80** enclosing the generator **50** and cooling fan device **60**. Outer rotor **54**, cooling fan device **60** and recoil starter **70** are mounted coaxially relatively to the engine output shaft **41**.

The electric-power generator **50** in the preferred embodiment is an outer-rotor-type generator based on multipolar magnets that are supported by the engine output shaft **41** in a cantilever fashion. More specifically, the generator **50** is made up of an inner stator **56** including a stator core **51** in the form of axially-stacked rings fixed to a side wall of the crankcase **42** and a plurality of coils wound on the stator core **51**, the outer rotor **54** generally in the shape of a cup and mounted on the engine output shaft **41** by means of a hub **53**, and a plurality of magnets **55** secured to the inner surface of the outer rotor **54**.

The cup-shaped outer rotor **54** surrounds the inner stator **56** (i.e., the stator core **51** and coils **52**) and has its one end (cup bottom portion) coupled with the centrifugal cooling fan device **60**; thus, the centrifugal cooling fan device **60** having a relatively large diameter can be mounted reliably in a simple manner. The large diameter of the centrifugal cooling fan device **60** can suck in a sufficient amount of air for cooling the engine **40** and generator **50**.

The outer rotor **54** in the preferred embodiment also functions as a cantilevered flywheel, which can eliminate a need for a separate flywheel. Thus, the dimension of the generator unit **10** in the axial direction of the engine output shaft **41** can be reduced accordingly to permit downsizing of the framework **11**, so that the generator unit **10** can be reduced in overall size. The cup-shaped outer rotor **54** also has air holes **54***a* and **54***b* in the cup bottom portion and cylindrical side wall.

Mounting accuracy of the fan cover **80** relative to the engine output shaft **41** need not be very high because it only has to enclose the outer-rotor-type generator **50** and the cooling fan device **60** attached to the outer rotor **54**.

The fan cover **80** is generally in the form of a cylinder extending horizontally along the engine output shaft **41** close to the engine **40**. Specifically, the fan cover **80** has a cooling-air inlet portion **81** at its outer end remote from the engine **40**, through which the outside air is introduced into the generator unit **10** by means of the cooling fan device **60** generally located inwardly of the cooling-air inlet portion **81**. More specifically, the cooling-air inlet portion **81** has at its outer end a plurality of parallel air sucking-in slits **82** extending along the longitudinal direction of the fan cover **80**, and a recoil starter cover **71** is attached to the cooling-air inlet portion **81** outwardly of the cooling-air inlet portion **81**.

By means of the recoil starter cover **71**, the recoil starter **70** supports a pulley **72** for rotation about an axis lying in horizontal alignment with the engine outputs haft **41** and operatively connects the pulley **72** with the cooling fan device **60**. The recoil starter cover **71** has a plurality of air holes **71***a*.

At the other or inner end adjacent the engine **40**, on the other hand, the cooling fan cover **80** is secured to the engine crankcase **42** by means of bolts **83** (only one of which is shown in FIG. **3**) while forming a cooling-air outlet portion **87** for blowing the cooling air onto the outer peripheral surface of the engine **40**.

FIG. **4** is a perspective view showing the cooling fan cover **80** secured directly to the engine crankcase **42**. The cooling fan cover **80** is made of die-cast aluminum alloy that has a high thermal conductivity and thus achieves a superior heat-radiating performance. By being made of such die-cast aluminum alloy and directly secured to the engine **40**, the cooling fan cover **80** can function as a very efficient heat radiator. Namely, the heat accumulated in the outer wall of the engine crankcase **42** can be readily transferred to the directly-secured fan cover **80**. This way, in the preferred embodiment, the outer surface of the engine **40** and the entire area of the cooling fan cover **80** can together provide an increased heat-radiating surface for the engine **40**. With such an increase in the heat radiating surface, the engine **40** can be cooled with increased efficiency, as a result of which the oil temperature and the like in the engine **40** can also be kept low with efficiency.

Further, as shown in FIG. **4**, a pair of supporting leg members **43** (only one of which is visible here) are secured to opposite (front and rear) end portions of the underside of the engine **40**. Similarly, a pair of supporting leg portions **84** are secured to opposite ends of the underside of the cooling fan cover **80**. These supporting leg members **43** and **84** of the engine **40** and cooling fan cover **80** are placed transversely on the above-mentioned left and right lower beams **14** and **15** and bolted to the beams **14** and **15** with shock absorbing members (vibration-isolating mounts) **44** and **85** interposed therebetween.

Because the cooling fan cover **80** made of the die-cast aluminum alloy has relatively great rigidity and such a rigid cooling fan cover **80** is firmly secured to the engine **40** that

is also rigid enough in general, the engine generator unit **10** of the present invention can provide a rugged assembly of the fan cover **80** and engine **40** which can be reliably retained on the framework **11** with an appropriate shock absorbing or cushioning capability.

Referring back to FIG. **2**, at least part of the engine **40** is covered with an engine shroud **111** with a relatively large empty space **112** left therebetween, and the empty space **112** serves as an air passage through which air is allowed to pass to cool the engine **40** (hereinafter referred to as an "engine-cooling air passage" **112**). Inlet portion **112***a* to the interior of the engine-cooling air passage **112** faces the cooling-air outlet portion **87** of the fan cover **80**.

The muffler **102** is covered or closed at least at its top end portion with a heat blocking cover **121** which is a dual-cover structure including an inner cover **123** covering the muffler **102** with a predetermined first gap **122** formed therebetween and an outer cover **125** covering the outer surface of the inner cover **123** with a predetermined second gap **124**. The inner cover **123** of the dual heat blocking cover structure **121** is generally in the shape of a halved cylinder opening downward to cover an almost entire outer surface of the muffler **102** except for a lower end surface of the muffler **102**. The outer cover **125** is also generally in the shape of a halved cylinder opening downward to cover an upper surface of the inner cover **123**.

The first gap **122** between the inner cover **123** and the muffler **102** functions as a first cooling-air path, while the second gap **124** between the inner cover **123** and the outer cover **125** functions as a second cooling-air path. Thus, these first and second cooling-air paths **122** and **124** together constitute a divided muffler-cooling air passage **126** separate from the engine-cooling air passage **112**.

As further shown in FIG. **2**, the engine shroud **111** has an air guide **113** integrally formed thereon for diverting a proportion of the cooling air from the engine-cooling air passage **112** upwardly into the muffler-cooling air passage **126**. With this air-diverting guide **113**, the cooling air drawn in from the outside via the cooling fan device **60** having cooled the generator **50** is allowed to flow into both the engine-cooling air passage **112** and the muffler-cooling air passage **126**, so that the engine **40** and muffler **102** can be cooled by the same cooling air having cooled and passed the upstream generator **50**. Because the air guide **113** is used only to divert a proportion of the cooling air within the engine shroud **111**, it can be of simple structure.

FIG. **5** is a vertical sectional view taken along the **5**—**5** line of FIG. **2**, which shows the left side of the framework **11**, engine **40** and muffler **102** and where illustration of the generator **50** is omitted for simplicity. In the preferred embodiment, as shown in FIG. **5**, the engine **40** is constructed to have a lower profile, i.e., a smaller height, than the conventional counterparts by tilting the cylinder **45**, cylinder head **46** and head cover **57**, i.e., the longitudinal axis of the engine **40**, rearwardly downward about the engine output shaft **41** with respect to the general vertical axis of the unit **10**, so as to be located obliquely upward of the engine output shaft **41**.

As further shown in FIG. **5**, the muffler **102** is connected via an exhaust pipe **101** to an exhaust port of the engine **40**.

As also seen from FIG. **5**, the horizontal muffler **102** extends to cross the engine output shaft **41**, substantially at right angles thereto, above the engine cylinder **45** and is secured to an engine bracket **48**. More specifically, tilting the cylinder **45** as above can lower the overall height or profile of the engine **40** and leaves a relatively large empty space above the thus-lowered cylinder **45**. This relatively large empty space is utilized to position the horizontal muffler **102** to cross the engine output shaft **41** substantially at right angles thereto; this arrangement can further increase the capacity of the muffler **102**.

Further, an exhaust port (tailpipe) **103** is positioned to extend in the same rearward direction as the cylinder **41** extends from the engine output shaft **41**, and the control panel **20** is positioned on the front of the generator unit **10** remotely from the exhaust port **103**, as denoted by phantom line.

In the preferred embodiment thus arranged, the exhaust from the muffler **102** is prevented from flowing toward the control panel **20**, which is therefore not thermally influenced by the muffler exhaust and can be constantly maintained in a suitable operating condition for a human operator to appropriately manipulate the panel **20** as necessary.

The inner and outer covers **123** and **125** of the dual heat blocking cover structure **121** are elongate covers spanning between the front and rear frames **12** and **13** and secured to the frames **12** and **13** with their opposite end flanges **123***a* and **125***a* superposed on each other. Further, a front support member **127** is provided between the vertical frame portions **12***a* of the front frame **12** while a rear support member **128** is provided between the vertical frame portions **13***a* of the rear frame **13**. Two pairs of the superposed end flanges **123***a* and **125***a* are bolted to the front and rear support members **127** and **128**, respectively, by which the dual heat blocking cover structure **121** is secured between the front and rear frames **12** and **13** above the muffler **102**.

FIG. **6** is an exploded perspective view showing the muffler **102** and heat blocking cover **121** and is particularly explanatory of a relationship between the muffler **102** and the inner and outer covers **123**, **125** in the preferred embodiment. As shown, the inner cover **123** has an opening **123***b* in its rear wall to avoid mechanical interference with the tailpipe **103** of the muffler **102**. The muffler **102** also has an exhaust inlet and a stay **105**, and reference numeral **106** is a bolt for insertion through the end flanges of the inner and outer covers **123** and **125**.

FIG. **7** is a sectional top plan view of the engine generator unit **10** in accordance with the preferred embodiment of the present invention, which particularly shows the engine **40** and generator **50** with the fuel tank **90**, muffler **102** and control panel **20** removed for clarity. As shown in the figure, a set of the engine **40**, generator **50**, electric power controller **30**, engine shroud **111**, air cleaner **141** and carburetor **142** is mounted snugly within a square space defined by the framework **11**, and the air guide **113** of the engine shroud **111** has a generally U-shape opening toward the cooling fan cover **80** as viewed in top plan.

As viewed in top plan, the cooling fan cover **80** bulges greatly along the engine cylinder **45**, and thereby allows the cooling air to be readily introduced into the space within the engine shroud **111**. The cooling fan device **60** is a double-side fan which includes a main fan **62** formed integrally on the rear surface of a base **61** and an auxiliary fan **63** formed integrally on the front surface of the base **61**. The main fan **62** functions to direct the outside air, introduced through the main cooling-air inlet portion **81**, toward the engine **40**, while the auxiliary fan **63** functions to direct the outside air, introduced through a plurality of auxiliary cooling-air inlets **133** and passed through the generator **50**, toward the engine **40**.

The cooling fan cover **80** has a predetermined gap **131** adjacent the engine **40** so that the gap **131** serves as the

auxiliary cooling-air inlets **133** for drawing in the outside air to cool the interior of the generator **50**. Namely, the gap **131** having a relatively large size is formed between one end of the fan cover **80** and one side of the crankcase **52** remotely from the engine cylinder **45**, and this gap **131** is closed by a plate **132** having the auxiliary cooling-air inlets **133** formed therein. The auxiliary air inlets **133** are formed in the plate **132** inwardly of the outer rotor **54** so as to be close to the center of the centrifugal cooling fan **60**. Because the central area of the centrifugal cooling fan **60** is subject to a greater negative pressure, the outside air can be efficiently sucked in through the auxiliary cooling-air inlets **133** located close to the center of the cooling fan **60** and then directed through the interior space of the generator **50** to the auxiliary fan **63**. The closing plate **132** bolted to the engine **40** and the auxiliary cooling-air inlets **133** formed in the closing plate **132** are illustratively shown in FIG. **5**.

FIG. **8** is a top plan view of the engine generator unit **10** in accordance with the preferred embodiment of the present invention. As shown, the muffler **102** is disposed adjacent the fuel tank **90** in a side-by-side relation thereto and covered at its top with the heat blocking cover **121**. Further, the fuel tank **90** and heat blocking cover **121** span horizontally between and secured to the front and rear support members **127** and **128**, so that the entire top region of an inner area defined by the pipe-shaped framework **11** is substantially closed by the fuel tank **90** and heat blocking cover **121**. In this figure, reference numeral **91** represents an oil filler hole, **92** an oil filler cap, and **93** an oil surface gauge.

FIG. **9** is a right side view of the engine generator unit **10** in accordance with the preferred embodiment of the present invention, which particularly shows that the muffler **102** is supported by the engine **40** via the above-mentioned exhaust pipe **101** and stay **105** and that the cylinder **45** and cylinder head **46** of the engine **40** are covered with a pair of upper and lower engine shroud members **111**.

FIG. **10** is a left side view of the engine generator unit **10** in accordance with the preferred embodiment of the present invention, which particularly shows that an actuating handle **73** of the recoil starter **70** is provided on a front left portion of the engine generator unit **10** and the air cleaner **141** is provided on a rear left portion of the unit **10**.

Further, FIG. **11** is a rear view of the engine generator unit **10** in accordance with the preferred embodiment of the present invention, which particularly shows that the muffler **102** is connected via the exhaust pipe **101** to the engine cylinder head **46** and that the rear support member **128** is bolted at its opposite ends to the vertical frame portions **13***a* of the rear frame **13**.

Now, a description will be made about exemplary behavior of the engine generator unit **10** constructed in the above-mentioned manner, with particular reference to FIGS. **12** and **13**.

FIG. **12** is a view explanatory of the behavior of the inventive engine generator unit **10**. Upon power-on of the engine **40**, the engine output shaft **41** causes the outer rotor **54** to start rotating, by which electric power generation by the generator **50** is initiated.

Simultaneously, the cooling fan device **60** is caused to rotate with the outer rotor **54** functioning as a magnetic rotor, so that the main fan **62** of the device **60** sucks in the outside air W1 through the air holes **71***a*, **71***b* of the recoil starter cover **71** and air sucking-in slits **82** of the fan cover **80**. The thus-introduced outside air W1 flows in the space enclosed by the fan cover **80** and is discharged radially out of the space by the centrifugal force of the main fan **62**. Then, the cooling air W1 flows through a cooling passage **86** to thereby cool the generator **50** and fan cover **80**, after which it exits via the cooling-air outlet portion **87** of the fan cover **80**. A proportion of the cooling air W1 from the cooling-air outlet portion **87** then enters the space defined by the engine shroud **111** and flows through the engine-cooling air passage **112** while cooling the outer surface of the engine **40**, after which it is discharged back to the outside. Because that proportion of the cooling air W1 flowing through the engine-cooling air passage **112** has just cooled and passed only the generator **50** and thus is still at a relatively low temperature, it can cool the engine **40** with sufficient efficiency. Further, because the air sucking-in slits **82** are formed in the cooling-air inlet portion **81** of the fan cover **80**, a sufficient amount of the outside air W1 can be introduced through these slits **82** into the engine generator unit **10** although the recoil starter **70** is provided in the inlet portion **81**.

The remaining portion of the cooling air W1 from the cooling-air outlet portion **87**, on the other hand, is diverted, via the air guide **113**, upwardly into the first and second passageways **122** and **124** of the divided muffler-cooling air passage **126**. The air guide **113** provides for positive and efficient diversion, and hence sufficient introduction, of the cooling air W1 into the muffler-cooling air passage **126**.

More specifically, the cooling air W1 diverted via the air guide **113** flows in the first cooling-air path **122** of the divided muffler-cooling air passage **126** along the inner surface of the inner cover **123**, to thereby cool the outer surface of the muffler **102**. The cooling air W1 diverted via the air guide **113** also flows in the second cooling-air path **124** of the divided muffler-cooling air passage **126** along the outer cover **125**, to thereby cool the outer surface of the inner cover **123**. The cooling air W1 flowing through the second cooling-air path **124** functions as a heat blocking air layer, namely, an air curtain, that effectively blocks the heat transfer from the inner cover **123**.

In the preferred embodiment, the outer surface temperature of the outer cover **125** can be reduced sufficiently by the cooling air W1 flowing through the two paths **122** and **124** of the divided muffler-cooling air passage **126** in the manner as described above. Further, because the proportion of the cooling air W1 flowing through the two cooling-air paths **122** and **124** has just cooled and passed only the generator **50** and thus is still at a relatively low temperature, it can cool the muffler **102** with sufficient efficiency. The cooling air W1 having thus cooled and passed the muffler **102** is discharged back to the outside.

Furthermore, the preferred embodiment can effectively reduce undesired heat radiation from the muffler **102** to the fuel tank **90**, by closing the top and side portions of the muffler **102** with the heat blocking cover **121**. Also, the cooling air W1 flowing between the fuel tank **90** and the muffler **102** can form an air curtain blocking the heat transfer between the two. Furthermore, with the cooling air W1 flowing through the muffler-cooling air passage **126**, the outer surface temperature of the heat blocking cover **121** can be kept low so that adverse thermal influences of the muffler **102** on the fuel tank **90** can be reliably avoided even where the muffler **102** is located close to the fuel tank **90**. Thus, in the preferred embodiment of the present invention, the fuel tank **90** and muffler **102** both having a great capacity can be safely positioned very close to each other, and such a great-capacity muffler **102** can reduce an undesired roar of the engine exhaust to a significant degree.

FIG. **13** is also a view explanatory of the behavior of the inventive engine generator unit **10**. The auxiliary fan **63** of

the cooling fan device **60** operates to suck in the cooling air from the outside through the auxiliary cooling air inlets **133** formed in the closing plate **132**. The thus-introduced cooling air W2 flows into the space defined by the outer rotor **54** to cool the stator core **51** and coils **52** and then is directed, through the air holes **54***a* formed in the bottom wall of the outer rotor **54**, onto the auxiliary fan **63**. Then, the cooling air W2 is discharged back to the outside by the centrifugal force of the fan **63** and merges with the above-mentioned cooling air W1 discharged via the main fan **62**.

In summary, the present invention arranged in the above-described manner affords various superior benefits as follows.

The engine generator unit in accordance with the present invention is characterized primarily in that the engine-cooling air passage is branched to provide the separate muffler-cooling air passage extending between the muffler and the heat blocking cover so that the cooling air introduced from the outside is allowed to cool both the engine and the muffler after having cooled the electric-power generator. The cooling air introduced or sucked in via the cooling fan first cools the generator within the fan cover, and then enters the engine-cooling air passage to cool the outer surface of the engine. With the arrangement that the engine-cooling air passage is branched upwardly to provide the separate muffler-cooling air passage, a proportion of the cooling air flowing out of the fan cover toward the engine-cooling air passage can be positively diverted into the muffler-cooling air passage extending between the muffler and the heat blocking cover and thereby can effectively cool the muffler. Because the proportion of the cooling air thus directed into the muffler-cooling air passage has just cooled and passed only the electric-power generator and thus is still relatively cool, it can cool the muffler with sufficient efficiency. Namely, the cooling air introduced from the outside is allowed to first cool the electric-power generator and then both the engine and the muffler efficiently while still maintaining a low temperature. Thus, with the arrangement that the engine-cooling air passage is branched to provide the muffler-cooling air passage between the muffler and the heat blocking cover, the engine, generator and muffler can be cooled with sufficient efficiency using a very simple structure.

Further, with the diverted cooling air flowing through the muffler-cooling air passage, the outer surface temperature of the heat blocking cover can be kept low so that adverse thermal influences of the muffler on the fuel tank can be reliably avoided even where the muffler is located close to the fuel tank. Thus, in the present invention, the fuel tank and muffler both having a great capacity can be safely positioned very close to each other, and such a great-capacity muffler can reduce the undesired roar of the engine exhaust to a significant degree.

Because the cooling air is directed to flow through the engine-cooling air passage between the engine and the engine shroud, the engine can be cooled even more effectively. Further, with the air guide positively diverting a proportion of the cooling air flowing out of the fan cover, the cooling air can be directed into the muffler-cooling air passage with increased efficiency; such an air guide can be of simple structure since it is only necessary for the air guide to perform the function of diverting the proportion of the cooling air within the engine shroud.

Furthermore, by constructing the heat blocking cover as a dual-cover structure that comprises an inner cover covering the muffler with a predetermined first gap left therebetween and an outer cover covering the inner cover with a predetermined second gap left therebetween, and by employing the muffler-cooling air passage that is made up of a first cooling-air path provided by the first gap and a second cooling-air path provided by the second gap and the second cooling-air path extends between the inner cover and the fuel tank, the diverted cooling air can flow in the first cooling-air path of the muffler-cooling air passage along the inner surface of the inner cover, to thereby cool the outer surface of the muffler. The diverted cooling air also can flow in the second cooling-air path of the muffler-cooling air passage along the outer cover, to thereby cool the outer surface of the inner cover. The cooling air flowing through the second cooling-air path functions as a heat blocking air layer or air curtain that blocks the heat transfer from the inner cover. By the diverted cooling air thus flowing through the two cooling-air paths of the muffler-cooling air passage, the outer surface temperature of the outer cover can be lowered even more effectively.

Furthermore, according to the present invention, the engine, electric-power generator, fuel tank and muffler are mounted together within a space defined by a framework preferably in the shape of a pipe and the cylinder of the engine is held in a downwardly tilted posture with respect to the general vertical axis of the engine generator unit, the fuel tank and the muffler is mounted above the cylinder of the engine such that the respective longitudinal axes of the tank and the muffler lie substantially horizontally and cross the engine output shaft at right angles thereto. By thus tilting the engine cylinder, the overall height or profile of the engine can be significantly lowered, which leaves a relatively large empty space above the thus-lowered engine cylinder within the space surrounded by the pipe-shaped framework. The relatively large empty space can be utilized to position the horizontal muffler substantially at right angles to the engine output shaft, with the result that the capacity of the muffler can be increased and the increased muffler can significantly reduce the roar of the engine exhaust. Besides, the engine, electric-power generator, fuel tank and muffler can be mounted together snugly within the limited space surrounded by the framework.

Obviously, various minor changes and modification of the present invention are possible in the light of the above teaching. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. An engine generator unit comprising:

an engine;

an electric-power generator to be driven by said engine, said engine and said electric-power generator being provided coaxially in a direction of an engine output shaft;

a fuel tank disposed above said engine and electric-power generator;

a muffler connected to an exhaust-discharging end of said engine and positioned above said engine adjacent said fuel tank;

a heat blocking cover covering top and side portions of said muffler;

a fan cover having a generally cylindrical shape, said fan cover covering said electric-power generator and extending close to said engine; and

a cooling fan device disposed in a cooling-air inlet portion of said fan cover for introducing cooling air, from outside said engine generator unit, to said electric-power generator covered with said fan cover, an engine-cooling air passage having a cooling-air inlet portion that faces a cooling-air outlet portion of said fan cover being provided to cool an outer surface of said engine by the cooling air flowing out through the cooling-air outlet portion of said fan cover,

said engine-cooling air passage being branched to provide a muffler-cooling air passage extending between said muffler and said heat blocking cover,

whereby the cooling air is allowed to cool both said engine and said muffler after having cooled said electric-power generator.

2. An engine generator unit as claimed in claim 1 where said engine-cooling air passage is provided, between said engine and an engine shroud covering at least a part of said engine, for passing therethrough the cooling air having cooled said electric-power generator, and wherein said engine-cooling air passage is branched into said muffler-cooling air passage by means of an air guide provided on said engine shroud.

3. An engine generator unit as claimed in claim 1 wherein said heat blocking cover is a dual-cover structure that comprises an inner cover covering said muffler with a predetermined first gap left therebetween and an outer cover covering said inner cover with a predetermined second gap left therebetween, and wherein said muffler-cooling air passage is made up of a first cooling-air path provided by said first gap and a second cooling-air path provided by said second gap and said second cooling-air path extends between said inner cover and said fuel tank.

4. An engine generator unit as claimed in claim 1 wherein said engine, electric-power generator, fuel tank and muffler are mounted within a space defined by a pipe-shaped framework, and wherein a cylinder of said engine is mounted in a downwardly tilted posture with respect to a general vertical axis of said engine generator unit, said fuel tank and said muffler are mounted above the cylinder of said engine in such a way that respective longitudinal axes of said fuel tank and said muffler lie substantially horizontally and cross the engine output shaft at right angles thereto.

* * * * *

US006941919B2

(12) **United States Patent**
Chiba et al.

(10) **Patent No.: US 6,941,919 B2**
(45) **Date of Patent: Sep. 13, 2005**

(54) **GENERAL PURPOSE ENGINE**

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(73) Assignee: **Honda Motor Co., Ltd.**, Tokyo (JP)

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(51) **Int. Cl.**[7] **F02F 7/00**
(52) **U.S. Cl.** ..... **123/195 A**; 123/195 C
(58) **Field of Search** ..... 123/195 R, 195 C, 123/195 A

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,421,297 A 6/1995 Tamba et al.
6,250,273 B1 * 6/2001 Ryu et al. ..... 123/195 C
2002/0011230 A1 1/2002 Furuya

FOREIGN PATENT DOCUMENTS

JP 2001-329910 11/2001

OTHER PUBLICATIONS

Patent abstract of JP 2002147213 published May 22, 2002.

* cited by examiner

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(57) **ABSTRACT**

In a general purpose engine, a crankcase is formed from a case main body and a cover secured to the case main body, and a bearing support member is disposed between a drive transmission wheel and a crank web that is at one end in the axial direction. The bearing support member is formed into a shape that allows oil held within the crankcase to flow between opposite sides of the bearing support member and is mounted on the case main body.

5 Claims, 2 Drawing Sheets

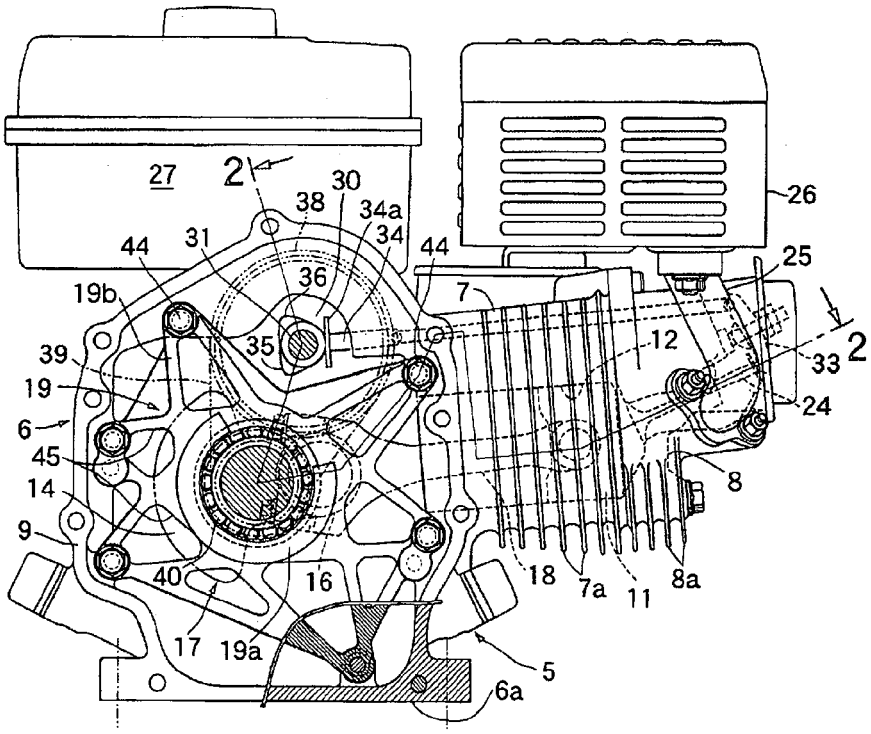

FIG. 1

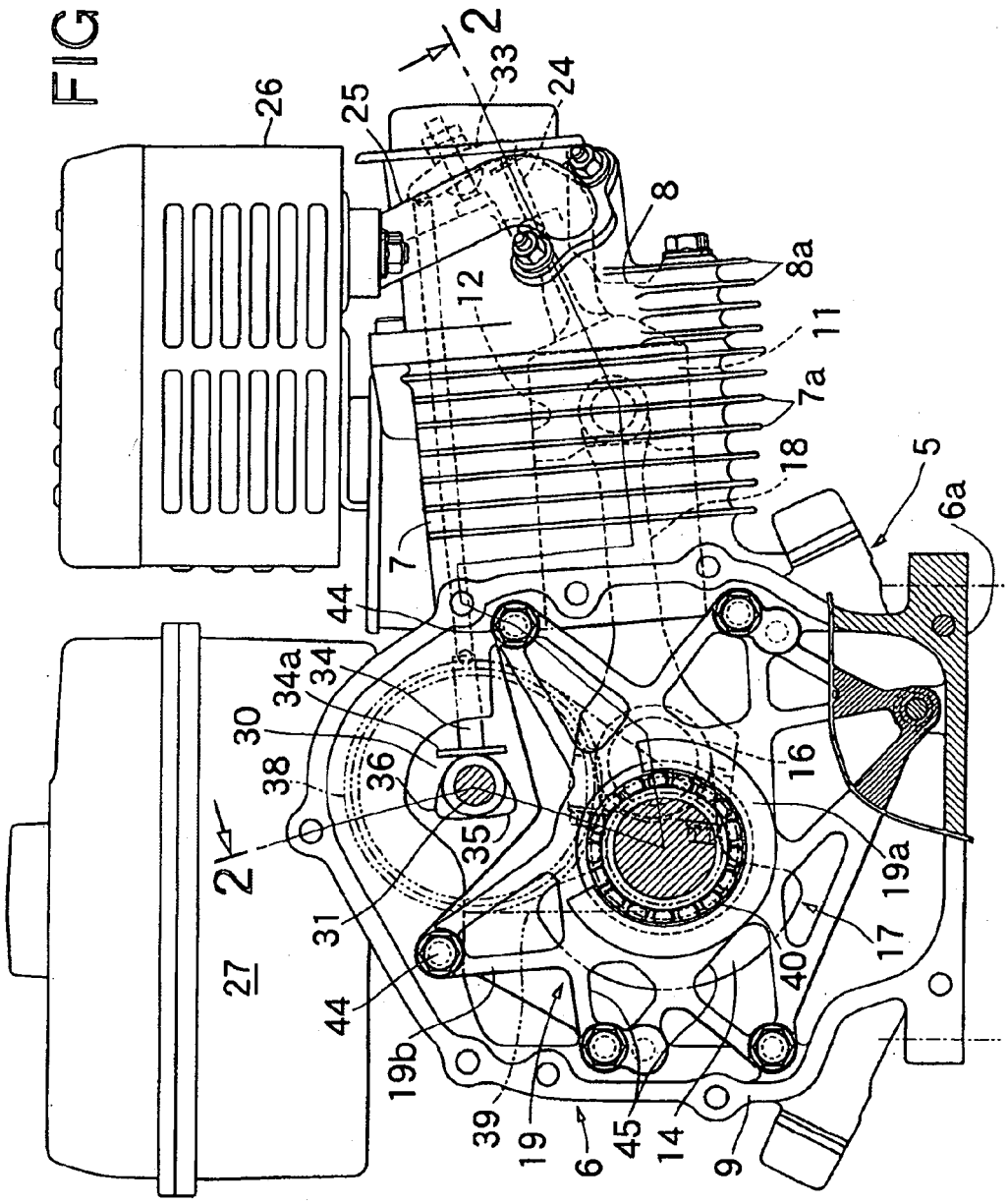
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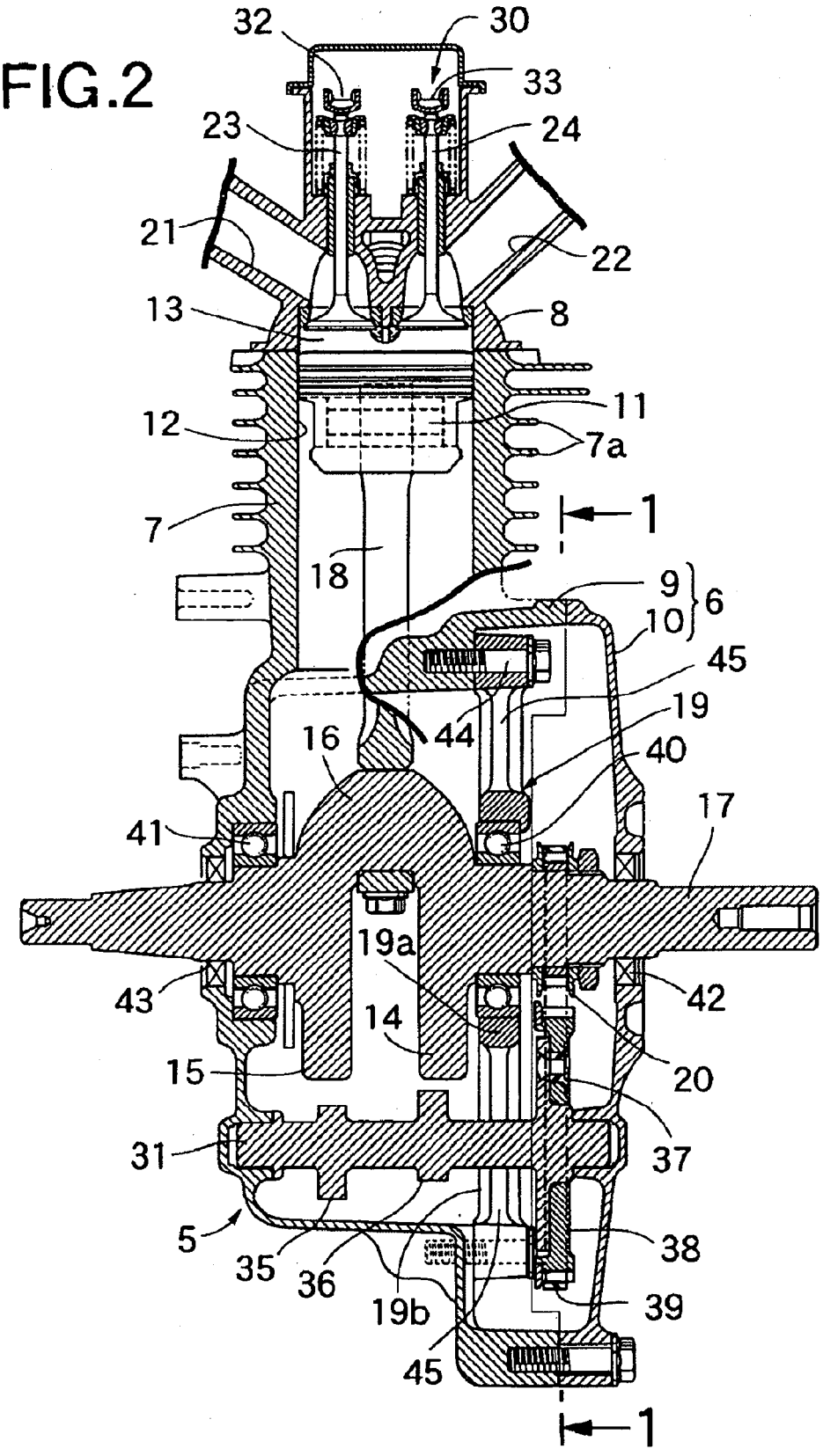
FIG.2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GENERAL PURPOSE ENGINE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a general purpose engine in which a case main body, which is a principal part of a crankcase, is integrally formed with a cylinder block, a crankshaft having a plurality of crank webs is rotatably supported via bearings in the case main body and a bearing support member mounted on the case main body, and a drive transmission wheel housed within the crankcase so as to transmit rotational power to a valve operating mechanism is fixedly provided on the crankshaft so as to be outside the crank web that, among the crank webs, is at one end in the axial direction.

2. Description of the Related Art

A general purpose engine in which a crankcase is formed from a case main body and a cover joined to the case main body, and the cover is used as a bearing support member, is already known from, for example, Japanese Patent Application Laid-open No. 2001-329910.

However, in this conventional arrangement, the cover (the bearing support member) is disposed outside a drive transmission wheel fixedly provided on a crankshaft so as to be outside a crank web that is at one end in the axial direction. Consequently, the distance between a crankpin and the cover is comparatively long, and thus the rigidity with which the crankshaft is supported is comparatively low. As a result of a load acting on the crankshaft in a direction perpendicular to the axial direction during a combustion stroke, etc., a comparatively large knocking sound is generated in a gap between the crankshaft and a bearing supported by the bearing support member.

In order to solve this problem, it is conceivable that the bearing support member, which is a separate member from the crankcase, is mounted on the case main body inside the cover, and the distance between the crankpin and the bearing support member is made comparatively short, to thereby enhance the rigidity with which the crankshaft is supported. However, when the interior of the crankcase is divided into two by means of the bearing support member, the amount of oil that can be held within the crankcase becomes small, leading to a possibility that the continuous operation time might be reduced. If an attempt is made to ensure a sufficient amount of oil, the dimensions of the crankcase, and consequently those of the general purpose engine become too large.

SUMMARY OF THE INVENTION

The present invention has been achieved in view of the above-mentioned circumstances, and it is an object thereof to provide a general purpose engine that can hold a sufficient amount of oil within a crankcase while avoiding any increase in dimensions, enhance the rigidity with which a crankshaft is supported, and suppress the generation of a knocking sound.

In order to accomplish this object, the present invention provides a general purpose engine in which a case main body, which is a principal part of a crankcase, is integrally formed with a cylinder block, a crankshaft having a plurality of crank webs is rotatably supported via bearings in the case main body and a bearing support member mounted on the case main body, and a drive transmission wheel housed within the crankcase so as to transmit rotational power to a valve operating mechanism is fixedly provided on the crankshaft so as to be outside the crank web that, among the crank webs, is at one end in the axial direction, wherein the crankcase is formed from the case main body and a cover secured to the case main body, and wherein the bearing support member, which is disposed between the drive transmission wheel and the crank web that is at one end in the axial direction, is formed into a shape that allows oil held within the crankcase to flow between opposite sides of the bearing support member and is mounted on the case main body.

In accordance with this arrangement, since the bearing support member is disposed in a position in the proximity of the crank web that is at one end in the axial direction, the rigidity with which the crankshaft is supported can be enhanced, thereby suppressing the knocking sound generated in a gap between the crankshaft and the bearing supported by the bearing support member. Moreover, since the bearing support member has a shape that can allow oil held within the crankcase to flow between opposite sides of the bearing support member, the amount of oil held within the crankcase is not be reduced due to the bearing support member being placed within the crankcase, thereby storing a sufficient amount of oil within the crankcase while avoiding any increase in the dimensions of the engine.

The above-mentioned object, other objects, characteristics, and advantages of the present invention will become apparent from an explanation of a preferred embodiment that will be described in detail below by reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** to FIG. **2** illustrate one embodiment of the present invention.

FIG. **1** is a longitudinal cross-sectional view of a general purpose engine with its cover removed, corresponding to a cross-sectional view along line **1**—**1** in FIG. **2**.

FIG. **2** is a cross-sectional view along line **2**—**2** in FIG. **1**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIG. **1** and FIG. **2**, this general purpose engine is an air-cooled single-cylinder engine used in, for example, a work machine. An engine main body **5** is formed from a crankcase **6**, a cylinder block **7** projecting at a slightly upward inclination from one side face of the crankcase **6**, and a cylinder head **8** joined to a head part of the cylinder block **7**. A large number of air-cooling fins **7***a* and **8***a* are provided on the outer side faces of the cylinder block **7** and the cylinder head **8**. The crankcase **6** is mounted on an engine bed of various types of work machine via a mounting face **6***a* which is a lower face of the crankcase **6**.

The crankcase **6** is formed from a case main body **9** and a cover **10**. The case main body **9** is a principal part of the crankcase **6** and is formed integrally with the cylinder block **7**. The cover **10** is secured to the case main body **9** so as to close an opening of the case main body **9** in a liquid-tight manner.

Formed in the cylinder block **7** is a cylinder bore **12** into which a piston **11** is slidably fitted. Formed between the cylinder block **7** and the cylinder head **8** is a combustion chamber **13** which the top of the piston **11** faces.

A crankshaft **17** has a plurality, for example, a pair, of crank webs **14** and **15**, and a crankpin **16** providing a

connection between the two crank webs **14** and **15**. The piston **11** is connected to the crankshaft **17** via a connecting rod **18** and the crankpin **16**. This crankshaft **17** is rotatably supported by the case main body **9** and a bearing support member **19** mounted on the case main body **9** via ball bearings **41** and **40**, respectively. A drive pulley **20**, which is a drive transmission wheel housed in the crankcase **6**, is fixedly provided on the crankshaft **17** so as to be outside the crank web **14** that, among the crank webs **14** and **15**, is at one end in the axial direction.

Provided in the cylinder head **8** are an intake port **21** and an exhaust port **22** that communicate with the combustion chamber **13**. Disposed in the cylinder head **8** are an intake valve **23** for opening and closing the communication between the intake port **21** and the combustion chamber **13**, and an exhaust valve **24** for opening and closing the communication between the exhaust port **22** and the combustion chamber **13**. An exhaust pipe **25** has its upstream end connected to the exhaust port **22** and its downstream end connected to an exhaust muffler **26** that is supported by and disposed above the cylinder block **7**. Disposed above the case main body **9** of the crankcase **6** is a fuel tank **27** which is supported by the case main body **9**.

A valve operating mechanism **30** for opening and closing the intake valve **23** and the exhaust valve **24** is formed from a camshaft **31**, an intake rocker arm **32**, an exhaust rocker arm **33**, and pushrods **34**. The camshaft **31** is rotatably supported in the crankcase **6** so as to have an axis parallel to the crankshaft **17**. The intake rocker arm **32** is rockably supported in the cylinder head **8** so as to have one of its ends abutting against the intake valve **23** which is spring-biased in a closing direction. The exhaust rocker arm **33** is rockably supported in the cylinder head **8** so as to have one of its ends abutting against the exhaust valve **24** which is spring-biased in a closing direction. Each of the pushrods **34** has one end abutting against the other end of the corresponding one of the rocker arms **32** and **33**, and follows the rotation of the camshaft **31** so as to operate in the axial direction.

An intake cam **35** and an exhaust cam **36** are integrally formed on the camshaft **31**. The pushrods **34** run through the cylinder block **7** in an axially movable manner, and are disposed between the cylinder head **8** and the crankcase **6**. Provided on the other end of each of the pushrods **34** is a sliding-contact plate **34***a* which is in sliding contact with the corresponding one of the intake cam **35** and the exhaust cam **36**.

The two pushrods **34** operate in the axial direction in accordance with the cam profile of the corresponding cams **35** and **36** in response to rotation of the camshaft **31**. As a result, the intake valve **23** and the exhaust valve **24** are driven to open and close with operating characteristics corresponding to the cam profile of the intake cam **35** and the exhaust cam **36**.

Power is transmitted to this valve operating mechanism **30** from the drive pulley **20**. An endless timing belt **39** is wound around the drive pulley **20** and a driven pulley **38** which is mounted on the camshaft **31** via a damper rubber **37** at a position corresponding to the drive pulley **20**. The rotational power of the crankshaft **17** is transmitted to the camshaft **31** at a reduction ratio of 1/2.

The bearing support member **19** is mounted on the case main body **9** between the drive pulley **20** and the crank web **14** which, among the crank webs **14** and **15** of the crankshaft **17**, is at one end in the axial direction, that is, at a position so that the drive pulley **20** is interposed between the bearing support member **19** and the cover **10**. One end of the crankshaft **17** runs rotatably through the bearing support member **19** and the cover **10**. The ball bearing **40** is disposed between the bearing support member **19** and the crankshaft **17**. An annular seal **42** is disposed between the cover **10** and the crankshaft **17**. The other end of the crankshaft **17** runs rotatably through the case main body **9**. The ball bearing **41** is disposed between the case main body **9** and the crankshaft **17**. An annular seal **43** is disposed outside the ball bearing **41**.

The bearing support member **19** is formed integrally from an annular support portion **19***a* and a mounting portion **19***b* projecting radially outward from the support portion **19***a*. The annular support portion **19***a* supports the ball bearing **40**. The bearing support member **19** is mounted on the case main body **9** by means of bolts **44** at a plurality of, for example, six positions spaced in the circumferential direction on the outer periphery of the mounting portion **19***b*. The mounting portion **19***b* is formed so that sections between the plurality of positions where the bolts are inserted through are indented toward the support portion **19***a*. A plurality of through holes **45** are also formed in the mounting portion **19***b*.

That is, the bearing support member **19** is formed into a webbed shape that allows oil held within the crankcase **6** to flow between opposite sides of the bearing support member **19** through the through holes **45**. See FIG. 1. The camshaft **31**, which has opposite ends rotatably supported by the case main body **9** and the cover **10** of the crankcase **6**, is also disposed so as to run through an empty space formed between the bearing support member **19** and the case main body **9**.

The operation of this embodiment is now explained. The crankcase **6** is formed from the case main body **9** and the cover **10** joined to the case main body **9**, the case main body **9** being integrally formed with the cylinder block **7**. The crankshaft **17** having the pair of crank webs **14** and **15** is rotatably supported by the bearing support member **19** and the case main body **9** via the ball bearings **40** and **41**, respectively. The bearing support member **19** is disposed between the drive pulley **20** and the crank web **14** that, among the crank webs **14** and **15**, is at one end in the axial direction, the drive pulley **20** being housed within the crankcase **6** and fixed to the crankshaft **17** so as to transmit rotational power to the valve operating mechanism **30**. As a result, the bearing support member **19** is disposed at a position in the proximity of the crank web **14** that is at one end in the axial direction, thus enhancing the rigidity with which the crankshaft **17** is supported and suppressing the knocking sound generated in a gap between the crankshaft **17** and the ball bearing **40** supported by the bearing support member **19**.

Moreover, since the bearing support member **19** is formed into the shape that allows oil held within the crankcase **6** to flow between opposite sides of the bearing support member **19** through the through holes **45**, the amount of oil held within the crankcase **6** is not be reduced due to the bearing support member **19** being placed within the crankcase **6**, thereby storing a sufficient amount of oil within the crankcase **6** while avoiding any increase in the dimensions of the engine.

Although an embodiment of the present invention is explained in detail above, the present invention is not limited to this embodiment, and the present invention can be modified in a variety of ways without departing from the subject matter of the present invention.

For example, in the above-mentioned embodiment, a single-cylinder general purpose engine is explained, but the

present invention is also applicable to a multi-cylinder general purpose engine.

What is claimed is:

1. A general purpose engine comprising:

a crankcase comprising a case main body as a principal part thereof;

a cylinder block with which the case main body is integrally formed;

a crankshaft having a plurality of crank webs;

bearings;

a bearing support member mounted on the case main body, the crankshaft being rotatably supported via the bearings in the bearing support member and the case main body;

a valve operating mechanism; and

a drive transmission wheel housed within the crankcase so as to transmit rotational power to the valve operating mechanism, the drive transmission wheel being fixedly provided on the crankshaft so as to be outside the crank web that, among the crank webs, is at one end in the axial direction;

wherein the crankcase comprises the case main body and a cover secured to the case main body;

wherein the bearing support member, which is formed with a plurality of through holes and is disposed between the drive transmission wheel and the crank web that is at one end in the axial direction, is formed into a shape that allows oil held within the crankcase to flow between opposite sides of the bearing support member through the through holes and is mounted on the case main body,

wherein the bearing support member is formed from an annular support portion for supporting one of the bearings and a mounting portion integrally projecting radially outward from the support portion and having circumferentially paced projecting portions.

2. The general purpose engine according to claim 1, wherein the mounting portion comprises said plurality of through holes.

3. The general purpose engine according to claim 1, wherein the bearing support member is mounted on the case main body at said circumferentially spaced projecting portions.

4. The general purpose engine according to claim 3, wherein the mounting portion is formed so that sections between the circumferentially spaced projecting portions are indented toward the support portion.

5. The general purpose engine according to claim 1, wherein the bearing support member is formed into a webbed shape.

* * * * *

US006525430B1

(12) **United States Patent**
Asai et al.

(10) **Patent No.: US 6,525,430 B1**
(45) **Date of Patent: Feb. 25, 2003**

(54) **PORTABLE ENGINE GENERATOR HAVING A FAN COVER WITH A CONTROL UNIT MOUNTING PORTION**

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(52) **U.S. Cl.** ..... **290/1 A**; 322/1; 123/41.56

(58) **Field of Search** ..... 290/1 R, 1 C, 290/1 A; 123/41.56, 41.65, 7, 2

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,919,620	A *	11/1975	McMurray et al.	321/13
5,287,831	A *	2/1994	Andersen et al.	123/179.3
5,636,606	A *	6/1997	Tsunoda et al.	123/185.3
5,943,221	A *	8/1999	Asai et al.	363/10
5,977,667	A *	11/1999	Hirose	310/51
6,028,369	A *	2/2000	Hirose et al.	290/1 A
6,084,313	A *	7/2000	Frank	290/40 C
6,100,599	A *	8/2000	Kouchi et al.	290/1 A
6,124,702	A *	8/2000	Pinkerton et al.	322/90
6,119,636	A *	9/2000	Fan	123/2
6,181,019	B1 *	1/2001	Frank	290/1 A
6,192,840	B1 *	2/2001	Durr et al.	123/195 R
D441,714	S *	5/2001	Yuzuriha	D13/116
6,232,672	B1 *	5/2001	Leufen et al.	290/1 A
6,331,740	B1 *	12/2001	Morohoshi et al.	123/41.56
6,362,533	B1 *	3/2002	Morohoshi et al.	123/41.56

FOREIGN PATENT DOCUMENTS

JP	359108826 A	*	6/1984
JP	63171632		11/1988
JP	6-11535		3/1994

* cited by examiner

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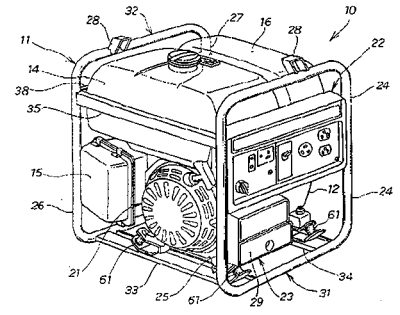
(57) **ABSTRACT**

An engine generator comprises a fan cover made of die-cast aluminum alloy, and a power control unit including an aluminum base sheet. The base sheet has a power control circuit formed thereon. The fan cover includes a mounting portion to be attached to the power control unit. When the power control unit is attached to the fan cover, a surface of the aluminum base sheet comes into intimate contact with an outer surface of the mounting portion. Heat generated at the unit is transmitted to the fan cover, and then released from the fan cover serving as a heat releasing member.

18 Claims, 10 Drawing Sheets



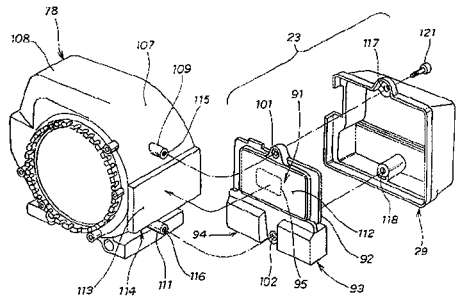


FIG. 1

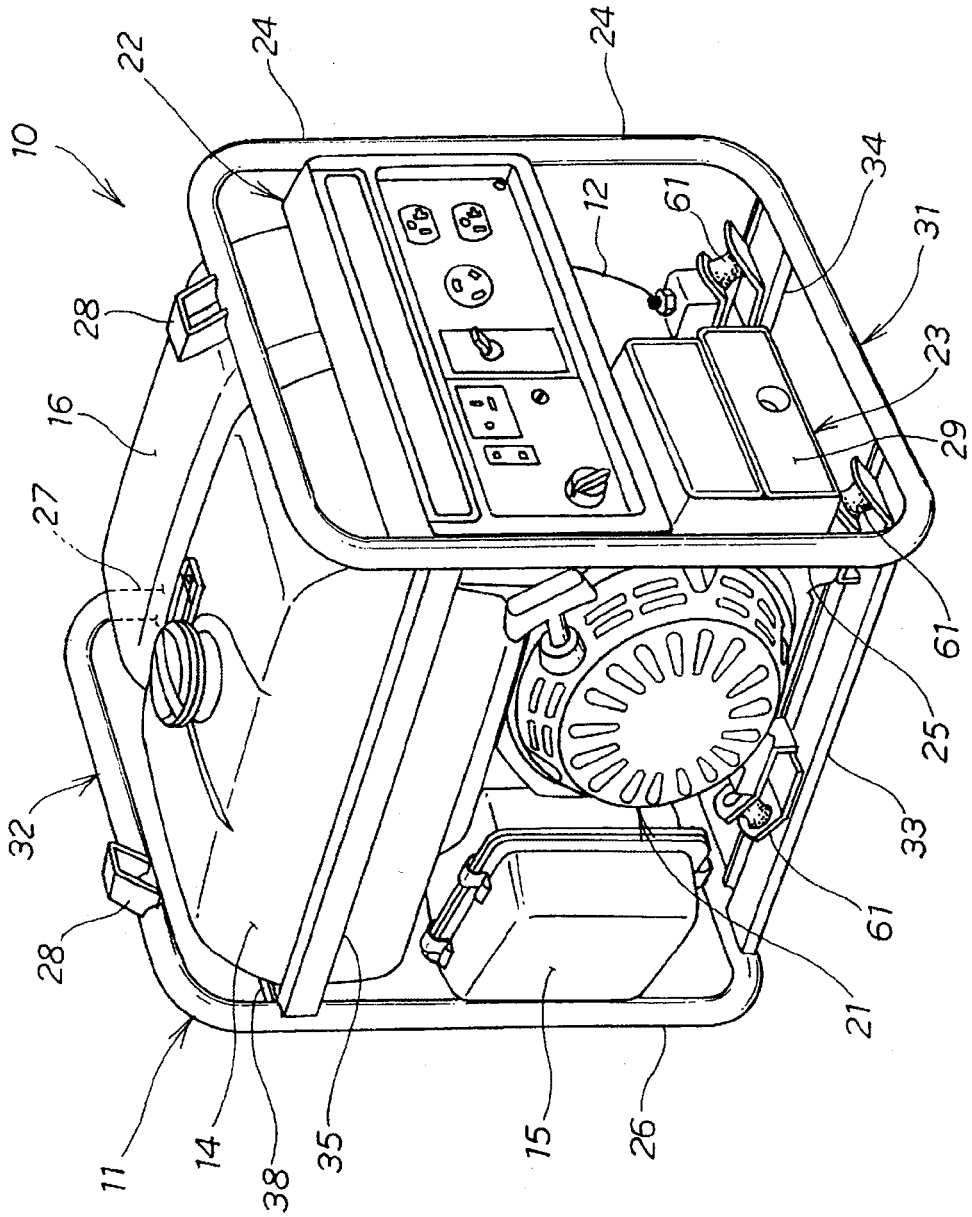

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FIG. 2

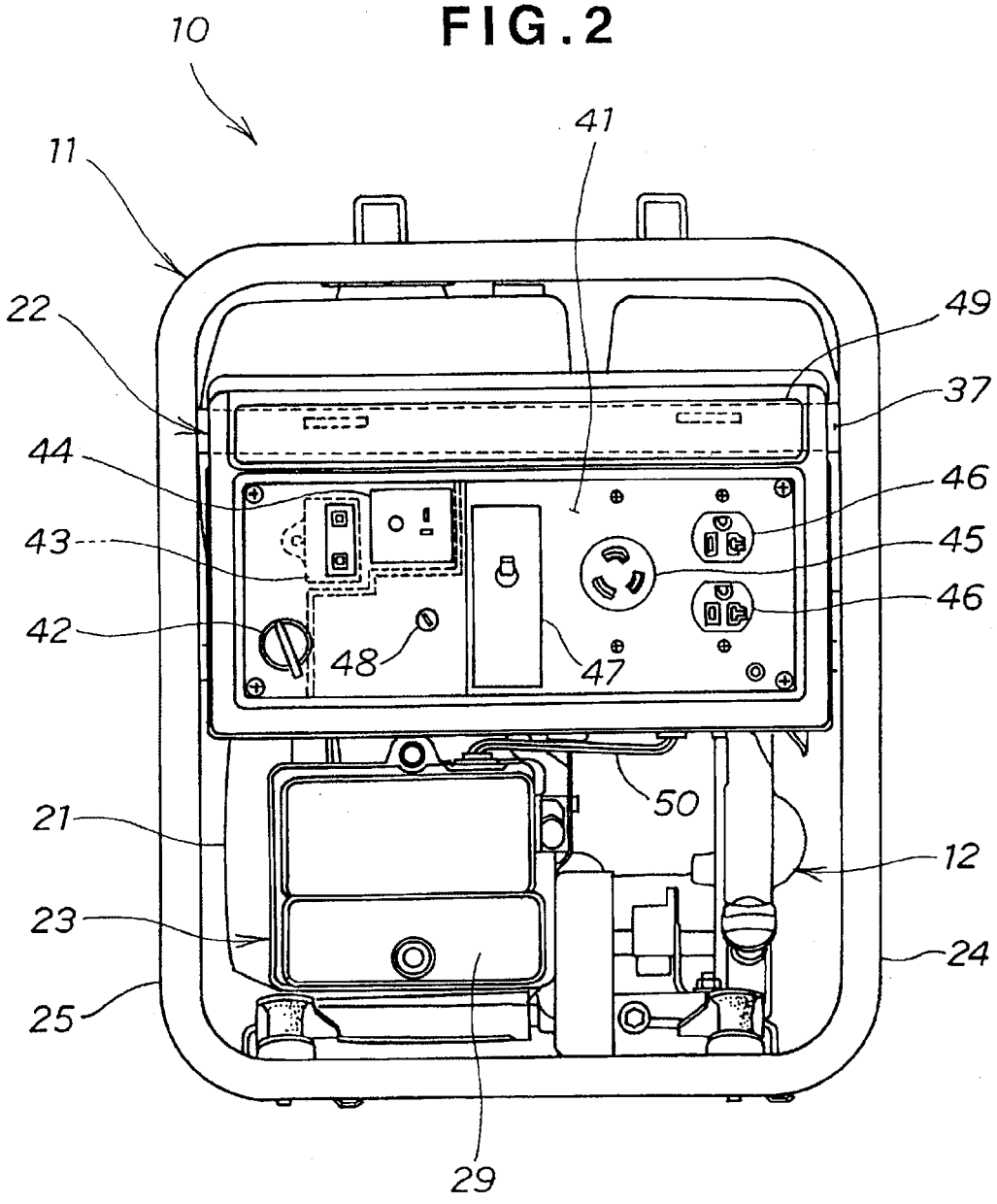

FIG. 3

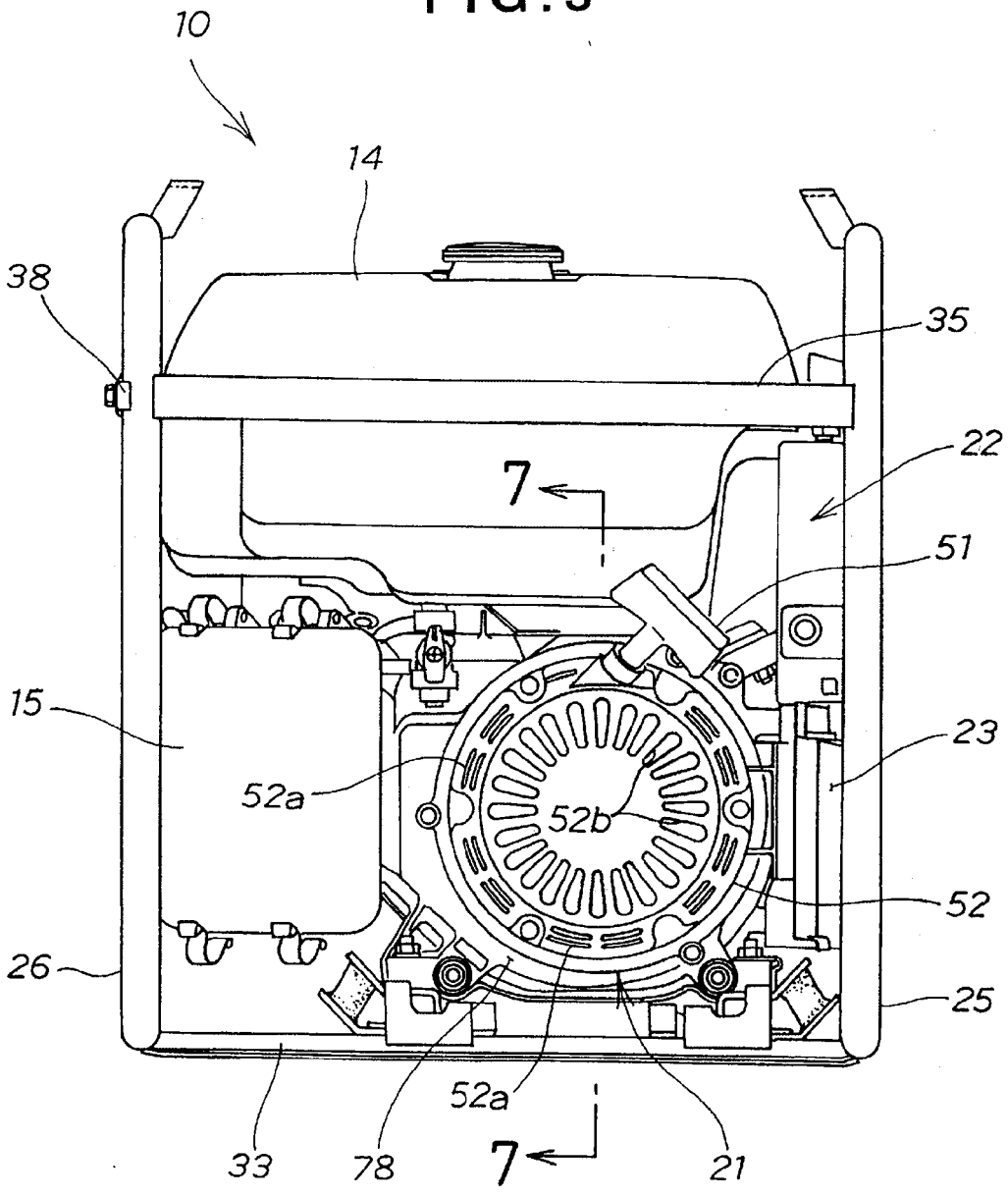

FIG. 4

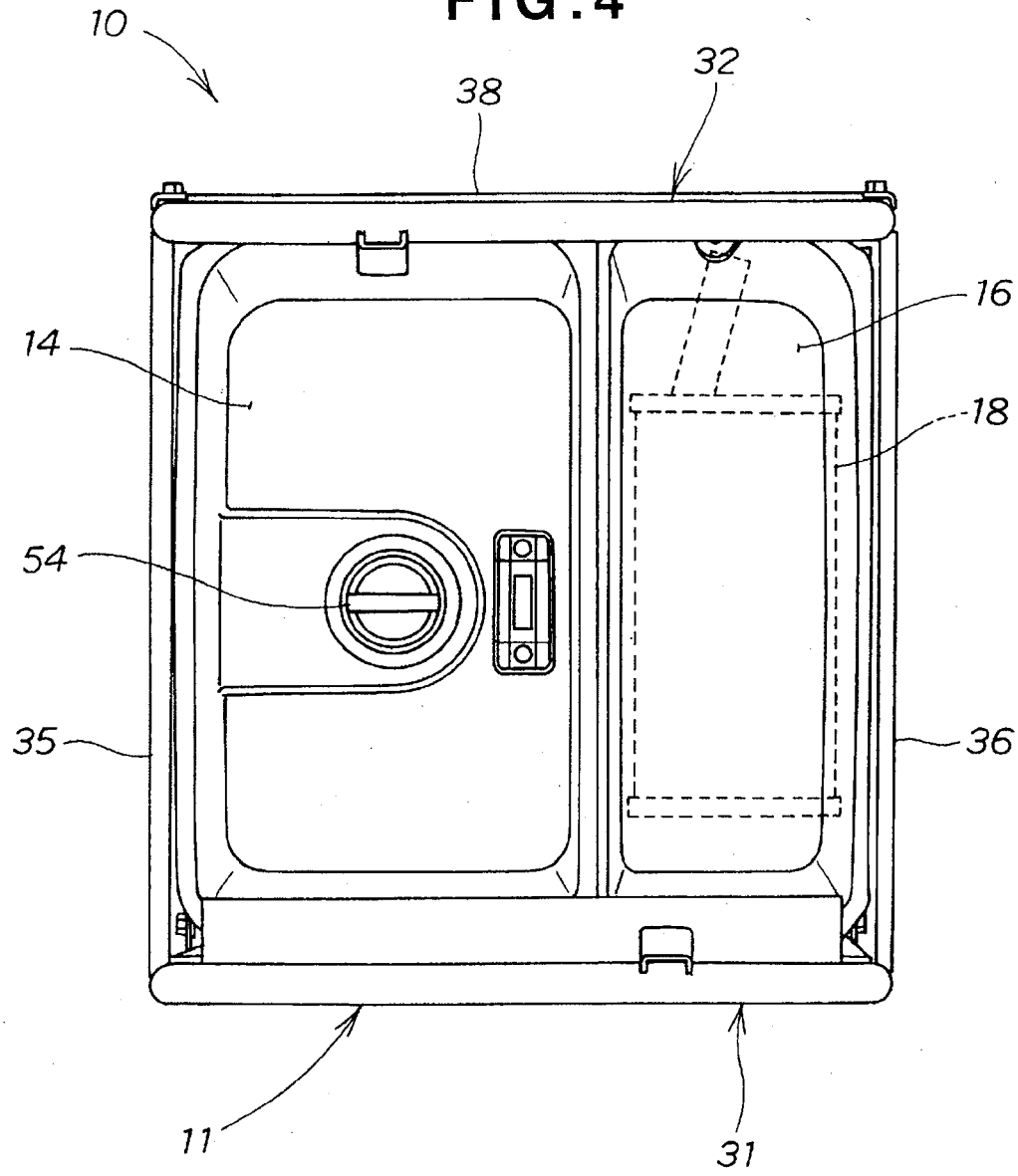

FIG. 5

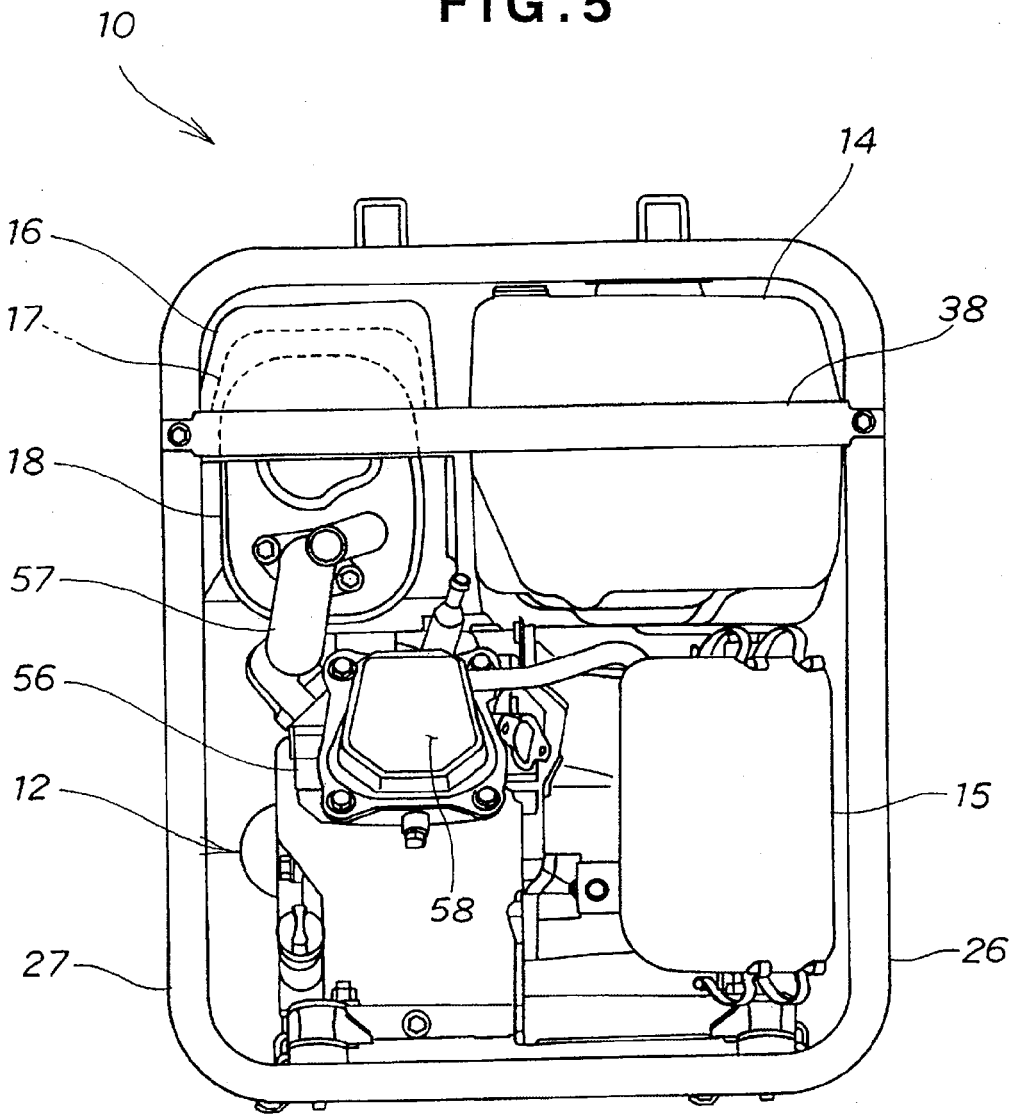

FIG. 6

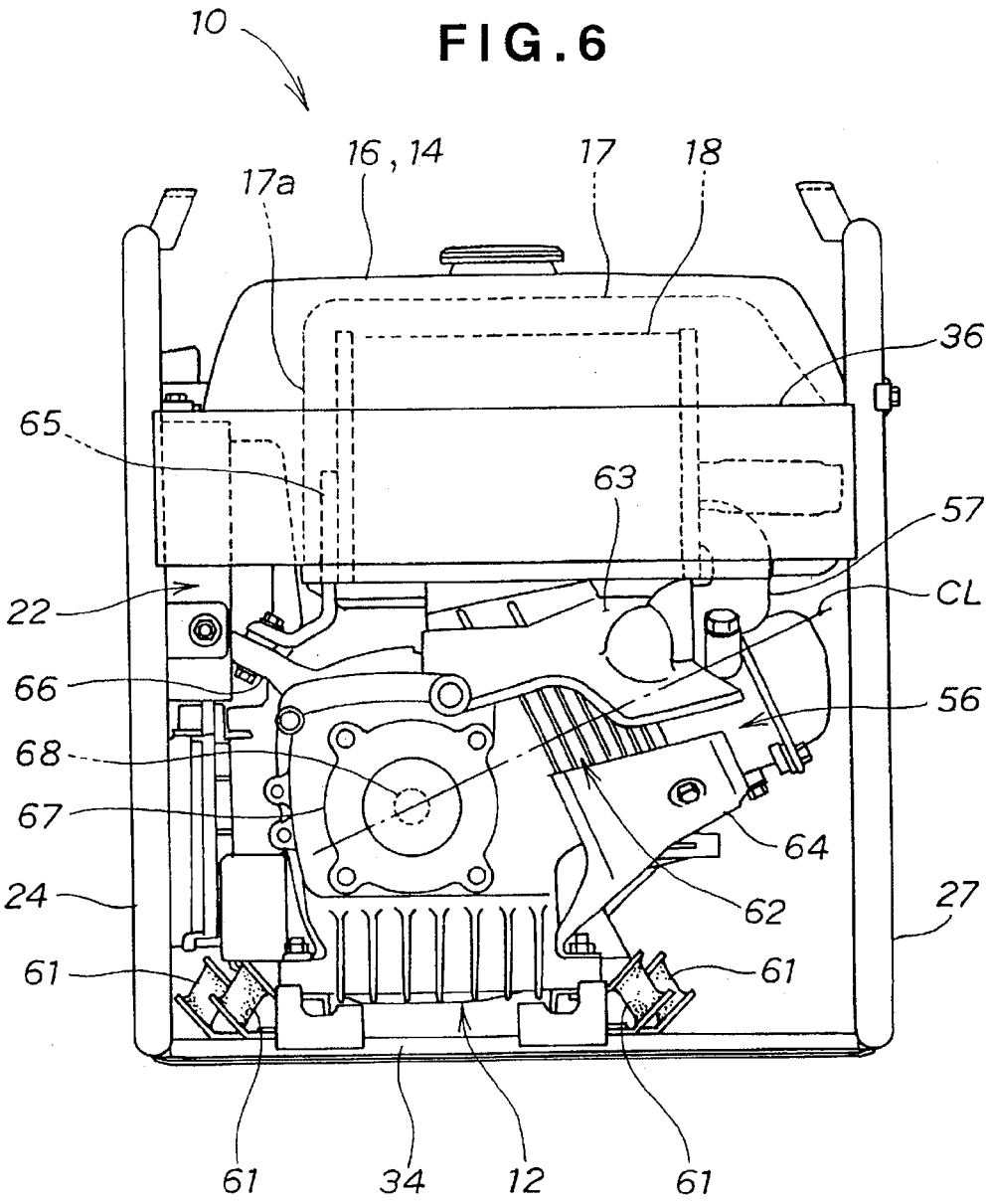
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FIG. 7

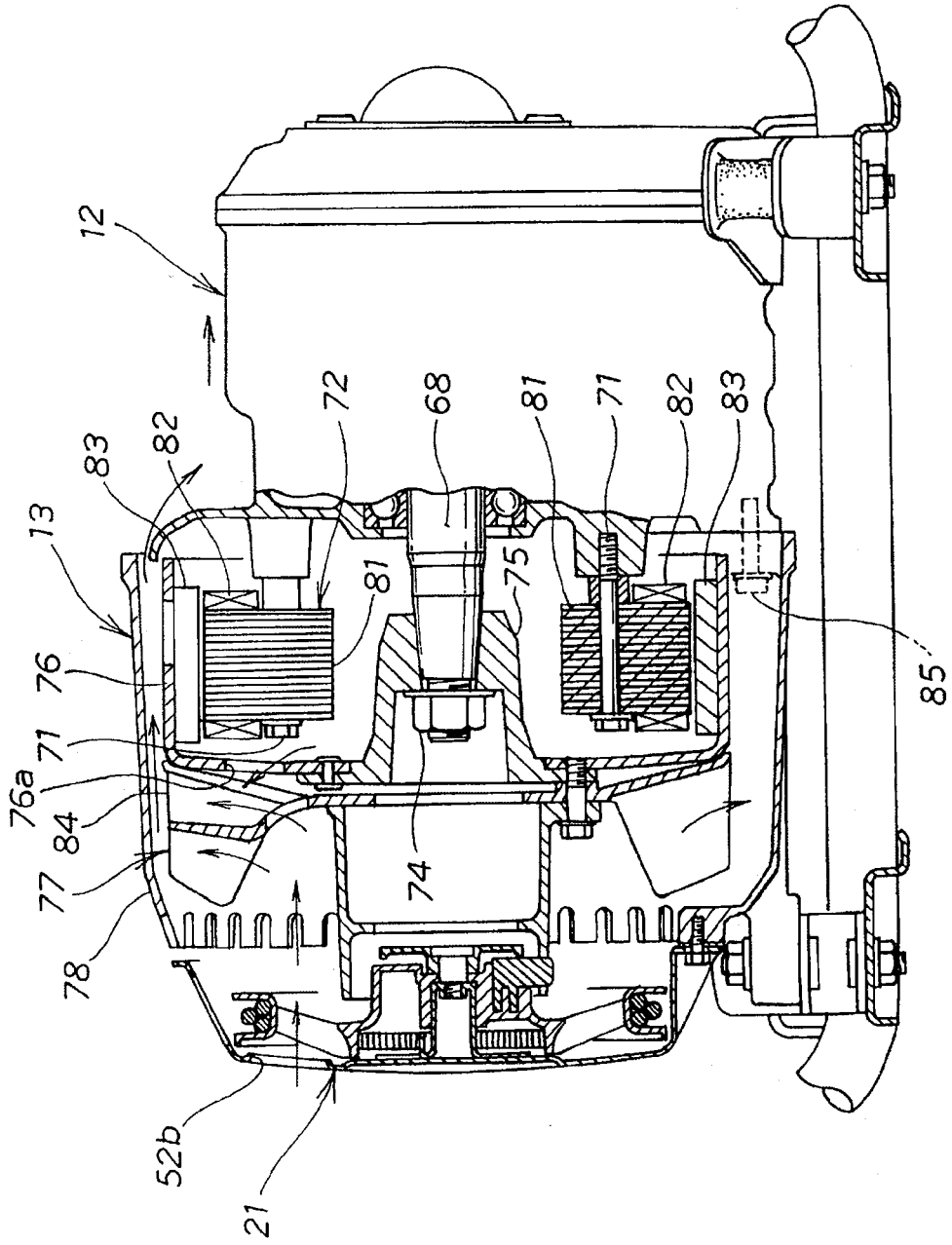
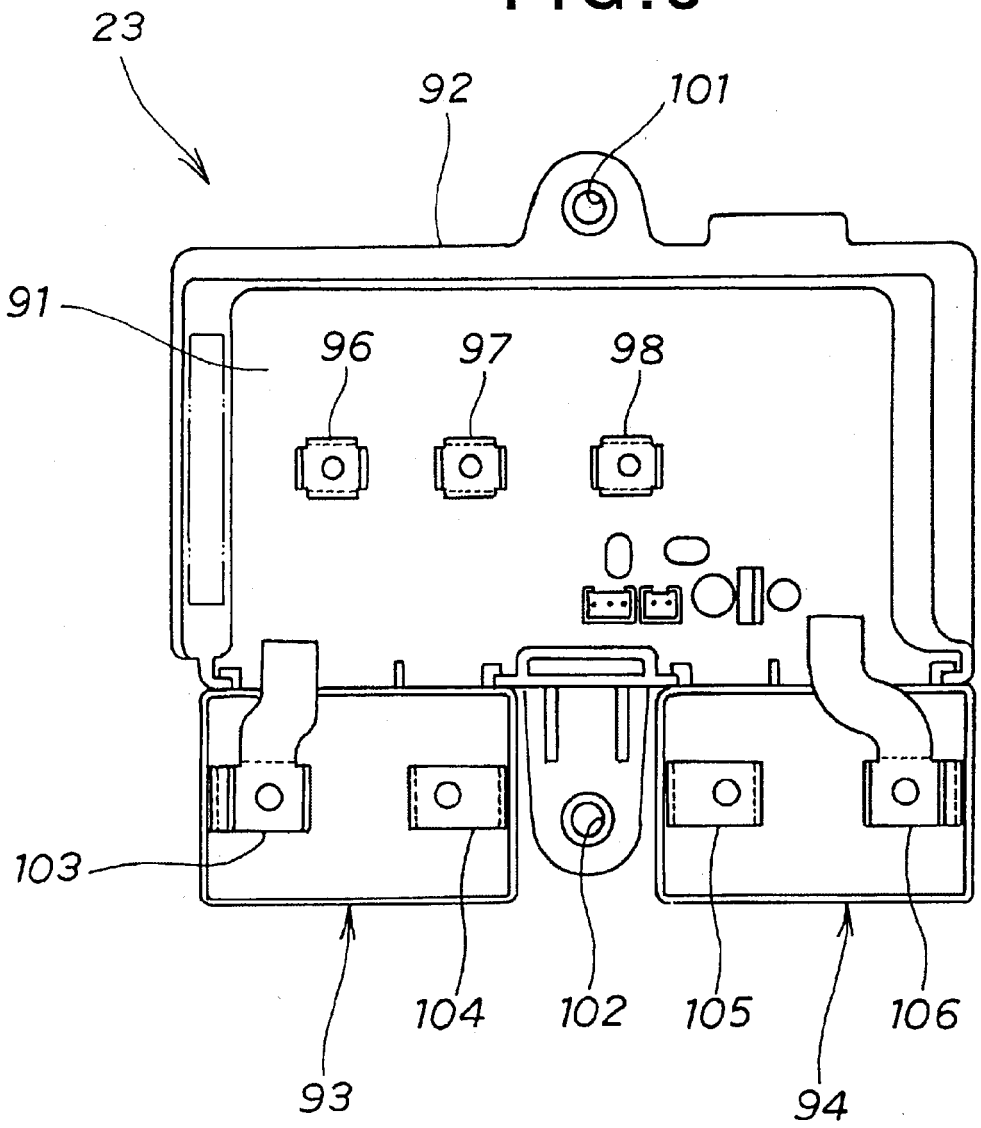


FIG. 8



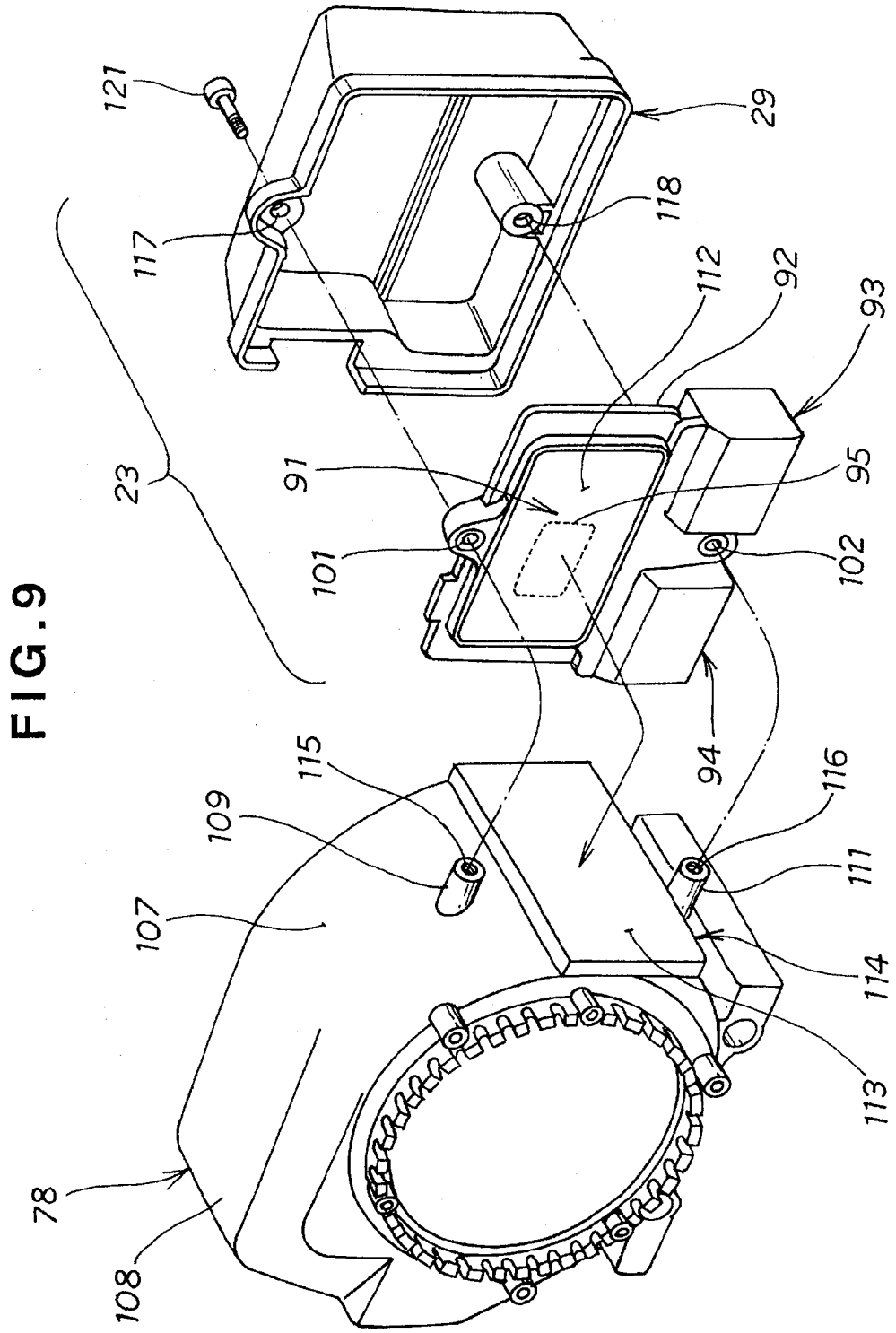

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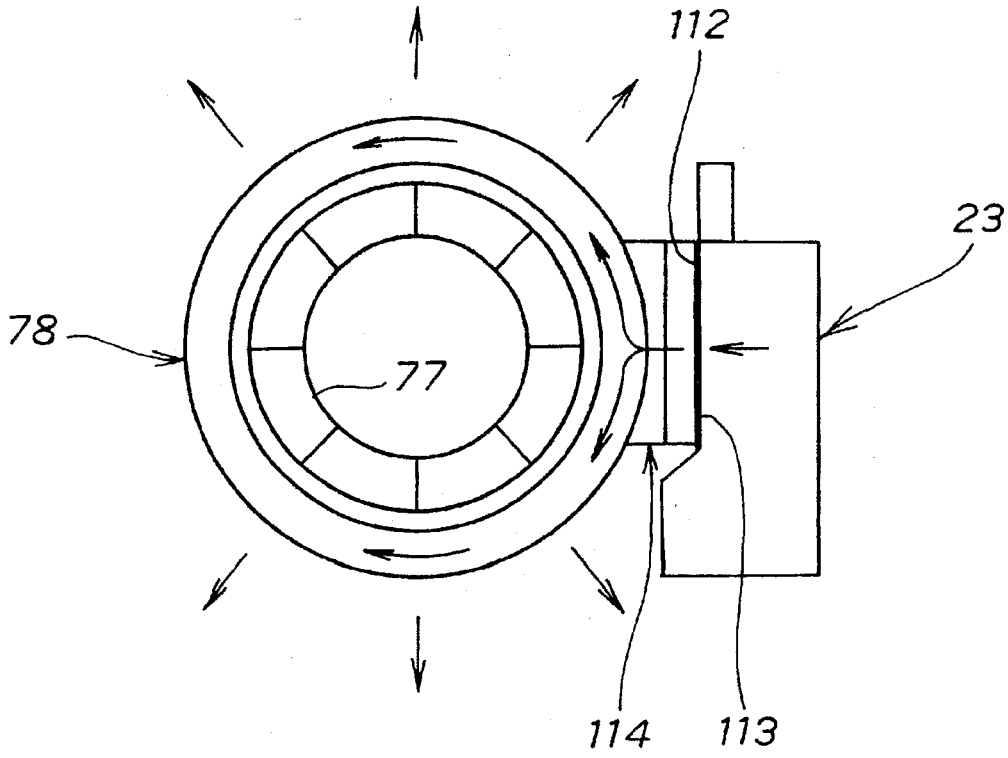
FIG. 9

FIG.10



PORTABLE ENGINE GENERATOR HAVING A FAN COVER WITH A CONTROL UNIT MOUNTING PORTION

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an engine generator suitable for preventing temperature rise in a power control unit of the generator.

2. Description of the Related Art

Engine generators are used outdoors as general-purpose power supplies. In recent years, there has been an increased demand for outputs of such engine generators to be controlled by a power control unit such as an inverter.

Such a power control unit includes a circuit board on which an electric circuit for controlling power supplied from an engine generator is provided. When the electric circuit is supplied with a large electric current, the board produces a large amount of heat. Therefore, it becomes necessary for the thus-heated board to be cooled down.

Technique for cooling the above-described circuit board is known from, for example, Japanese Utility Model Laid-Open Publication No. SHO-63-171632 entitled "PORTABLE ENGINE GENERATOR" and Japanese Utility Model Post-Exam Publication No. HEI-6-11535 entitled "ELECTRONIC COMPONENT UNIT".

The engine generator disclosed in the Publication No. SHO-63-171632 includes an end surface cover forming therein openings for taking in air, and a box member having an outer surface facing towards the end surface cover. The box member accommodates therein a control circuit unit. On the outer surface of the box member, there are provided a plurality of heat releasing fins. The adjacent fins define an intake passage therebetween. Air taken into the openings flows through the respective intake passages. With this arrangement, when the control circuit unit generates heat, the heat is transmitted to the box member. The box member is cooled by the air passing through the intake passages as described above.

The Publication No. HEI-6-11535 discloses an electronic component unit including a case of aluminum accommodating therein a base sheet on which plural electronic components are mounted. The case is filled with hardened resin to cover the base sheet. With this arrangement, heat generated by the base sheet is released by means of the case having improved thermal conductivity.

As disclosed in the Publication No. SHO-63-171632, the air is directed against the outer surface of the box member to thereby cool the box member having the control circuit accommodated therein. However, when the engine generator supplies large power to thereby cause the control circuit unit to generate a large amount of heat, the box member can not be sufficiently cooled because the outer surface of the box member having the fins provided thereon provides limited area. As a result, the control circuit unit is difficult to cool.

Also, when the electronic components as disclosed in the Publication No. HEI-6-11535 provide large power to thereby generate a large amount of heat, it is required that the surface of the case serving as a heat releasing sheet have an enlarged area or that a separate heat releasing sheet of large size be added to the base sheet such that the case can effectively release the heat therefrom. In such a case, however, the electronic component unit is inevitably made large in size.

SUMMARY OF THE INVENTION

An object of the present invention is to provide an engine generator including a power control unit and a heat releasing member which is formed from an existent member to thereby downsize the unit and which is disposed to effectively cool the unit to thereby prevent the temperature of the unit from rising.

According to an aspect of the present invention, there is provided an engine generator carrying thereon an engine and a generator driven by the engine, the engine generator comprising: a cooling fan mounted on a rotational shaft of the generator; a fan cover for covering the cooling fan; a power control unit including an aluminum base sheet forming thereon a power control circuit for controlling an output from the generator; the fan cover being made of die-cast aluminum alloy; the power control unit being attached to the fan cover with a surface of the aluminum base sheet intimately contacting an outer surface of the fan cover.

Heat generated by the control circuit unit is transmitted to the fan cover made of die-cast aluminum alloy. The heat is then released from the fan cover. The fan cover intimately contacts the surface of the aluminum base sheet of the power control. The cooling fan directs cooling air against the fan cover.

Since the surface of the aluminum base sheet intimately contacts the fan cover, the heat generated by the power control circuit can be efficiently transmitted to the fan cover. In addition, the cooling fan directs cooling air against the fan cover during the operation of the power control unit. Thus, the heat can be effectively released from the fan cover to thereby prevent temperature of the power control unit from rising.

The fan cover for covering the cooling fan serves as a heat releasing member for the power control unit. This eliminates the need to provide the power control unit with a separate heat releasing member of large size such as the heat releasing fins. Thus, it becomes possible to downsize the power control unit as well as to make small the number of parts forming the engine generator. Consequently, the cost of the engine generator can be reduced.

In a preferred form of the invention, the fan cover has a thick mounting portion formed thereon, the mounting portion having a flat outer surface to be attached to the surface of the aluminum base sheet.

The heat generated at the unit is transmitted from the surface of the aluminum base sheet of the unit to the entire fan cover through the thick mounting portion having the flat outer surface.

Since the mounting portion of the fan cover is made thick to thereby increase heat capacity thereof, the transmission of the heat to the fan cover is improved. It thus becomes possible to prevent the temperature of the unit from rising.

Moreover, the flat mounting portion is advantageous in that the intimate contact between the unit and the surface of the aluminum base sheet can be readily effected, and in that the mounting portion can be easily formed.

In a further preferred form of the present invention, the generator has a flywheel structure including an outer rotor fixed to the rotational shaft, the outer rotor having the cooling fan mounted thereon, and the fan cover for covering the cooling fan has a cylindrical configuration and is opener at opposite end portions either of which is secured to the engine and discharges cooling air therefrom.

The cooling fan directs cooling air along the cylindrical fan cover towards the engine to thereby cool the engine.

The cooling air is continuously taken into the fan cover of cylindrical configuration. The fan cover has the inner surface exposed to the cooling air. Therefore, heat transmitted to the fan cover can be effectively released therefrom.

In a still further preferred form of the present invention, the outer rotor includes permanent magnets, the cooling fan is formed from a centrifugal fan, the outer rotor and an inner surface of the fan cover define a passageway therebetween, and the cooling air is forced to flow through the passageway towards the engine.

The outer rotor includes the permanent magnets and the cooling fan is formed from the centrifugal fan. With this arrangement, the cooling air is directed radially outwardly from inside the cooling fan. The air is then forced to flow through the passageway, defined between the outer rotor and the inner surface of the fan cover, towards the engine.

Thus, since a large amount of cooling air is directed against the inside of the peripheral surface of the fan cover, the fan cover can be effectively cooled.

In a still further preferred form of the present invention, the power control unit is a cycloconverter unit or an inverter unit for converting an output from the generator into a power having a predetermined frequency.

The inverter unit or the cycloconverter unit converts the output from the generator into a power having a predetermined frequency.

An inverter or cycloconverter generates a large amount of heat corresponding to power loss caused when controlling a large power supplied from the generator. It was therefore difficult to reduce the size of a conventional inverter or cycloconverter unit. However, since the present invention employs the unit attached to the fan cover, the size of the unit can be reduced to ½to ⅓of the size of the conventional unit.

BRIEF DESCRIPTION OF THE DRAWINGS

A certain preferred embodiment of the present invention will hereinafter be described in detail, by way of example only, with reference to the accompanying drawings, in which:

FIG. **1** is a perspective view of an engine generator according to the present invention;

FIG. **2** is a front elevational view of the engine generator;

FIG. **3** shows the engine generator as viewed from a side on which a recoil starter is provided;

FIG. **4** is a top plan view of the engine generator;

FIG. **5** is a rear elevational view of the engine generator;

FIG. **6** shows the engine generator as viewed from a side on which an engine is provided;

FIG. **7** is a cross-sectional view taken along line **7**—**7** of FIG. **3**;

FIG. **8** shows a cycloconverter unit of the engine generator with a converter cover removed;

FIG. **9** shows in perspective a fan cover and the cycloconverter unit exploded; and

FIG. **10** shows how the fan cover is operated to release heat generated by the cycloconverter.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The following description is merely exemplary in nature and is in no way intended to limit the invention or its application or uses.

Referring to FIG. **1**, an engine generator **10** for use as a general-purpose power supply includes a frame **11** formed from a pipe frame, an engine **12**, a generator **13** (see FIG. **7**) driven by the engine **12**, a fuel tank **14** for storing fuel for the engine **12**, an air cleaner **15** connected to the engine **12**, a muffler **18** (see FIG. **5**) connected to the engine **12** and covered with an upper cover **16**, a recoil starter **21** for starting the engine **12**, a control box **22** to which an output from the generator **13** is input, and a cycloconverter unit **23** for use as a power control unit for converting an output from the generator **13** into a power having a predetermined frequency. The control box **22** accommodates therein an ignition control device **43** (see FIG. **2**) for the engine **12** and the like. The air cleaner **15** is provided on an intake side of the engine **12**. The muffler **18** is provided on an exhaust side of the engine **12**. The power control unit may employ an inverter unit in lieu of the cycloconverter unit **23**. All the engine **12**, the generator **13**, the fuel tank **14**, the air cleaner **15**, the muffler **18**, the recoil starter **21**, the control box **22**, and the cycloconverter unit **23** are attached to the frame **11**.

As shown in FIG. **1**, the engine generator **10** includes the control box **22** provided forwardly thereof.

The frame **11** comprises front and rear frames **31**, **32** provided forwardly and rearwardly of the engine generator **10**, respectively, lower longitudinal beams **33**, **34** each laid between the front and rear frames **31**, **32**, upper longitudinal beams **35**, **36** (best shown in FIG. **4**) each laid between the front and rear frames **31**, **32**, a front lateral beam **37** (see FIG. **2**) laid between upper portions of the front frame **31**, and a rear lateral beam **38** laid between upper portions of the rear frame **32**. The front and rear frames **31**, **32** have rectangular configurations.

The front frame **31** includes vertical portions **24**, **25** while the rear frame **32** includes vertical portions **26**, **27**. Reference numerals **28**, **28** denote positioning support portions provided on the front and rear frames **31**, **32**. By virtue of the positioning support portions **28**, **28**, a plurality of the engine generators **10** can be stacked with the support portions **28**, **28** engaged with the lower longitudinal beams **33**, **34**. Denoted by reference numeral **29** is a converter cover for use as a cover of the cycloconverter unit **23**.

With reference to FIG. **2**, the control box **22** has an operational panel **41** attached to a front side thereof. On the panel **41**, there are mounted an engine switch **42** for an ignition system for placing the ignition system in an ON state, an ignition control device **43** for controlling ignition timing, a battery charge outlet **44** for providing a dc output to charge a battery disposed outside the engine generator **10**, a first outlet **45** for outputting a large alternating current, second outlets **46**, **46** for outputting small alternating currents each of which is smaller than the alternating current output from the first outlet **45**, a circuit breaker **47** for blocking the flow of currents which are output from the first and second outlets **45**, **46** and have levels exceeding a predetermined level, and a frequency switch **48** for switching to 50 or 60 Hz the frequencies of currents output from the first and second outlets **45**, **46**. A sticker **49** for showing the names of a manufacturer and a model of the control box **22** is stuck on the control box **22**. The control box **22** includes inner components electrically connected to the cycloconverter unit **23** through a wire **50**.

As shown in FIG. **3**, the recoil starter **21** includes a pulley attached via a one-way clutch to a crankshaft **68** of the engine **12** provided behind the recoil starter **21**. The pulley has a wire wound thereon. The wire includes its end connected to a handle **51**. With this arrangement, when the handle **51** is pulled, the crankshaft **68** is rotated to thereby start the engine **12**. The recoil starter **21** includes its rotating

part covered with a cover **52**. The cover **52** has plural slits **52***a*, **52***b* into which air is introduced.

Turning to FIG. **4**, the fuel tank **14** and the muffler **18** are disposed in lateral alignment with each other.

The fuel tank **14** has front and rear parts thereof mounted to the front lateral beam **37** (see FIG. **2**) and the rear lateral beam **38**, respectively. The fuel tank **14** includes an opening into which a fuel is poured. Such an opening is closed by a cap **54**.

Reference is made to FIG. **5**. The engine **12** has a cylinder head **56** attached to an exhaust pipe **57**. The exhaust pipe **57** is mounted to the muffler **18**. The engine **12** includes a head cover **58**.

The muffler **18** has an upper part thereof covered with a heatproof cover **17** disposed such that heat generated by the muffler **18** can not be transmitted to the fuel tank **14** and parts provided in the vicinity of the muffler **18**. The cover **17** includes an upper part thereof covered with the upper cover **16**.

As shown in FIG. **6**, the engine **12** and the generator **13** are mounted to the lower longitudinal beams **34**, **33** through mounting brackets **61**.

The engine **12** has a cylinder portion **62** inclined rearwardly of the engine generator **10**. In other words, the cylinder portion **62** is inclined away from the control box **22** provided forwardly of the engine generator **10**. Also, the cylinder portion **62** is disposed below the muffler **18**. The cylinder portion **62** has upper and lower engine shrouds **63**, **64** mounted on upper and lower parts thereof, respectively. The shrouds **63**, **64** are disposed such that cooling air flows over the cylinder portion **62** and the cylinder head **56**. Reference character CL designates a cylinder axial line.

Since the cylinder portion **62** is inclined away from the control box **22**, heat generated by the cylinder portion **62** is not transmitted to the control box **22**.

The thus inclined cylinder portion **62** provides the advantage that the height of the engine **12** is made smaller to thereby make the overall height of the engine generator **10** smaller. Consequently, the engine generator **10** can be steadily disposed.

The muffler **18** has a front part thereof connected to an arm portion **66** by means of a stay **65**. The arm portion **66** extends forwardly from the engine **12**. A rear part of the muffler **18** is supported by an exhaust pipe **57** attached to the engine **12**.

The muffler **18** and the control box **22** are disposed closely to each other with a front panel **17***a* of the cover **17** provided therebetween.

An end cover **67** is provided for covering one end portion of the crankshaft **68** extending in a direction perpendicular to this sheet.

Reference is made to FIG. **7**. The generator **13** is a multipolar generator including an outer rotor **76** of flywheel structure. The outer rotor **76** has one end thereof fixed to the crankshaft **68**. More specifically, the generator **13** includes stators **72** attached to an end surface of the engine **12** by means of bolts **71**, **71**, a flange member **75** mounted on another end portion of the crankshaft **68** through a nut **74**, the cup-shaped outer rotor **76** mounted on the flange member **75** and disposed radially outwardly of and closely to the stator **72**, a cooling fan **77** mounted on a front part of the flange member **75**, and a substantially cylindrical fan cover **78** for covering the cooling fan **77** and the outer rotor **76**. The outer rotor **76** includes a front part forming therein apertures **76***a* (only one shown) through which air passes. The crankshaft **68** serves as a rotational shaft of the generator **13**.

The stator **72** includes a stator core **81** and a stator coil **82** wound on the stator core **81**. The stator core **81** has plural magnetic materials such as metal sheets laid one on the other.

The outer rotor **76** has permanent magnets **83** mounted on an inner peripheral surface thereof.

Since the generator **13** includes the outer rotor **76** thus arranged, it is unnecessary to provide wires to the outer rotor **76**. Thus, the outer rotor **76** becomes simple in structure.

The cooling fan **77** is a centrifugal fan including blades **84**. The rotation of the blades **84** of the fan **77** causes air to flow radially outwardly from inside the blades **84**.

The fan cover **78** is a die-cast product of aluminum alloy attached to the end surface of the engine **12** through bolts **85** (only one shown).

The rotation of blades **84** of the cooling fan **77** further causes the thus outwardly flowing air to flow through a passageway, defined between the outer rotor **76** and the fan cover **78**, towards the engine **12**. The generator **13** and the engine **12** can be therefore cooled.

Referring to FIG. **8**, the cycloconverter unit **23** for use as a power control unit converts an output from the generator **13** (see FIG. **7**) into a power having a predetermined frequency. For example, the frequency of an alternating-current output from the generator **13** is converted into a frequency of 50 or 60 Hz by the unit **23**. The cycloconverter unit **23** includes an aluminum base sheet **91** having electronic components mounted thereon, a case **92** for receiving the base sheet **91** therein, capacitors **93**, **94** having large capacitances, and the converter cover **29** for covering the case **92** and the capacitors **93**, **94**. More specifically, the case **92** and the capacitors **93**, **94** include a front side on which the electronic components are provided. Such a front side is covered with the cover **29**. The capacitors **93**, **94** are mounted to a lower part of the case **92**. The case **91** is filled with hardened resin to cover the electronic components mounted on the base sheet **91**.

Formed at the aluminum base sheet **91** is a power control circuit **95** (see FIG. **9**) for controlling an output from the generator **13**. The base sheet **91** includes input terminals **96**, **97**, **98** provided on the front side. An output from the generator **13** is input to the terminals **96**, **97**, **98**. The base sheet **91** has a flat surface **112** (see FIG. **9**) provided at a side opposite to the front side.

The case **92** includes case mounting holes **101**, **102** for use in attaching the cycloconverter unit **23** to the fan cover **78**.

The capacitors **93**, **94** serving as filters include output terminals **103**, **104**, **105**, **106** for providing outputs having frequencies converted by the unit **23**. These terminals **103**, **104**, **105**, **106** are connected to the first outlet **45** and the second outlets **46**, **46** as shown in FIG. **2**.

Although the cycloconverter unit **23** or the inverter unit serving as the power control unit generates a large amount of heat corresponding to loss caused by the conversion of power supplied from the generator **13**, the unit can be effectively cooled to thereby prevent the temperature of unit from rising. Moreover, the unit **23** can be made small in size.

Turning to FIG. **9**, the fan cover **78** includes a curved side wall **107** and a bulged wall **108**. On the wall **107**, there are mounted boss portions **109**, **111** for use in attaching the unit **23** thereto, and a thick mounting portion **114** having a flat outer surface **113**. The outer surface **113** is flatten to intimately contact the surface **112** when the unit **23** is attached to the fan cover **78**. The boss portions **109**, **111** have internal threads **115**, **116** formed therein.

The converter cover **29** has cover mounting holes **117, 118** formed therein. The cycloconverter unit **23** is attached to the fan cover **78** through two bolts **121, 121** (only one shown). More specifically, for attachment of the unit **23** to the fan cover **78**, the one bolt **121** is screwed into the boss portion **115** through the holes **117, 101** while the other bolt **121** is screwed into the boss portion **111** through the holes **118, 102** to thereby bring the surface **112** into intimate contact with the outer surface **113**.

As described above, the power control circuit **95** for controlling an output from the generator **13** is formed at the aluminum base sheet **91** of the cycloconverter unit **23**. On the fan cover **78**, there is formed the mounting portion **114** having the flat outer surface **113** to be attached to the sheet surface **112**. Because the outer surface **113** is flat, the intimate contact between the surface **112** and the outer surface **113** can be easily effected. Further, the mounting portion **114** can be readily formed.

Discussion will be made as to operation of cooling the fan cover **78** having the cycloconverter unit **23** attached thereto in relation to FIG. **10**.

As indicated by arrows, heat generated by the unit **23** is transmitted from the surface **112** to the entire fan cover **78** through the mounting portion **114** and the outer surface **113** provided in intimate contact with the surface **112**. The heat is then released from the fan cover **78** into the air.

Because the surface **112** of the unit **23** is in intimate contact with the outer surface **113** of the die-cast fan cover **78** of aluminum alloy, heat is efficiently transmitted from the unit **23** to the fan cover **78**.

The mounting portion **114** of the fan cover **78** is made thick to thereby provide the mounting portion **114** with increased heat capacity thereof. Therefore, the heat generated by the unit **23** is transmitted to the fan cover **78** more satisfactorily through the thick mounting portion **114** than through a less thick mounting portion **114**.

The fan cover **78** has heat transmitted thereto in the above manner as the unit **23** is operated. However, since the peripheral surface of the fan cover **78** has a large area and the cooling fan **77** continuously directs cooling air against the inside of the peripheral surface when rotating, the fan cover **78** can be effectively cooled to prevent the temperature of the unit **23** from rising.

In other words, the thus arranged fan cover **78** for covering the cooling fan **77** serves as a heat releasing member for releasing heat generated by the unit **23** to thereby eliminate the need to provide the unit **23** with a separate heat releasing member. Thus, the number of parts forming the engine generator **10** can be made small to thereby reduce the cost of the engine generator **10**.

Turning back to FIG. **7**, as the engine **12** is operated to rotate the cooling fan **77**, cooling air passes through a first passage. This means that the cooling air flows through the slits **52***a*, **52***b* and the recoil starter **21** into the fan cover **78**, whereafter the air is directed to the inside of the fan **77** and then flows radially outwardly from inside the fan **77** into passageways defined between the cooling fan **77** and an inner surface of the fan cover **78** and between the outer rotor **76** and the inner surface of the fan cover **78**, as indicated by arrows. After passing through these passageways, the air flows over an outer surface of the engine **12**. Also, the rotation of the fan **77** causes cooling air to pass through a second passage. This means that the cooling air flows radially outwardly from within the outer rotor **76** of the generator **13** through the apertures **76***a* (only one shown). Between the engine **12** and the generator **13**, there are formed intake openings (not shown). Through such openings, cooling air is introduced into the outer rotor **76**.

That is, the engine generator **10** is cooled by the cooling air passing through the first and second passages.

As described above, the rotation of the cooling fan **77** formed from the centrifugal fan forces the cooling air to flow towards the engine **12** through the passageway defined between the inner surface of the fan cover **78** and the outer rotor **76**.

With this arrangement, the first and second passages become simple in configuration. Since the thus arranged passages provide a reduced resistance to the flow of cooling air, the cooling air is efficiently directed to the generator **13**, the fan cover **78**, and the engine **12**. Therefore, the generator **13**, the fan cover **78**, and the engine **12** can be sufficiently cooled.

The cylindrical fan cover **78** for covering the cooling fan **77** has one end secured to the engine **12**. Therefore, the rotation of the cooling fan **77** causes cooling air to flow along the fan cover **78** towards the engine **12**. Further, heat generated by the engine **12** is transmitted directly to the fan cover **78**, whereafter the heat is released from the fan cover **78**. Consequently, it becomes possible to cool the engine **12** by means of both the cooling air and the fan cover **78**.

Obviously, various minor changes and modifications of the present invention are possible in the light of the above teaching. It is therefore to be understood that within the scope of the appended claims, the present invention may be practiced otherwise than as specifically described.

What is claimed is:

1. An engine-driven generator unit having an engine and an electric power generator driven by said engine, said engine-driven generator unit comprising:

a cooling fan mounted on a rotational shaft of said electric power generator;

a fan cover for covering said cooling fan, the fan cover being made of die-cast aluminum alloy; and

a power control unit comprising an aluminum base sheet and a power control circuit provided thereon for controlling an output from said electric power generator, the power control unit being attached to said fan cover with a surface of said aluminum base sheet intimately contacting an outer surface of said fan cover.

2. An engine-driven generator unit according to claim **1**; wherein said fan cover has a thick mounting portion, said mounting portion having a flat outer surface attached to said surface of said aluminum base sheet.

3. An engine-driven generator unit according to claim **1**; wherein said electric power generator includes an outer rotor serving as a flywheel of the engine, said outer rotor having one end thereof fixed to said rotational shaft, said outer rotor having said cooling fan mounted thereon, and said fan cover for covering said cooling fan has a cylindrical configuration and is opened at opposite end portions either of which is secured to said engine and discharges cooling air therefrom onto an outer peripheral surface of the engine.

4. An engine-driven generator unit according to claim **3**; wherein said outer rotor includes permanent magnets, said cooling fan is a centrifugal fan, an annular passageway is defined between said outer rotor and an inner surface of said fan cover, and said cooling air is forced to flow through said passageway towards said engine.

5. An engine-driven generator unit according to claim **1**; wherein said power control unit comprises one of a cycloconverter unit and an inverter unit for converting an output from said electric power generator into a power having a predetermined frequency.

6. An engine-driven generator unit according to claim 3; wherein the cooling fan comprises a centrifugal cooling fan device that forces cooling air between the outer rotor and the fan cover so as to send the cooling air to the outer peripheral surface of the engine.

7. An engine-driven generator unit according to claim 1; wherein the fan cover has an opening at a first end proximate the engine, and the cooling fan has a first rotary blade member for drawing outside air and blowing the air to cool the engine and the electric power generator.

8. An engine-driven generator unit according to claim 1; wherein the electric power generator is a multipolar generator having a magnet rotor, and the power control circuit converts an output of the multipolar generator into an alternating current of a predetermined frequency.

9. An engine-driven generator unit according to claim 1; wherein the engine has a cylinder inclined sideways obliquely and a muffler disposed in a space above the cylinder.

10. An engine-driven generator unit according to claim 9; wherein the muffler is substantially cylindrical and elongated in a direction perpendicular to the output shaft of the engine.

11. An engine-driven generator unit according to claim 1; further comprising an engine shroud covering a portion of the engine and having one end disposed proximate the fan cover so that air blown out of the fan cover by the cooling fan passes between the engine shroud and the engine to cool the engine.

12. An engine-driven generator unit according to claim 1; wherein the fan cover has a first end disposed proximate the engine and a second end disposed remote from the engine; and further comprising a recoil starter for starting the engine attached to the second end of the fan cover.

13. An engine-driven generator unit comprising: an engine; an electric power generator driven by the engine; a cooling fan mounted to a rotary output shaft of the engine; a thermally conductive fan cover covering the cooling fan and the electric power generator; and a power control unit comprising a thermally conductive metallic base sheet and a power control circuit provided on the base sheet for controlling an output of the electric power generator, the power control unit being attached to the fan cover so that a surface of the base sheet is in direct contact with an outer surface of the fan cover.

14. An engine-driven generator unit according to claim 13; wherein the fan cover is formed of a die-cast aluminum alloy, and the base sheet is formed of aluminum.

15. An engine-driven generator unit according to claim 13; wherein the fan cover has a flat surface at a location where the base sheet of the power control unit is attached.

16. An engine-driven generator unit according to claim 13; wherein the electric power generator has an outer rotor serving as a flywheel of the engine, the outer rotor has one end fixed to the rotary output shaft, the cooling fan is mounted to the outer rotor, and the fan cover has a generally cylindrical shape and is opened at opposite ends thereof, one of the ends being disposed proximate the engine to discharge cooling air therefrom onto the engine.

17. An engine-driven generator unit according to claim 16; wherein the cooling fan is a centrifugal fan for drawing air from outside the electric power generator into the fan cover, through an annular passageway defined between the outer rotor and an inner surface of the fan cover, and out a discharge portion of the fan cover onto the engine.

18. An engine-driven generator unit according to claim 13; wherein the power control unit comprises one of a cycloconverter unit and an inverter unit for converting an output of the generator into a power having a predetermined frequency.

* * * * *

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE TRADEMARK TRIAL AND APPEAL BOARD

BRIGGS & STRATTON CORPORATION Opposer, vs. HONDA GIKEN KOGYO KABUSHIKI KAISHA, Applicant.	Opposition No. 91200832 (Parent)
KOHLER CO. Opposer, vs. HONDA GIKEN KOGYO KABUSHIKI KAISHA, Applicant.	Opposition No. 91200146

United States Patent and Trademark Office
Trademark Trial and Appeal Board
P.O. Box 1451
Alexandria, Virginia 22313-1451

OPPOSERS' SIXTH NOTICE OF RELIANCE
(REDACTED – PUBLIC VERSION)

PART 2

Exhibits S to Z

US007086389B2

(12) **United States Patent**
Yamada

(10) **Patent No.: US 7,086,389 B2**
(45) **Date of Patent: Aug. 8, 2006**

(54) **GENERAL-PURPOSE ENGINE**

(75) Inventor: **Yoshikazu Yamada**, Wako (JP)

(73) Assignee: **Honda Motor Co., Ltd.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/981,783**

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F02M 37/04 (2006.01)

(52) **U.S. Cl.** **123/516**; 123/519

(58) **Field of Classification Search** 123/516, 123/518, 519, 520; 137/587, 589, 590, 574
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,372,679	A *	3/1968	Aitken	123/519
3,757,753	A *	9/1973	Hunt	123/519
4,653,762	A *	3/1987	Nakamura et al.	280/835
4,657,156	A *	4/1987	Uranishi et al.	220/694
4,701,198	A *	10/1987	Uranishi et al.	96/148
4,714,171	A *	12/1987	Sasaki et al.	220/746
4,919,103	A *	4/1990	Ishiguro et al.	123/514
5,408,977	A *	4/1995	Cotton	123/520
5,704,337	A *	1/1998	Stratz et al.	123/519
6,182,693	B1 *	2/2001	Stack et al.	137/565.17
6,269,802	B1 *	8/2001	Denis et al.	123/519
6,273,070	B1 *	8/2001	Arnal et al.	123/519
2005/0121004	A1 *	6/2005	Yamada et al.	123/519

* cited by examiner

Primary Examiner—Carl S. Miller
(74) *Attorney, Agent, or Firm*—Arent Fox PLLC

(57) **ABSTRACT**

A general-purpose engine includes a canister for adsorbing fuel vapor that has evaporated within a fuel tank. The fuel vapor, which has desorbed from the canister, is guided to an intake system communicating with an engine main body. A housing recess is formed in a base of the fuel tank, recesses toward the interior of the fuel tank, and houses the canister. Thus, an external impact to the canister can be avoided while also avoiding any increase in the dimensions of the general-purpose engine.

10 Claims, 6 Drawing Sheets

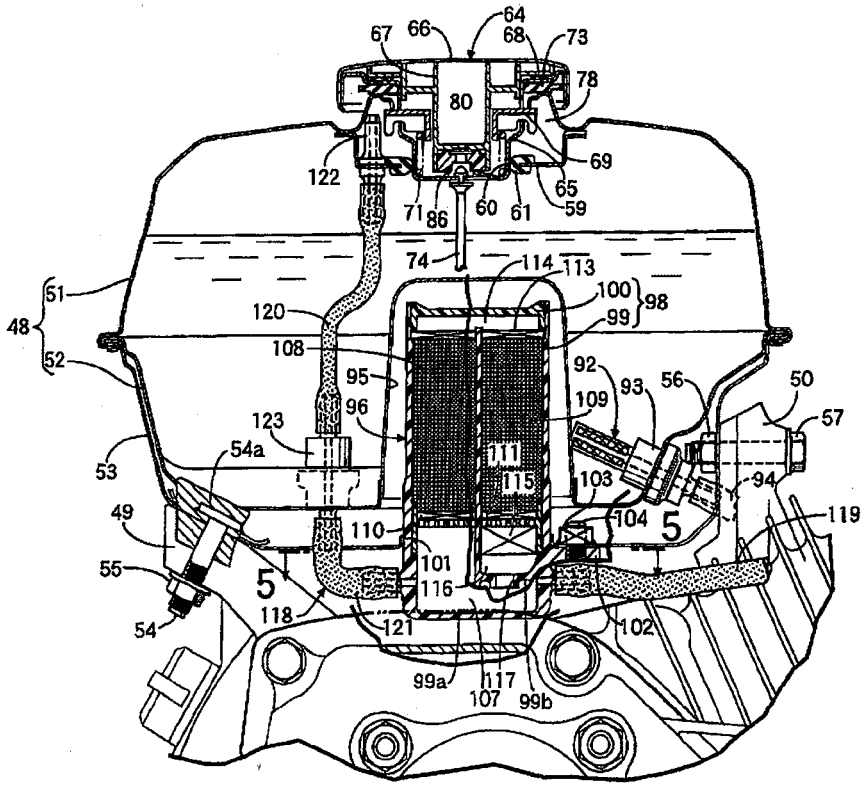

FIG.1

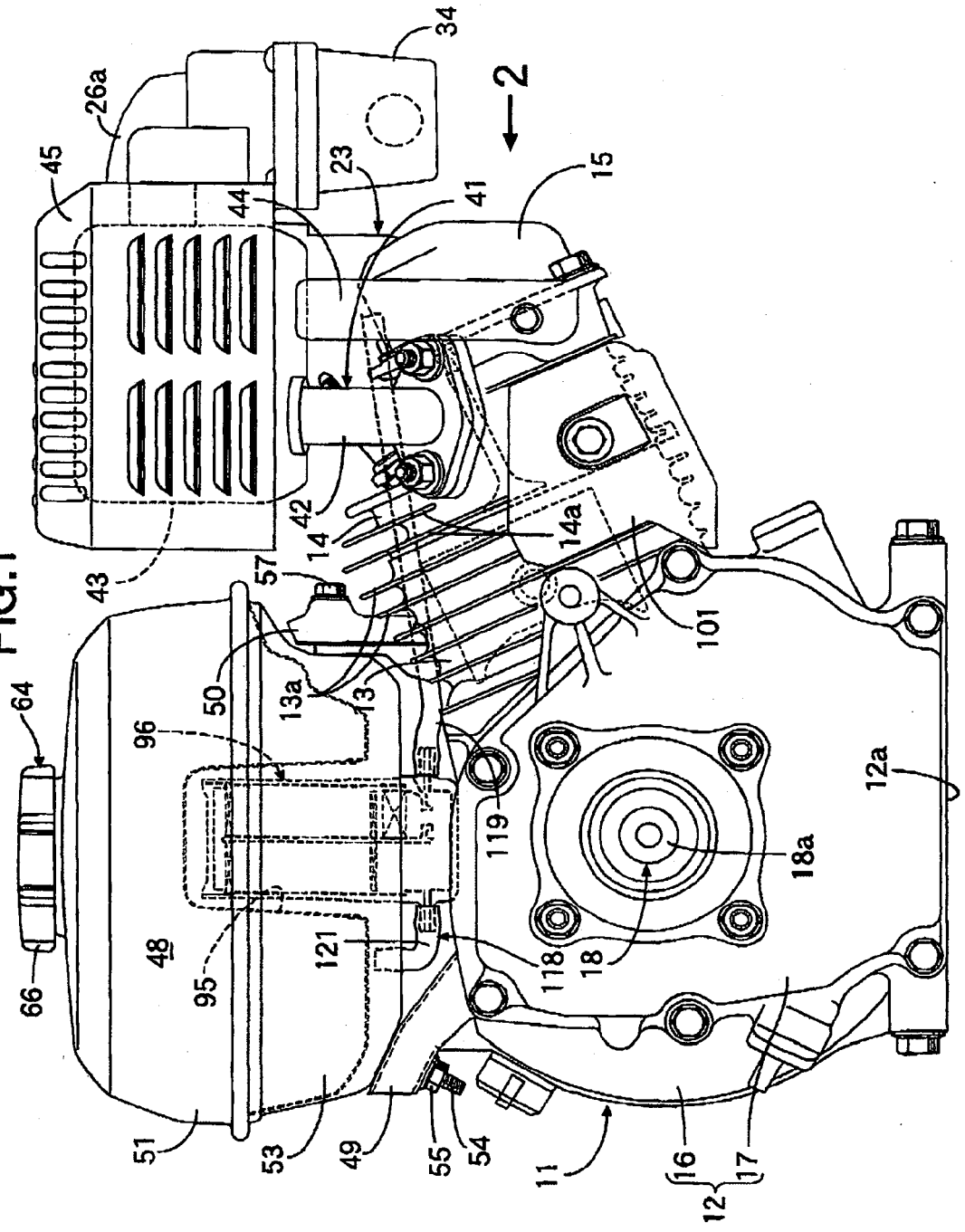
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FIG.2

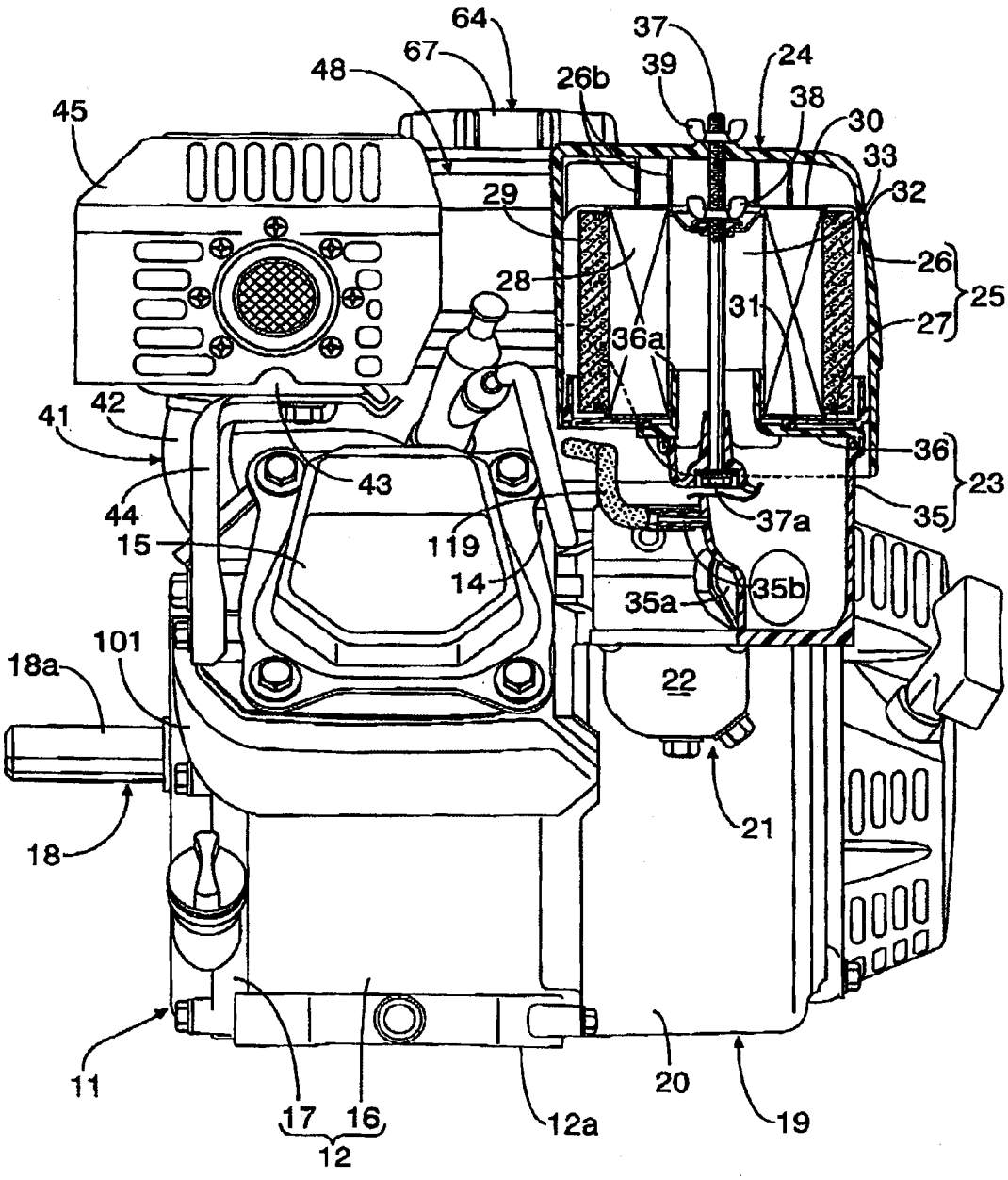
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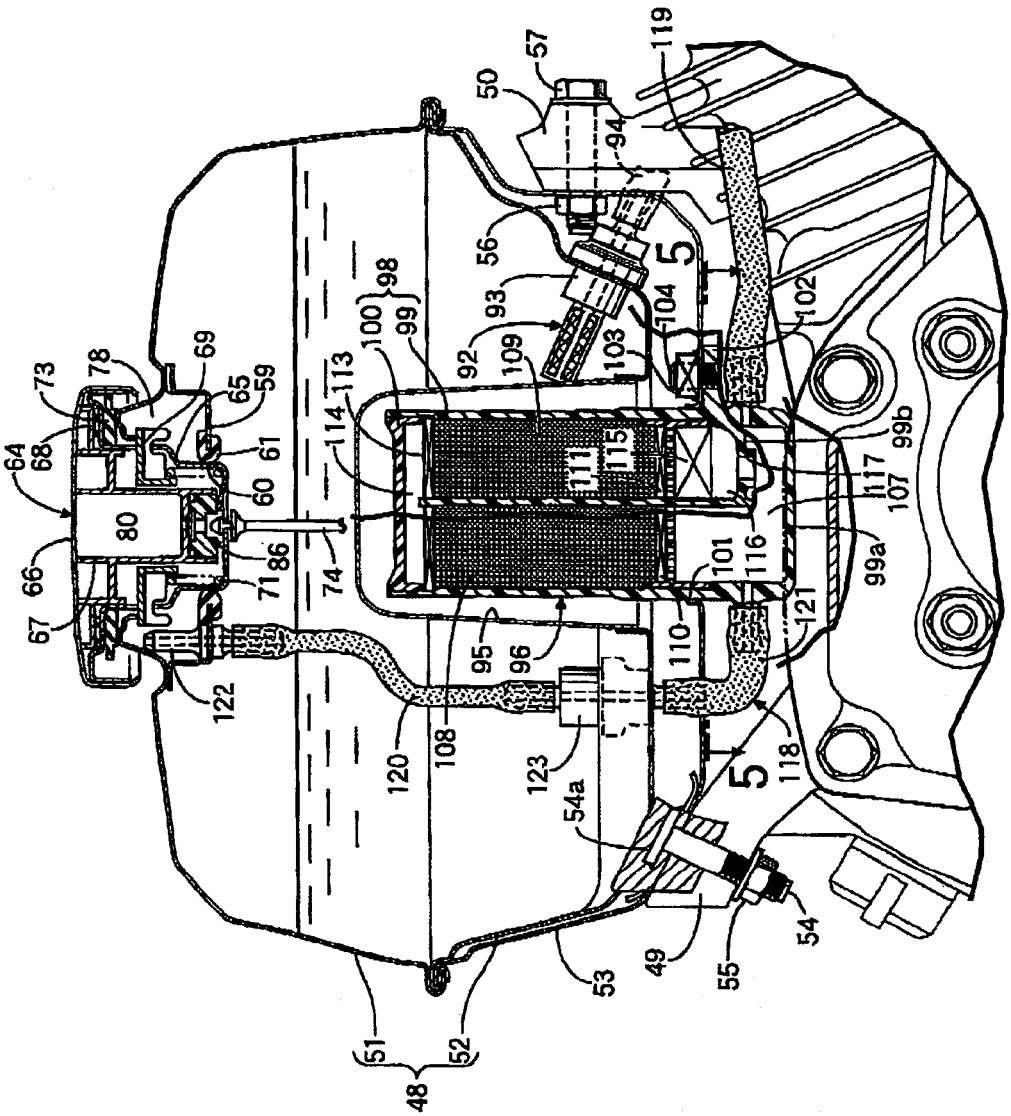
FIG.3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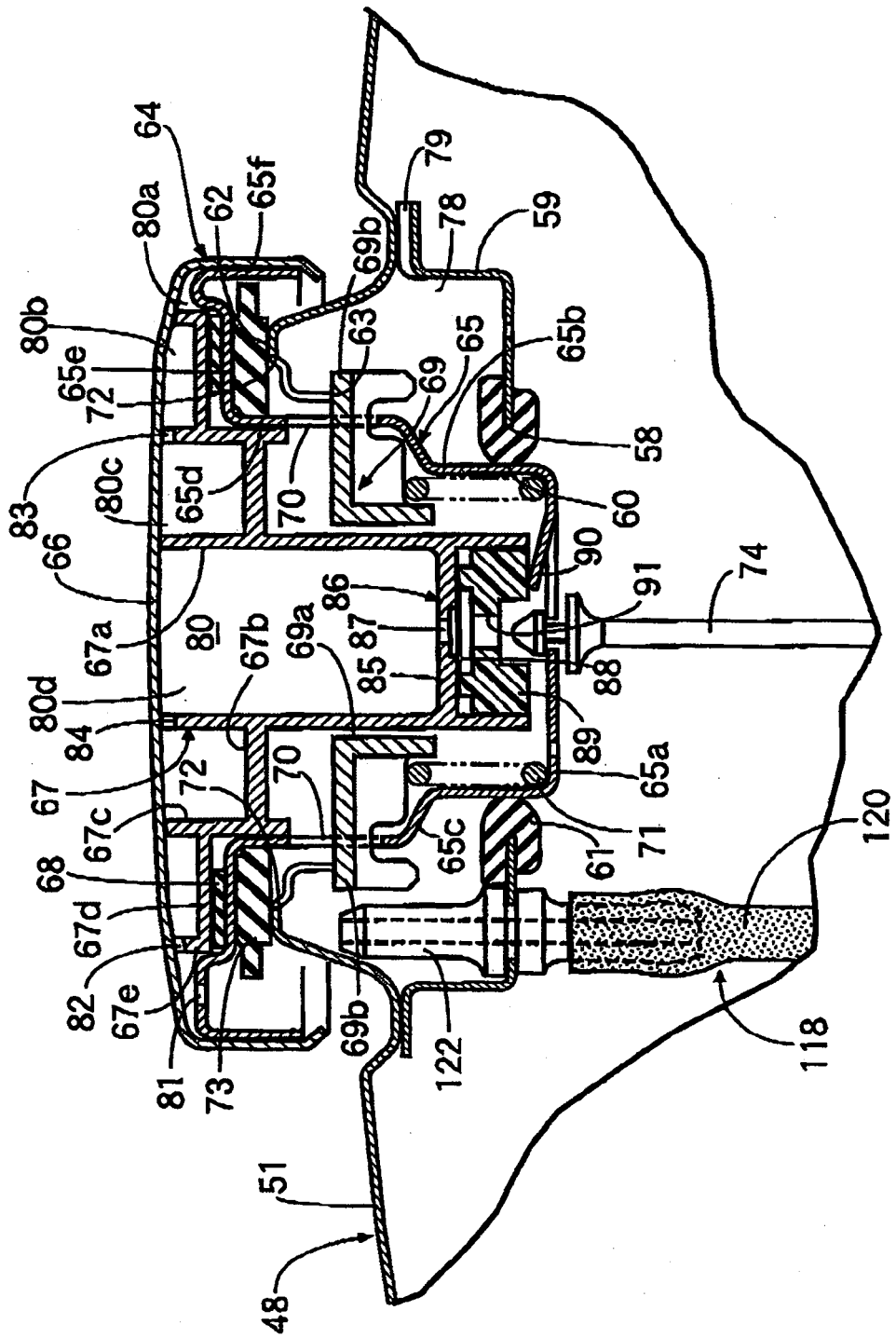
99a

FIG.4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87
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88
80d
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89
65a
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51
48

FIG.5

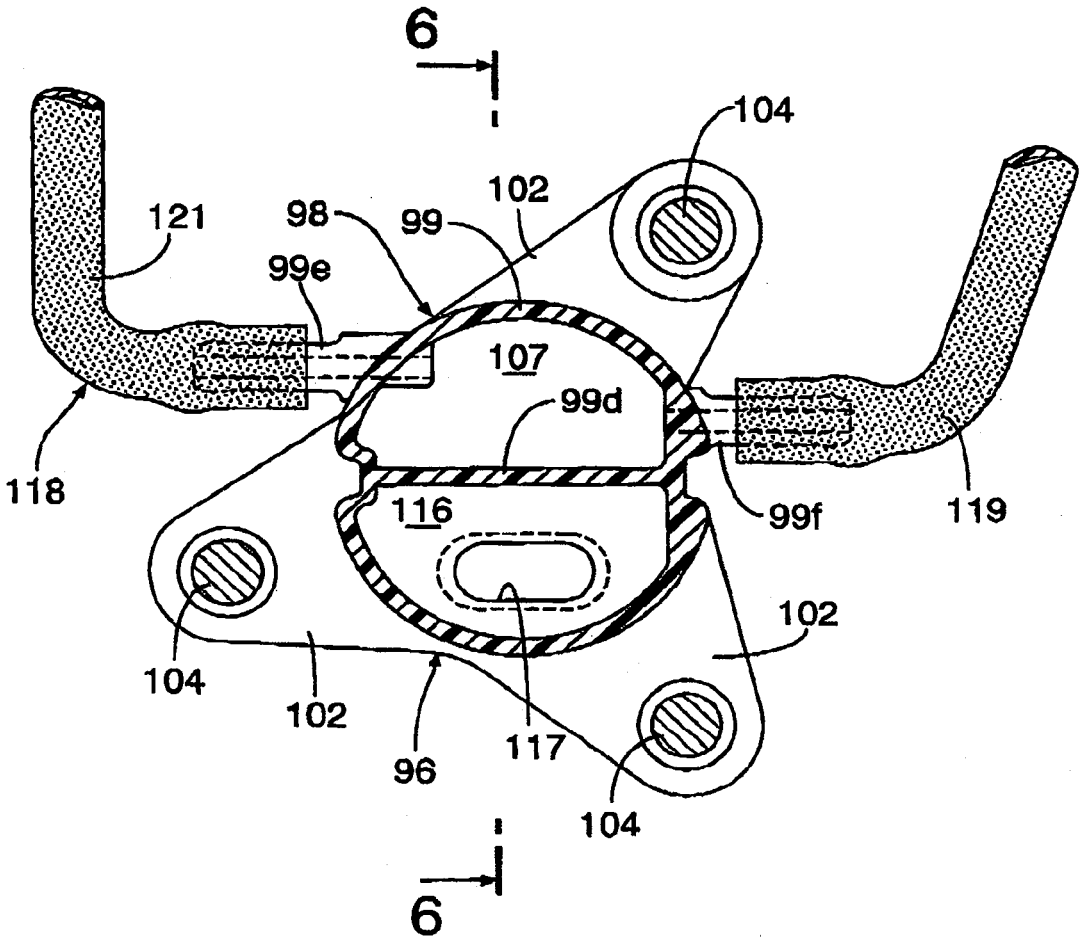
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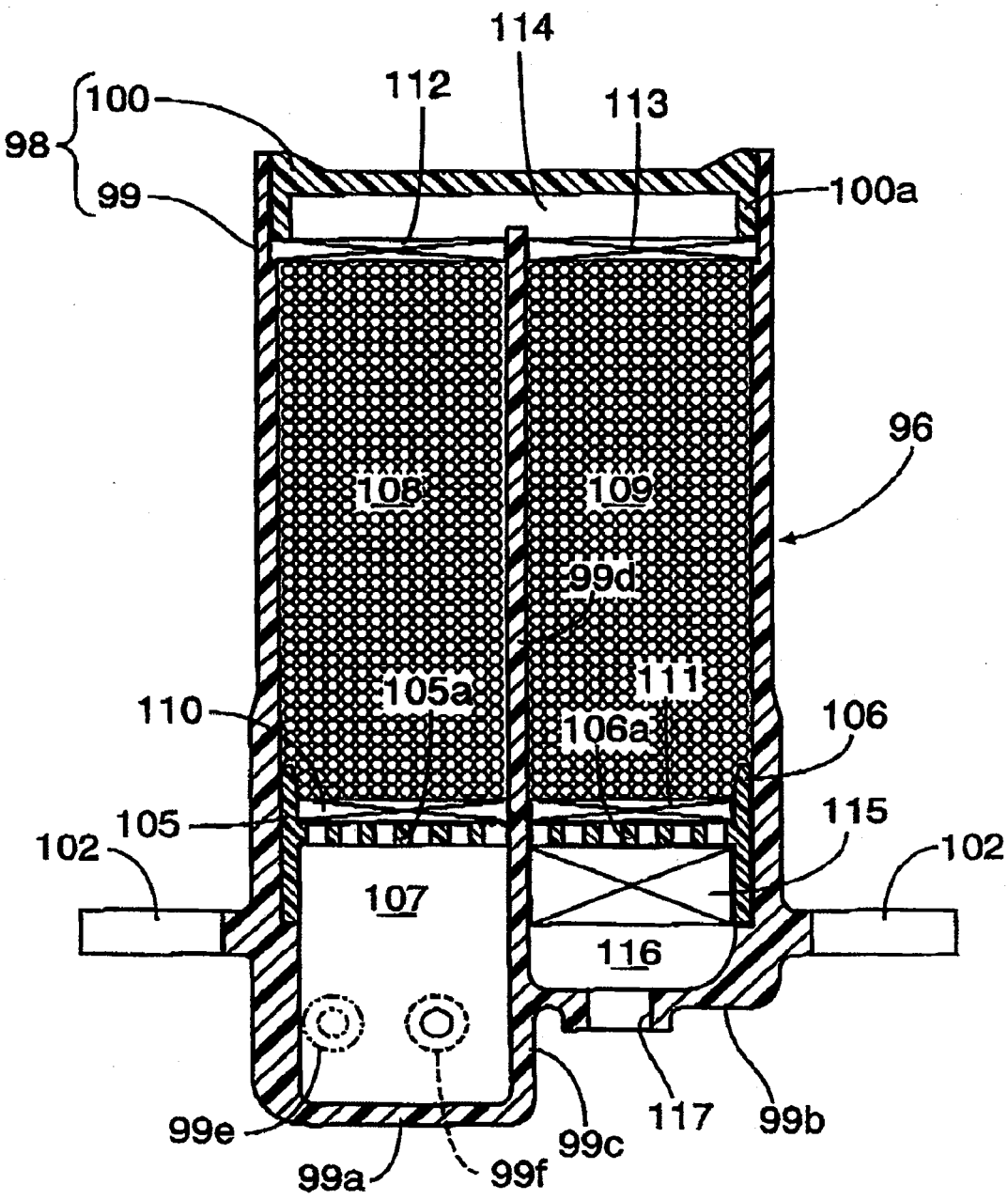
FIG.6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99e
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99f
99c
117
99b

GENERAL-PURPOSE ENGINE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a general-purpose engine having a canister to adsorb fuel vapor that has evaporated within a fuel tank, wherein fuel vapor desorbed from the canister is guided to an intake system in communication with an engine main body.

2. Description of the Related Art

A general-purpose engine having a canister disposed within a tank cap of a fuel tank is known from, for example, Japanese Patent Application Laid-open No. 7-34985.

A general-purpose engine usually needs to be compact so that a work machine that includes the general-purpose engine does not become large. A conventional general-purpose engine having a canister disposed within the tank cap causes enlargement to a portion around the tank cap and, thereby, an increase to the overall size of the general-purpose engine. Further, the canister is subject to external impact when attaching and removing the tank cap.

SUMMARY OF THE INVENTION

The present invention has been achieved under the above-mentioned circumstances to provide a general-purpose engine having a canister protected from external impact while also avoiding any increase in the dimensions of the general-purpose engine.

According to a first aspect of the present invention, a general-purpose engine includes a canister for adsorbing fuel vapor that has evaporated within a fuel tank, wherein fuel vapor desorbed from the canister is guided to an intake system in communication with an engine main body, a housing recess is formed in a base of the fuel tank and is recessed toward the interior of the fuel tank, and the canister is housed within the housing recess.

With this arrangement, a lower portion of the fuel tank covers the canister located within the housing recess of the fuel tank. Therefore, it is possible to position the canister within the general-purpose engine without increasing the dimensions of the general-purpose engine. Moreover, external impacts upon the canister are greatly reduced.

According to a second aspect of the present invention, the fuel tank is disposed above an engine component forming a part of the engine main body, the casing of the canister has an open-to-atmosphere hole provided therein which opens toward an engine component, and the open-to-atmosphere hole provides communication between the interior and exterior of the canister.

With this arrangement, the engine main body covers the area around the open-to-atmosphere hole of the canister, greatly reducing the amount of dirt and moisture drawn into the canister via the open-to-atmosphere hole, and thereby greatly improving the durability of the canister.

The above-mentioned aspects, other aspects, characteristics, and advantages of the present invention will become apparent from a preferred embodiment described below in detail by reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front view of the engine, according to a preferred embodiment of this invention;

FIG. **2** is a partially cutaway side view of the engine when viewed from the direction of arrow **2** in FIG. **1**;

FIG. **3** is a sectional view of the fuel tank;

FIG. **4** is an enlarged view of an upper part of FIG. **3**;

FIG. **5** is an enlarged sectional view along line **5**—**5** in FIG. **3**; and

FIG. **6** is a sectional view along line **6**—**6** in FIG. **5**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. **1** and FIG. **2** show an air-cooled, single cylinder general-purpose engine used in, for example, a work machine. An engine main body **11** includes a crankcase **12**, a cylinder block **13**, and a cylinder head **14**. The cylinder block **13** is inclined upward and joined to one side of the crankcase **12**. The cylinder head **14** is joined to a head of the cylinder block **13**. A large number of air-cooling fins **13***a* and **14***a* are provided on outer side faces of the cylinder block **13** and the cylinder head **14**. The crankcase **12** is mounted on an engine bed of various types of work machines via a mounting face **12***a* on a lower face of the crankcase **12**. A head cover **15** is joined to the cylinder head **14** to cover a valve operating system, which is not illustrated.

The crankcase **12** is formed from a case main body **16** and a side cover **17**. The case main body **16** is cast-molded integrally with the cylinder block **13**. The side cover **17** is joined to an open end of the case main body **16**. A crankshaft **18** has a horizontal axis and is rotatably supported in the crankcase **12**. The crankshaft **18** has one end **18***a* projecting from the side cover **17**. A recoil starter **19** is connected to the other end of the crankshaft **18**. A case **20** of the recoil starter **19** is mounted on the case main body **16** on the side opposite to the side cover **17**.

An intake system **21** of the engine includes a carburetor **22**, an intake pipe **23**, and an air cleaner **24**. The carburetor **22** is disposed on one side of the recoil starter **19** and is connected to the cylinder head **14** of the engine main body **11**. The downstream end of the intake pipe **23** is connected to the carburetor **22**. The upstream end of the intake pipe **23** is connected to the air cleaner **24**.

A cleaner case **25** of the air cleaner **24** includes a cleaner case main body **26** and a cover plate **27**. The cleaner case main body **26** is formed in a bowl shape opening downward. The cover plate **27** blocks a lower open end of the cleaner case main body **26**. Housed within the cleaner case **25** are a cylindrically shaped first cleaner element **28** and a cylindrically shaped second cleaner element **29** coaxially surrounding the first cleaner element **28**. Opposite ends, in the axial direction, of each of the first and second cleaner elements **28** and **29** are supported by a pair of disc-shaped retaining plates **30** and **31**. The first and second cleaner elements **28** and **29** are housed within the cleaner case **25** so that the retaining plate **31** abuts the cover plate **27**.

The interior of the cleaner case **25** is divided into an uncleaned chamber **32** on the outer side and a cleaned chamber **33** on the inner side by the two cleaner elements **28** and **29**. Provided integrally with the cleaner case main body **26** of the cleaner case **25** is an inlet pipe portion **26***a*, which communicates with the uncleaned chamber **32**. Connected to the inlet pipe portion **26***a* is an inlet pipe **34** for feeding external air into the uncleaned chamber **32**.

The external air fed into the uncleaned chamber **32** via the inlet pipe **34** and the inlet pipe portion **26***a* is cleaned while passing through the first **28** and second **29** cleaner elements, and is guided to the cleaned chamber **33**. The cleaned air within the cleaned chamber **33** is guided to the carburetor **22** via the intake pipe **23**.

The intake pipe **23** extends downward from the air cleaner **24** and includes a pipe **35** and a cover **36**. The pipe **35** extends vertically with an open upper end and, in a lower part, includes an integral connecting tube portion **35***a* connected to the carburetor **22**. The cover **36** blocks an upper end opening of the pipe **35** and abuts the cover plate **27** of the cleaner case **25** from below. A feed pipe portion **36***a* is provided integrally with the cover **36** and extends through central regions of the cover plate **27** and the retaining plate **31** and projecting into the interior of the cleaned chamber **33** from below.

An increased diameter head portion **37***a* of a bolt **37** engages with the pipe **35** from below. The bolt **37** extends through the pipe **35**, the feed pipe portion **36***a* of the cover **36**, the retaining plate **30**, and the closed upper end of the cleaner case main body **26**. A wing nut **38** screws onto the bolt **37** engaging the retaining plate **30** from above. Tightening the wing nut **38** enables the first and second cleaner elements **28** and **29**, the cover plate **27** of the cleaner case **25**, and the intake pipe **23**, which are held between the two retaining plates **30** and **31**, to be made into a unit. A plurality of ribs **26***b* are provided at the closed upper end of the cleaner case main body **26** of the cleaner case **25** and abut the retaining plate **30** from above. Screwing and tightening a wing nut **39** around a portion of the bolt **37** projecting upward from the closed upper end of the cleaner case main body **26** completes assembly of the air cleaner **24**, thus connecting the air cleaner **24** to the intake pipe **23**.

An exhaust system **41** of the engine includes an exhaust pipe **42** and an exhaust muffler **43**. The exhaust pipe **42** is connected to the cylinder head **14** of the engine main body **11** on the side opposite to the carburetor **22**. The exhaust muffler **43** is connected to the exhaust pipe **42** while being supported by a bracket **44** attached to the cylinder head **14** of the engine main body **11**. A cover **45** covers the exhaust system **41**.

A fuel tank **48** is disposed above the crankcase **12** of the engine main body **11**. The fuel tank **48** is supported by support arms **49** and **50**. The support arm **49** is provided integrally with the case main body **16** of the crankcase **12**, while the support arm **50** is provided integrally with the cylinder block **13**.

In FIG. **3**, the fuel tank **48** is formed by joining the peripheral edge of an upper tank half **51** to the peripheral edge of a lower tank half **52**. The upper tank half **51** forms a bowl shape that opens downward. The lower tank half **52** forms a bowl shape that opens upward. The peripheral edge of a support cover **53** is joined to the peripheral edges of the upper and lower tank halves **51** and **52**. The support cover **53** forms a bowl shape that opens upward and covers the lower tank half **52** from below.

A head **54***a* of a bolt **54** is inserted through the support cover **53** and the support arm **49**. Both a weld nut **56** and the head **54***a* of the bolt **54** are secured to an inner face of the support cover **53**. A nut **55** is screwed around a portion of the bolt **54** projecting from the support arm **49**. A bolt **57** inserted through the support arm **50** and the support cover **53** screws into the weld nut **56**. Tightening the nut **55** and the bolt **57** enables the engine main body **11** to support the support cover **53** and the fuel tank **48**.

Referring to FIG. **4**, a seal support member **59** is welded to a central portion of an inner face of the upper tank half **51** of the fuel tank **48**. The central portion of the seal support member **59** has a seal-mounting hole **58** therein. Mounted in the seal-mounting hole **58** is an annular seal **61** forming a fuel filler hole **60** along an inner periphery thereof. Furthermore, a sealing portion **62** and a tubular latching portion **63**

are integrally formed with the central portion of the upper tank half **51** at a position corresponding to the seal support member **59**. The sealing portion **62** protrudes upward into a ring shape. The tubular latching portion **63** is connected to the inner periphery of the sealing portion **62** and extends downward.

The fuel filler hole **60** is closed with a tank cap **64** such that the fuel filler hole **60** can be opened and closed. The tank cap **64** includes an insertion tube **65**, a dish-shaped operating member **66**, and a support tube **67**. The insertion tube **65** is removably inserted into the fuel filler hole **60**. The operating member **66** is joined to the upper end of the insertion tube **65**. The support tube **67** is held between the insertion tube **65** and the operating member **66**.

The insertion tube **65** is integrally formed from a bottomed small-diameter cylindrical portion **65***b*, a tapered portion **65***c*, a large-diameter cylindrical portion **65***d*, a flange portion **65***e*, and a mating tubular portion **65***f*. The small-diameter cylindrical portion **65***b* has a lower end closed by an end wall **65***a*. The tapered portion **65***c* has a small-diameter end connected coaxially to an upper end of the small-diameter cylindrical portion **65***b*. The large-diameter cylindrical portion **65***d* is connected coaxially to a large-diameter end of the tapered portion **65***c*. The flange portion **65***e* extends radially outward from the other end of the large-diameter cylindrical portion **65***d*. The mating tubular portion **65***f* extends from the outer periphery of the flange portion **65***e* downward to surround the large-diameter cylindrical portion **65***d*. The small-diameter cylindrical portion **65***b* is inserted into the fuel filler hole **60** while in resilient sliding contact with the annular seal **61**.

The mating tubular portion **65***f* of the insertion tube **65** is fitted into the operating member **66**. The operating member **66** is joined to the upper end of the insertion tube **65** by swaging an open edge of the operating member **66** to engage the tip of the mating tubular portion **65***f*.

The support tube **67** integrally includes a first cylindrical portion **67***a*, a first connecting collar portion **67***b*, a second cylindrical portion **67***c*, a second connecting collar portion **67***d*, and a third cylindrical portion **67***e*. The first cylindrical portion **67***a* is disposed coaxially within the small-diameter cylindrical portion **65***b* of the insertion tube **65**. The first connecting collar portion **67***b* projects radially outward from a middle portion proximate the upper end of the first cylindrical portion **67***a*. The second cylindrical portion **67***c* is fitted into the large-diameter cylindrical portion **65***d* of the insertion tube **65** to coaxially surround the first cylindrical portion **67***a*, and is connected to the outer periphery of the first connecting collar portion **67***b*. The second connecting collar portion **67***d* projects radially outward from a middle portion proximate the upper end of the second cylindrical portion **67***c*. The third cylindrical portion **67***e* is connected to the outer periphery of the second connecting collar portion **67***d* to coaxially surround the second cylindrical portion **67***c*. Upper ends of the first through third cylindrical portions **67***a*, **67***c*, and **67***e* abut the closed end of the operating member **66**.

An annular spacer **68**, which is made of an elastic material, is held between the second connecting collar portion **67***d* of the support tube **67** and the flange portion **65***e* of the insertion tube **65**. By swaging the open edge of the operating member **66** to engage the mating tubular portion **65***f* of the insertion tube **65**, the operating member **66** is joined to the upper end of the insertion tube **65**, and the support tube **67** is held between the insertion tube **65** and the operating member **66**.

An engagement member **69** is slidably supported on the first cylindrical portion **67***a* of the support tube **67** beneath the first connecting collar portion **67***b*. The engagement member **69** integrally includes a cylindrical boss **69***a* and a pair of engagement arms **69***b*. The cylindrical boss **69***a* is fitted around the first cylindrical portion **67***a*. The engagement arms **69***b* extend to opposite sides from the cylindrical boss **69***a* on one diameter of the first cylindrical portion **67***a*. Provided in the large-diameter cylindrical portion **65***d* of the insertion tube **65** are a pair of slits **70** extending in the axial direction through which the two engagement arms **69***b* extend. That is, the engagement member **69** is mounted on the tank cap **64** to prevent the engagement member **69** from pivoting around an axis of the engagement member **69** by the two slits **70**, and the axial sliding range of the engagement member **69** is restricted by longitudinally opposite ends of the two slits **70**. A spring **71** is provided under compression between the end wall **65***a* of the insertion tube **65** and the engagement member **69** so that the spring **71** exhibits a spring force urging the engagement member **69** toward the first connecting collar portion **67***b* of the support tube **67**.

Tips of the engagement arms **69***b* of the engagement member **69** project from the large-diameter cylindrical portion **65***d* of the insertion tube **65**. A pair of cutouts **72** is formed in the tubular latching portion **63** of the fuel tank **48**. The tips of the engagement arms **69***b* are removably inserted into the cutouts **72**. The tubular latching portion **63** is formed so that the tubular latching portion **63** pushes the engagement member **69** compressing the spring **71**. Tank cap **64** then pivots in one direction through a predetermined angle while the tips of the engagement arms **69***b* are inserted into the cutouts **72**. When the tank cap **64** pivots through the predetermined angle, the latching portion **63** engages the engagement arms **69***b* of the engagement member **69** resiliently urged by the spring **71**, thereby maintaining the mounting state of the tank cap **64**.

A ring-shaped gasket **73** is fitted around the outer periphery of the large-diameter cylindrical portion **65***d* of the insertion tube **65** in the tank cap **64**. When the tank cap **64** is fitted into the fuel tank **48**, the gasket **73** is held between the sealing portion **62** of the fuel tank **48** and the flange portion **65***e* of the insertion tube **65** in the tank cap **64**.

An upper end portion of a strap **74** is secured to the end wall **65***a* of the insertion tube **65** in the tank cap **64**. The lower end of the strap **74** is formed integrally with a hook (not illustrated) that does not easily pass through the filler hole **60**. Therefore, even when the tank cap **64** is detached from the fuel tank **48**, the hook catches on the seal support member **59** at the peripheral edge of the fuel filler hole **60** and prevents the tank cap **64** from falling off.

When the tank cap **64** is mounted on the fuel tank **48**, the sealing portion **62** of the fuel tank **48**, the seal support member **59**, and the tank cap **64** form an annular fuel vapor passage **78** surrounding the tank cap **64**. A channel **79** is provided on the seal support member **59** to provide communication between the fuel vapor passage **78** and the interior of the fuel tank **48**. The seal support member **59** and an inner face of the upper tank half **51** of the fuel tank **48** form the channel **79**. That is, the fuel vapor passage **78** communicates with the interior of the fuel tank **48**.

An external communication passage **80**, formed between the operating member **66** and the support tube **67** of the tank cap **64**, communicates with the exterior of fuel tank **48**. The external communication passage **80** includes a first annular passage portion **80***a*, a second annular passage portion **80***b*, a third annular passage portion **80***c*, and a central passage portion **80***d*. The first annular passage portion **80***a* is formed between the flange portion **65***e* of the insertion tube **65** and the operating member **66** outside the third cylindrical portion **67***e* of the support tube **67**. The second annular passage portion **80***b* is formed between the second and third cylindrical portions **67***c* and **67***e* of the support tube **67**. The third annular passage portion **80***c* is formed between the first and second cylindrical portions **67***a* and **67***c* of the support tube **67**. The central passage portion **80***d* is formed within the first cylindrical portion **67***a* of the support tube **67**.

An external communication hole **81**, provided on the flange portion **65***e* of the insertion tube **65**, provides communication between the first annular passage portion **80***a* and the exterior of fuel tank **48**. A communication channel **82**, provided at the upper end of the third cylindrical portion **67***e* of the support tube **67**, provides communication between the first and second annular passage portions **80***a* and **80***b*. A communication channel **83**, provided at the upper end of the second cylindrical portion **67***c* of the support tube **67**, provides communication between the second and third annular passage portions **80***b* and **80***c*. A communication channel **84**, provided at the upper end of the first cylindrical portion **67***a* of the support tube **67**, provides communication between the third annular passage portion **80***c* and the central passage portion **80***d*.

A partition **85** is integrally provided in the inner periphery of the first cylindrical portion **67***a* proximate a lower end thereof. Partition **85** defines the lower end of central passage portion **80***d* of the external communication passage **80** and divides the interior of the first cylindrical portion **67***a* into upper and lower parts.

A one-way valve **86** is provided within the tank cap **64** and opens allowing communication between the external communication passage **80** and the interior of the fuel tank **48** when the pressure in the fuel tank **48** is lower than the external pressure. The one-way valve **86** includes a valve hole **87** and a leaf valve member **88**. The valve hole **87** is provided in a central part of the partition **85** and extends coaxially to the lower end of the central passage portion **80***d* of the external communication passage **80**. The leaf valve member **88** is capable of closing the valve hole **87** by sitting on the central part of the partition **85** from the side opposite to the central passage portion **80***d*.

A blocking member **89** fits into a lower end part of the first cylindrical portion **67***a*. Blocking member **89** is retained within the first cylindrical portion **67***a* by a support piece **90** that abuts the blocking member **89**. The support piece **90** is formed by cutting and raising a part of the end wall **65***a* of the insertion tube **65**.

A passage **91** is provided in a central part of the blocking member **89** and communicates with the interior of the fuel tank **48**. The passage **91** permits the internal pressure of fuel tank **48** to be exerted on a side of leaf valve member **88** opposite the partition **85**. The gap between the blocking member **89** and the partition **85** is such that leaf valve member **88** may open and close.

Referring again to FIG. **3**, a housing recess **95**, formed in the base of the fuel tank **48**, is recessed toward the interior of the fuel tank **48**. The housing recess **95**, cylindrical in shape with a closed upper end and an open lower end, is located at a position below and offset from the tank cap **64** and is welded to the lower tank half **52**. A canister **96** is housed within the housing recess **95**.

Referring also to FIG. **3**, a casing **98** of the canister **96** is made of a synthetic resin and includes a casing main body **99** and a cover **100**. The casing main body **99** has a cylindrical shape with a closed lower end and extends

vertically. The cover **100** is fitted into and fixed to the casing main body **99** to close an upper end opening of the casing main body **99**. The casing **98** is inserted into the housing recess **95** from an opening **101** provided in the support cover **53** that covers the fuel tank **48** from below. A plurality of, for example, three, mounting arms **102** provided integrally with a lower part of the casing main body **99** are attached to the support cover **53** by weld nuts **103** and bolts **104**. The weld nuts **103** are secured to an inner face of the support cover **53**. The bolts **104** are inserted into the mounting arms **102** and support cover **53**, and are screwed into the weld nuts **103**.

Referring also to FIG. **6**, the closed lower end of the casing main body **99** is formed from a semicircular first end wall portion **99***a*, a semicircular second end wall portion **99***b*, and a connecting wall portion **99***c*. The first end wall portion **99***a* closes the lower end of substantially half of the casing main body **99**. The second end wall portion **99***b* is disposed above the first end wall portion **99***a* to close the lower end of the remainder of the casing main body **99**. The connecting wall portion **99***c* is disposed on one diameter of the casing main body **99**, and provides a connection between the first and second end wall portions **99***a* and **99***b*. Provided integrally with an inner face of the casing main body **99** is a partition wall portion **99***d*, which is connected to the connecting wall portion **99***c* and extends upward. The partition wall portion **99***d* divides the interior of the casing main body **99** into left and right portions corresponding to the first and second end wall portions **99***a* and **99***b*.

First and second support members **105** and **106** are fitted into and fixed to a lower part of the interior of the casing main body **99**. Provided integrally with the first and second support members **105** and **106** are grid portions **105***a* and **106***a* that have semicircular exterior shapes corresponding to the first and second end wall portions **99***a* and **99***b*, respectively, and which are formed into grid shapes to allow the circulation of fuel vapor. An introduction chamber **107** is formed within the casing main body **99** between the grid portion **105***a* of the first support member **105** and the first end wall portion **99***a*.

A first adsorbent layer **108**, packed with an adsorbent such as activated carbon, is housed within the casing main body **99** on one side of the partition wall portion **99***d*, wherein a filter **110** is disposed between the first adsorbent layer **108** and the grid portion **105***a* of the first support member **105**. A second adsorbent layer **109**, packed with an adsorbent such as activated carbon, is housed within the casing main body **99** on the other side of the partition wall portion **99***d*, wherein a filter **111** is disposed between the second adsorbent layer **109** and the grid portion **106***a* of the second support member **106**.

The first and second adsorbent layers **108** and **109** are held between filters **110**, **112** and filters **111**,**113**, respectively. Provided integrally with the cover **100** closing the open end of the casing main body **99** is a tubular retaining portion **100***a* fitted into the interior of the casing main body **99** so that the filters **112** and **113** are held between the tubular retaining portion **100***a* and the first and second adsorbent layers **108**, **109**, respectively. Moreover, a middle chamber **114** is formed between the filters **112**, **113** and the cover **100**.

A filter **115**, abutting the grid portion **106***a* from below, is fitted within the casing main body **99** beneath the grid portion **106***a* of the second support member **106**. A discharge chamber **116** is formed within the casing main body **99** between the filter **115** and the second end wall portion **99***b*.

An open-to-atmosphere hole **117**, providing communication between the discharge chamber **116** and the exterior of casing **98**, is provided in the second end wall portion **99***b*, wherein the hole **117** opens toward the crankcase **12** of the engine main body **11**.

Referring to FIG. **5**, a pair of connecting tube portions **99***e* and **99***f* that communicate with the introduction chamber **107** are projectingly provided integrally with a lower part of the casing main body **99**, wherein the connecting tube portions **99***e* and **99***f* project outward at positions offset from each other along the periphery of the casing main body **99**. Connected to the connecting tube portion **99***e* is a charge pipeline **118** for guiding fuel vapor from the fuel tank **48**. Connected to the connecting tube portion **99***f* is a purge pipeline **119** for guiding fuel vapor that has desorbed from the canister **96** to the intake pipe **23**.

Referring again to FIG. **3**, the charge pipeline **118** includes pipelines **120** and **121**. The pipeline **120** is formed between the tank cap **64** and the fuel tank **48**, providing communication with the interior of the fuel tank **48** via fuel vapor passage **78**. The pipeline **121** provides a connection between the pipeline **120** and the canister **96**. The pipelines **120** and **121** are, for example, rubber hoses.

A connecting tube **122** extends vertically through the seal support member **59** of the fuel tank **48** on the side opposite to the canister **96** relative to the axis of the tank cap **64**. A middle portion of the connecting tube **122** is mounted on the seal support member **59**, wherein the upper end of the connecting tube **122** communicates with the fuel vapor passage **78**. The lower end of the connecting tube **122** is connected to the upper end of the pipeline **120**. A connecting tube **123** extends vertically through the base of the lower tank half **52** of the fuel tank **48** in a liquid-tight manner. A middle portion of the connecting tube **123** is mounted on the base of the lower tank half **52**. The upper end of the connecting tube **123** is connected to the lower end of the pipeline **120**. The pipeline **121** extends through the support cover **53** and is connected to the lower end of the connecting tube **123**.

That is, the pipeline **120** of the charge pipeline **118** is provided entirely within fuel tank **48** and communicates with the fuel vapor passage **78**. Therefore, it is possible to reduce the portion of the charge pipeline **118** exposed to the exterior of fuel tank **48**; reduce the overall dimensions of the general-purpose engine and consequently the dimensions of the work machine; enhance the ease of mounting and the appearance of the general-purpose engine, thereby improving product quality; and improve safety while taking into consideration the leakage of fuel vapor, damage to the pipelines, etc.

Referring again to FIG. **2**, one end of the purge pipeline **119** communicates with the introduction chamber **107**, and the other end connects to a connecting tube portion **35***b* that is integral with the pipe **35** of the intake pipe **23** in the intake system **21**.

Referring again to FIG. **3**, a filter case **93** equipped with a filter **92** for filtering fuel within the fuel tank **48** mounts on the base of the lower tank half **52** of the fuel tank **48**. A fuel hose **94** for guiding fuel to the carburetor **22** is connected to the filter case **93**.

In the canister **96**, fuel vapor that has evaporated in the fuel tank **48** when the engine is stopped feeds from the charge pipeline **118** to the introduction chamber **107**. Once in the introduction chamber **107**, the fuel vapor flows toward the discharge chamber **116** via the grid portion **105***a* of the first support member **105**, the filter **110**, the first adsorbent layer **108**, the filter **112**, the middle chamber **114**, the filter **113**, the second adsorbent layer **109**, the filter **111**, the grid

portion **106***a* of the second support member **106**, and the filter **115**. The first and second adsorbent layers **108** and **109** adsorb the fuel vapor.

When the engine is running, air introduced into the discharge chamber **116** through the open-to-atmosphere hole **117** flows toward the intake pipe **23** via the filter **115**, the grid portion **106***a* of the second support member **106**, the filter **111**, the second adsorbent layer **109**, the filter **113**, the middle chamber **114**, the filter **112**, the first adsorbent layer **108**, the filter **110**, the grid portion **105***a* of the first support member **105**, the introduction chamber **107**, and the purge pipeline **119**. The fuel vapor that has desorbed from the first and second adsorbent layers **108** and **109** is guided to the intake pipe **23** side accompanied by the air.

In this way, the interior of the casing **98** of the canister **96** is divided into left and right portions by the partition wall portion **99***d*, and the fuel vapor or the air for accompanying the fuel vapor flows sequentially through the first adsorbent layer **108** on one side of the partition wall portion **99***d* and the second adsorbent layer **109** on the other side of the partition wall portion **99***d*. Therefore, it is possible to increase the adsorption length while keeping the casing **98** compact, thus improving adsorption efficiency.

Operation of the invention according to the embodiment described above will now be explained. The housing recess **95**, recessed toward the interior of the fuel tank **48**, is formed in the base of the fuel tank **48**, and the canister **96** is housed in the housing recess **95**. Therefore, the canister **96** may be arranged within the general-purpose engine while avoiding any increase in the overall dimensions of the general-purpose engine. Moreover, placement of canister **96** within housing recess **95** greatly reduces the possibility of an external impact to the canister **96**.

Further, the fuel tank **48** is disposed above the crankcase **12** of the engine main body **11**. Hence, the hole **117** within the casing **98** of the canister **96**, providing communication between the interior and exterior of canister **96**, opens downward toward the crankcase **12**. Therefore, the engine main body **11** covers the area around hole **117** and improves the durability of the canister **96** by reducing the amount of dirt and moisture drawn into the canister **96** through hole **117**.

Further, the external communication passage **80** of the tank cap **64** provides communication between the interior and exterior of tank cap **64**. The one-way valve **86** also opens allowing communication between the external communication passage **80** and the interior of fuel tank **48** when the pressure within the fuel tank **48** is lower than the external pressure. Therefore, even when air flow resistance through the charge pipeline **118**, canister **96**, and intake system **21** increases due to the adsorption of fuel vapor or residing impurities in the canister **96**, operation of the one-way valve **86** prevents the pressure within the fuel tank **48** from becoming negative, which provides a smooth supply of fuel from the fuel tank **48**, even when the fuel level within the fuel tank **48** decreases.

Although a preferred embodiment of the present invention has been described in detail, the present invention is not limited to the embodiment and can be modified in a variety of ways without departing from the spirit and scope of the present invention.

What is claimed is:

1. A general-purpose engine comprising:

an engine main body;

a fuel tank;

a canister which adsorbs fuel vapor evaporated within the fuel tank;

an intake system communicating with the engine main body, wherein fuel vapor desorbed from the canister is guided to the intake system;

a housing recess formed in a base of the fuel tank, the housing recess being recessed toward an interior of the fuel tank and housing the canister; and

a charge pipeline extending through the interior of the fuel tank for conveying fuel vapor from the fuel tank to the canister.

2. The engine according to claim **1**, wherein the fuel tank is disposed above an engine component forming a part of the engine main body, the canister having an open-to-atmosphere hole provided in a casing of the canister which opens toward the engine component and provides communication between an interior and exterior of the casing.

3. The engine according to claim **1**, the engine further comprising:

a tank cap securably affixed to the fuel tank comprising:

a one-way valve;

an external communication passage; and

a fuel vapor passage,

wherein the one-way valve opens when an external pressure of the fuel tank exceeds an internal pressure of the fuel tank,

wherein the external communication passage provides communication between an exterior and the interior of the fuel tank when the one-way valve opens,

wherein the fuel vapor passage provides communication between the interior of the fuel tank and the charge pipeline, and

wherein the charge pipeline provides communication between the fuel vapor passage and the canister.

4. The engine according to claim **3**, wherein the charge pipeline comprises a plurality of pipes.

5. The engine according to claim **4**, wherein the plurality of pipes are formed from an elastomeric material.

6. The engine according to claim **5**, wherein the canister is internally partitioned and increases a flow distance of any fuel vapor traveling through the canister from a canister inlet to an open-to-atmosphere hole communicating with the canister exterior.

7. The engine according to claim **2**, the engine further comprising:

a tank cap securably affixed to the fuel tank comprising a one-way valve and an external communication passage,

wherein the one-way valve opens when an external pressure of the fuel tank exceeds an internal pressure of the fuel tank,

wherein the external communication passage provides communication between an exterior and the interior of the fuel tank when the one-way valve opens,

wherein the tank cap integrally includes a fuel vapor passage providing communication between the interior of the fuel tank and the charge pipeline, and

wherein the charge pipeline provides communication between the fuel vapor passage and the canister.

8. The engine according to claim **7**, wherein the charge pipeline comprises a plurality of pipes.

9. The engine according to claim **8**, wherein the plurality of pipes are formed from an elastomeric material.

10. The engine according to claim **9**, wherein the canister is internally partitioned and increases a flow distance of any fuel vapor traveling through the canister from a canister inlet to an open-to-atmosphere hole communicating with the canister exterior.

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PAGES T-1 to T-12

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EXHIBIT

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PAGES U-1 to U-7

CONFIDENTIAL

ATTORNEYS' EYES ONLY

EXHIBIT

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PAGES V-1 to V-4

CONFIDENTIAL

ATTORNEYS' EYES ONLY

EXHIBIT

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PAGES W-1 to W-8

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(54) Power Cultivator

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EXHIBIT
13

Specification

1. Title of the Invention
POWER CULTIVATOR

2. Scope of Patent Claims

A power cultivator comprising a configuration such that engine cylinders are tilted toward a back side, a fuel tank is arranged above a crank case while an auxiliary device such as an air cleaner or the like is arranged above the cylinders, and the cylinders are disposed in front of a transmission case and above a cultivating rotor.

3. Detailed Description of the Invention

The present invention relates to a power cultivator that improves stability and cultivating capacity by lowering a center of gravity.

It is necessary to consider making as large as possible an outermost radius of a cultivating rotor and the like mounted to an axle on a compact power cultivator that implements cultivation work on agricultural land, and to implement stable cultivation work by lowering a center of gravity of a main unit. However, these conditions are contradictory; satisfying both conditions is an extremely difficult problem.

FIG. 4 is a schematic side view showing a conventional cultivator, more specifically, a vertical engine-type power cultivator. To provide more explanation of the general configuration, a power cultivator indicated by the symbol 40 has a body frame (engine bed) 41; a vertical engine 42 is mounted thereabove, which is composed of a crank case 42a and a cylinder 42b integrated above that. Still farther above, more specifically above the cylinder 42b, a fuel tank 43 is disposed.

Conversely, at a back end of the body frame 41, a long horizontal transmission case 44 is integrated; a handle 46 is supported at an upper part of the transmission case 44 by a handle support post 45, while a cultivating rotor 48 is supported at a lower part, for example,

by an axle 47. A coupler 49 is further disposed at a back side, where a resistance rod 50, for example, is pivotably supported during cultivating.

Moreover, auxiliary devices such as an air cleaner 51, or a muffler or the like (not shown) are disposed in a space between the engine 42 and the transmission case 44. Furthermore, rotation of the engine 42 and the transmission case 44 is transmitted by an endless belt 54 trained around pulleys 52 and 53.

Therefore, pursuant to the configuration described above, the engine 42 is disposed farther to the front side than a cultivating rotor 48. Moreover, the height tends to be increased and the center of gravity is positioned toward the front. This configuration does not adequately satisfy a condition to attain stable cultivating work, as described above.

To improve on these points, an object of the present invention is to provide a power cultivator that lowers the center of gravity by rationally implementing shapes and configurations of each part, thereby implementing stable cultivating work, as well as not allowing uncultivated areas or the like by biasing the center of gravity above the cultivating rotor.

In order to attain the aforementioned object, engine cylinders are tilted toward a back side, for the main configuration, and a fuel tank is mounted above a crank case. Moreover, an auxiliary device such an air cleaner, a muffler, or the like is disposed above the cylinders, while the cylinders are disposed in front of a transmission case and above a cultivating rotor.

A preferred embodiment of the present invention will now be described with reference to FIGS. 1 to 3.

FIG. 1 is a side view of a power cultivator according to the present invention; FIG. 2 is a sectional view of line 2-2 shown in FIG. 3, showing a detail of an engine, auxiliary devices, and a fuel tank; and FIG. 3 is a back side view of the positions shown in FIG. 2.

A power cultivator indicated by the symbol 1 includes a body frame (engine bed) 2 and an engine 3 is mounted on a top front side thereof. The engine 3 is equipped with a crank case 3a fastened on top of the body frame 2, and is equipped at the top back side thereof with an integrated cylinder 3b, tilted toward the back side. Moreover, a fuel tank 4 is disposed on a top portion of the crank case 3a, and auxiliary devices 7, such as an air cleaner 5, muffler 6, and the like are disposed above the cylinder 3b, as shown in FIG. 3.

Pursuant to this configuration, the fuel tank 4 is disposed on the top front side, the crank case 3a is disposed on the bottom front side, the auxiliary devices 7 are disposed on the back top side, and the cylinder 3b is disposed on the back bottom side, as shown from the side in FIG. 1. This enables a compact design without wasted space. When compared to the power cultivator 40 shown in FIG. 4 as an example of the conventional technology, the power cultivator 40, which has substantially the same performance of each part, capacity, and the like, has an overall height H_1 (virtual line in FIG. 1), while on the other hand, the power cultivator 1 has an overall height H_2 that is lower than H_1, making the center of gravity lower by that amount.

Moreover, because cylinder 3b is tilted toward the back side as shown in FIG. 2, a cylinder head 11 equipped with valves 8, a rocker arm 9, a spark plug 10, and the like projects toward the back side. Moreover, cam 12 and push-rod 13 are positioned below the cylinder 3b. Furthermore, consideration was given to external contours of fine parts and the like to allow space to be used effectively.

Moreover, as shown in FIG. 3, the air cleaner 5 and the muffler 6 disposed above the cylinder 3b are arranged in line, but are arranged to be disposed on both sides. Furthermore, in consideration of protecting against heat, an exhaust pipe 14 and an air intake pipe 15 are disposed biased to one side, and a carburetor 16 is disposed at a back side of the cylinder 3b, below the cleaner 5.

Conversely, as shown in FIG. 1, a long horizontal transmission case 17 is integrated to a backside of the body frame 2, and the cylinder 3b is disposed directly in front of this transmission case 17. At an upper end of the transmission case 17, the handle 19 is supported by a handle support post 18, and at a lower end, a cultivating rotor 21 is supported by an axle 20. A coupler 22 is further disposed at a back side, where a resistance rod 23, for example, is pivotably supported during cultivating.

Moreover, rotation is transmitted at an engine 3 side and a transmission case 17 side by an endless belt 26 trained respectively around a drive pulley 24 and a follower pulley 25, with an auxiliary pulley 27 disposed therebetween.

However, the cylinder 3b described above is tilted to the back side, and as a result, a comparatively heavy cylinder 3b is positioned above the cultivating rotor 21, as shown in FIG. 1. More specifically, by fitting the back side cylinder 3b farther back than the vertical line X that passes through the outermost radius side of the cultivating rotor 21, as shown in FIG. 1, the center of gravity is shifted by that amount, effectively adding the weight to the cultivating rotor 21. It is clear that the cylinder 42b is disposed farther to the front than the vertical line X in the conventional example shown in FIG. 4.

Moreover, the numeral 28, which does not require any special description in FIG. 2, denotes a piston; 29 denotes a crank shaft; and 30 denotes an air cleaner element.

As is clear from the description above, the power cultivator pursuant to the present invention implements stable cultivating work by effectively lowering the center of gravity with a rational layout configuration for each part.

Moreover, by placing the center of gravity to the back side, in other words, by effectively placing weight over the cultivating rotors, the center of gravity is biased to the back side, and uncultivated land areas and the like are reduced

Furthermore, the auxiliary devices, represented by air exhaust and intake systems, are fit above or near the cylinder, which effectively cools them, and prevents erroneous temperature rises of the carburetor and the like, for example. Additionally, the overall configuration can be made compact, so it is possible to provide a power cultivator that has the conveniences of an excellent product with a beautiful design.

4. Brief Description of the Drawings

FIG. 1 is a side view of a power cultivator according to the present invention; FIG. 2 is a sectional side view of line 2-2 in FIG. 3 showing a detail of an engine, auxiliary devices, and a fuel tank; FIG. 3 is a back side view of the positions shown in FIG. 2; and FIG. 4 is a schematic side view of a power cultivator according to conventional technology.

In the drawings, 3 denotes an engine; 3a denotes a crank case; 3b denotes a cylinder; 4 denotes a fuel tank; 5 denotes an air cleaner; 7 denotes auxiliary systems; 17 denotes a transmission case; and 21 denotes a cultivating rotor.

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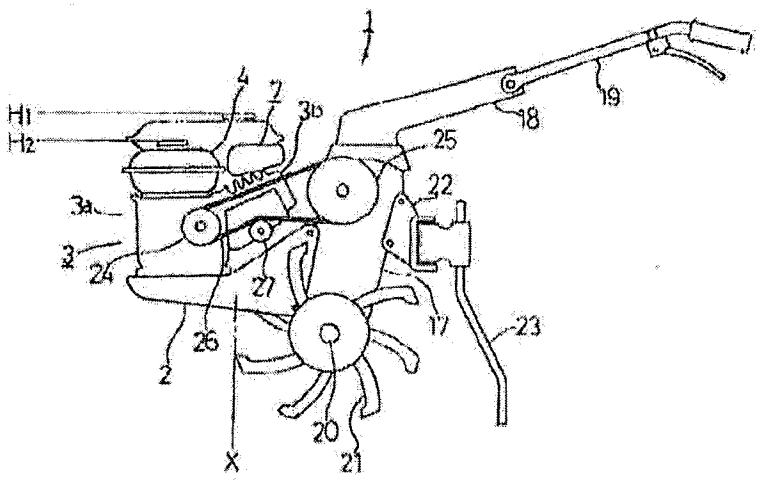
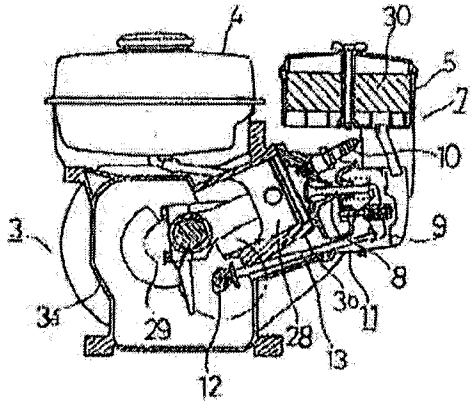
Case #: JP S59-59577A

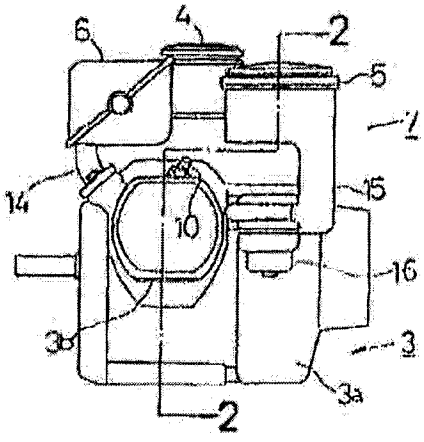
[FIG. 1]



[FIG. 2]

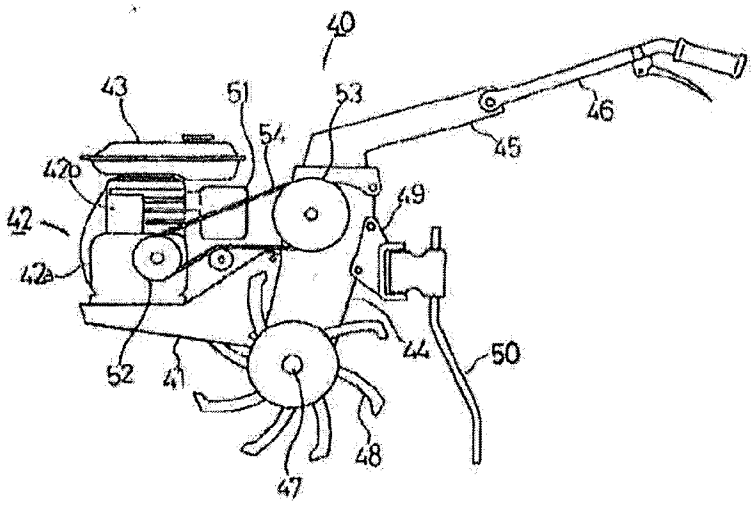


[FIG. 3]



Case #: JP S59-59577A

[FIG. 4]



PATENT ABSTRACTS OF JAPAN

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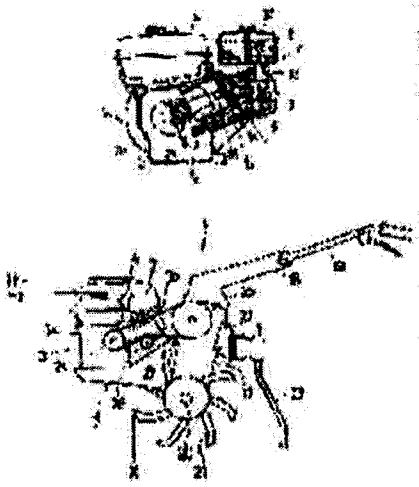
(54) POWER DRIVEN TILLING MACHINE



(57)Abstract:
PURPOSE: To lower the center of gravity of a power-driven tilling machine for agriculture by a method wherein, an engine cylinder, slanted backward, is located in front of a transmission case and above a tilling roller, an auxiliary system is situated thereabove, and a fuel tank is positioned on a crank case.
CONSTITUTION: An engine cylinder 3b, slanted backward, is positioned in front of a transmission case 17 and above a tilling roller 21. Further, an auxiliary system 7 consisting of an air cleaner 5, muffler 6 and the like, is located above the cylinder 3b. A fuel tank 4 is disposed on a crank case 3. This constitution eliminates wasteful space to form a compact device, permits reduction in the total height of a tilling machine, enables lowering of the center of gravity, and improves safety and tilling capacity.

LEGAL STATUS
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[Date of final disposal for application]

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[Date of registration]

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⑲ 日本国特許庁（JP）　⑪ 特許出願公開

⑫ 公開特許公報（A）　昭59—59577

⑤Int. Cl.³	識別記号	庁内整理番号
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A 01 B 33/02		7196—2B
F 02 B 61/00		7191—3G
67/00		7191—3G

⑬公開　昭和59年(1984)4月5日

発明の数　1
審査請求　有

（全 4 頁）

⑭動力耕耘機

⑳特　願　昭57—170212
㉒出　願　昭57(1982)9月29日

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明　細　書

1. 発明の名称

動力耕耘機

2. 特許請求の範囲

エンジンのシリンダを後方へ傾斜させ、クランクケース上に燃料タンクを、前記シリンダ上方にエアクリーナ等の補機系を配設するとともに、前記シリンダをミッションケースの前方、且つ耕耘ロータの上方に位置するように構成したことを特徴とする動力耕耘機。

3. 発明の詳細な説明

本発明は重心を下げ安定性及び耕耘能力を向上させた動力耕耘機に関する。

農業用地の耕耘作業を行う小型の動力耕耘機に於ては車輪に取付ける耕耘ロータ等の最外径を可及的に大とすると共に、本体の重心を下げ安定した耕耘作業を行ない得るように配慮することを要するが、これらの条件は相反するもので、両者を共に満足させることは極めて困難な問題である。

第4図は従来におけるこの種耕耘機、即ち、整型エンジン搭載型の動力耕耘機を示す概略側面図であり、その概略構成について説明を加えると、符号40で示された動力耕耘機は車体フレーム（エンジンベッド）41を有し、この前上部にクランクケース42a及びその上部に一体化したシリンダ42bから成る整型エンジン42を搭載し、更にこの上部、即ちシリンダ42b上に燃料タンク43を配設する。

他方、車体フレーム41の後端部には減速ミッションケース44を一体的に設け、この上部にはハンドル支柱45を介してハンドル46が、下部には車軸47を介して例えば耕耘ロータ48が支持されると共に、更に後部には運転座49を備え、例えば耕耘時の抵抗棒50が後方支持される。

また、前記エンジン42とミッションケース44の間のスペースにはエアクリーナ51、或いは図に現れないマフラ等の補機系が配設され、更に、エンジン42及びミッションケース44はブーリ52及び53に掛け渡した伝動ベルト54にて回

転が伝達される。

したがつて、上述する構造では排気ロータ48より前側にエンジン42が配置され、しかも、高さが高くなる傾向があり、重心が前上方に位置し、前述した如く安定した排気作業を行い得る条件を十分満足するには至つていない。

本発明は斯かる点を改善するもので、各部を合理的形状及び構成とすることにより重心を下げ、もつて安定な排気作業を行わせしめると共に、更に、重心を排気ロータの上方に僅かせしめることにより視界等の妨げない動力排気機の提供を目的とする。

本発明は以上の目的を達するため、その主たる構成とする処はエンジンのシリンダを後方へ傾斜させ、クランクケース上に燃料タンクを搭載し、また、上記シリンダ上方にエアクリーナ及びマフラ等の周機系を配設するとともに、排気シリンダをミッションケースの前方、且つ排気ロータの上方に位置させたことを特徴とする。

以下には本発明を更に具体化した好適な実施例を挙げ第1図乃至第3図を参照して詳細に説明する。

第1図は本発明に係る動力排気機の側面図、第2図はエンジン、補機系及び燃料タンクを詳細に示す第3図中2－2線側面断面図、第3図は第2図に示す部位の背面図である。

符号1で示された動力排気機は車体フレーム（エンジンヘッド）2を有し、この前上面にエンジン3を搭載する。エンジン3は前記車体フレーム2上に載置固定されるクランクケース3a、この後上部から後方へ傾斜して一体化したシリンダ3bを備える。そして、クランクケース3aの上部には燃料タンク4を配設するとともに、シリンダ3bの上方には第3図の如くエアクリーナ5、マフラ6等の補機系7を配設する。

以上により、第1図の如く側面は前上部に燃料タンク4、前下部にクランクケース3a、後上部に補機系7、後下部にシリンダ3bが各配置され、無駄のスペースが全くコンパクトにまとめられ、図に従来例で示した第4図の排気機40と比較した場合、各部の性能、容量等を略同じに構成したとして排気機40の全高がH_1（第1図仮想線）であるのに対し本排気機1のそれはH_1より低いH_2となり、この分重心が下がることになる。

なお、第2図の如くシリンダ3bが後方へ傾斜するためバルブ8、ロッカアーム9、点火プラグ10等を備えるシリンダヘッド11は後方へ突出し、又カム12、プッシュロッド13はシリンダ3bの下方に位置しており、更に、細部の外部形状等は有効にスペースが利用できるよう考慮されている。

また、第3図の如くシリンダ3bの上方に配設したエアクリーナ5及びマフラ6は並んで設けられるが夫々両側寄りに設け、更に排気管14、吸気管15は防熱を考慮して側方寄りに偏して設け、クリーナ5の下方に在りシリンダ3bの側方にはオヤプレタ16を配設している。

他方、第1図の如く車体フレーム2の後端部には縦長なミッションケース17を一体的に設け、前記シリンダ3bはこのミッションケース17の最も後方に位置することになる。ミッションケース17の上部にはハンドル支柱18を介してハンドル19が取付けられ、他方、下部には車軸20を介して排気ロータ21が支持され、更に後部には運転台22を備え、例えば排気時の抵抗棒23を支持する。

また、エンジン3側とミッションケース17側は夫々駆動プーリ24及び被動プーリ25に掛け渡した無端ベルト26及び中間に配した補助プーリ27にて回転が伝達される。

ところで、前述したシリンダ3bを後方へ傾斜せしめたが、この結果、比較的重量のある当該シリンダ3bは第1図の如く排気ロータ21の上方に位置することになる。即ち、第1図に示す排気ロータ21の最外径前端を通る鉛直線Xより後方へシリンダ3bが納まるため、この分重心が後方へ移り、これにより排気ロータ21には効果的に重量が加わることになる。このことは第4図に示す従来例に於ては当該鉛直線Xより前方にシリンダ42bが位置していることからも明らかである。

なお、第2図中特に説明を要しない符号28はピストン、29はクランクシャフト、30はエアクリーナエレメントを夫々示している。

以上の説明から明らかなように、本発明に係る動力耕転機は本体各部を合理的にレイアウト構成したため重心を効果的に下げることができ安定な耕耘作業を行うことができる。

また、重心を後方、即ち、耕耘ロータの上方へ有効に偏寄せしめ得るため重量が効果的に耕耘ロータ上へかかることにより浅耕等が惹起される。

更にまた、駆動系で代表される各種補機系をシリンダの上方又は近傍に納めることができ、これらの冷却が効果的になされ例えばキャブレタの異常な温度上昇等を防止できるとともに、全体をコンパクトに構成することができるためデザイン価値上良好で商品性に優れる等の種々の利点を備える動力耕耘機として提供できる。

4. 図面の簡単な説明

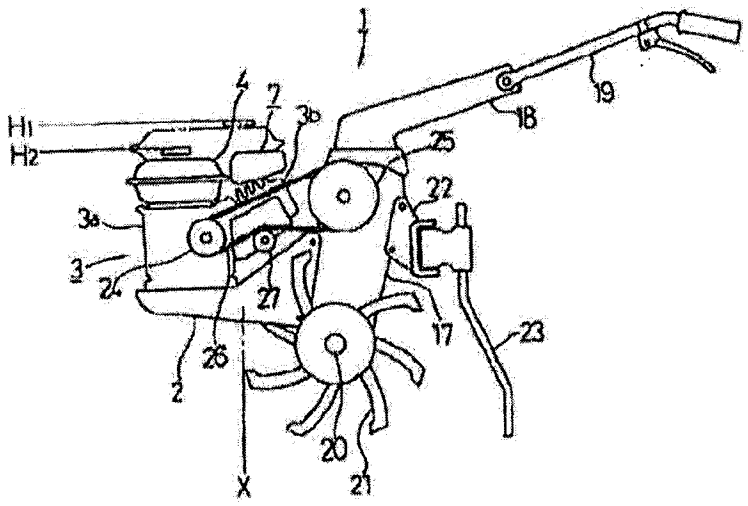
第1図は本発明に係る動力耕耘機の側面図、第2図はエンジン、補機系及び燃料タンクを斜線に示す第3図中2－2線断面図、第3図は第2図に示す部位の背面図、第4図は従来における動力耕耘機を示す概略側面図である。

図面中、3はエンジン、3aはクランクケース、3bはシリンダ、4は燃料タンク、5はエアクリーナ、7は補機系、17はミッションケース、21は耕耘ロータである。

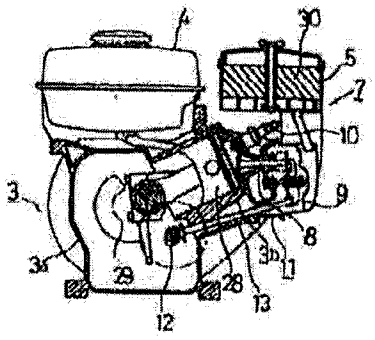
特許出願人　本田技研工業株式会社

代理人弁理士　下田容一郎
同　弁理士　大橋邦彦
同　弁理士　小山有

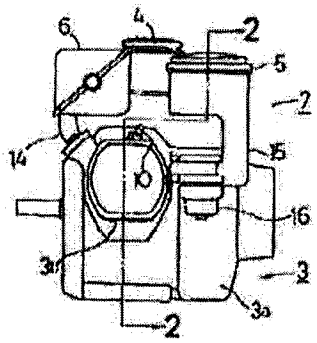
第1図



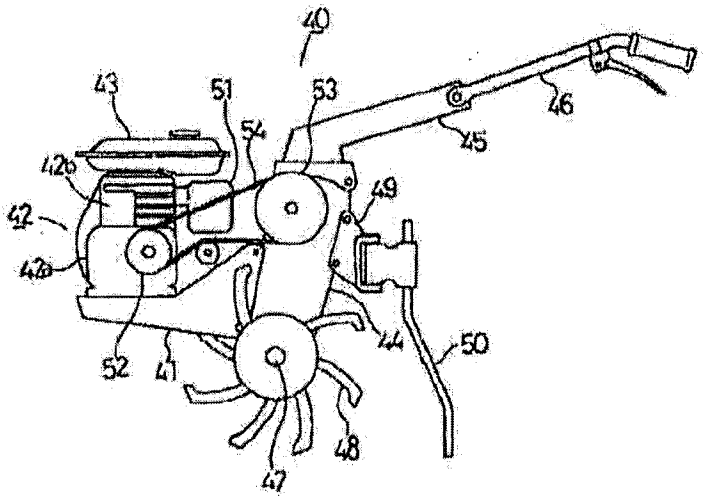
第 2 図


4
30
5
7
10
9
8
3
3a
29
28
11
13
12

第 3 図


6
4
2
5
2
14
15
10
16
3
3a
2

第 4 図


40
43
51
53
46
54
45
42b
49
42
42a
44
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52
41
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47

PAGES Y-1 to Y-4

CONFIDENTIAL

ATTORNEYS' EYES ONLY

EXHIBIT

FILED UNDER SEAL

PAGES Z-1 to Z-6

CONFIDENTIAL

ATTORNEYS' EYES ONLY

EXHIBIT

FILED UNDER SEAL

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE TRADEMARK TRIAL AND APPEAL BOARD

BRIGGS & STRATTON CORPORATION Opposer, vs. HONDA GIKEN KOGYO KABUSHIKI KAISHA, Applicant.	Opposition No. 91200832 (Parent)
KOHLER CO. Opposer, vs. HONDA GIKEN KOGYO KABUSHIKI KAISHA, Applicant.	Opposition No. 91200146

United States Patent and Trademark Office
Trademark Trial and Appeal Board
P.O. Box 1451
Alexandria, Virginia 22313-1451

OPPOSERS' SIXTH NOTICE OF RELIANCE
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PART 3

Exhibits AA to GG

PAGES AA-1 to AA-4

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EXHIBIT

FILED UNDER SEAL

PAGES BB-1 to BB-6

CONFIDENTIAL

ATTORNEYS' EYES ONLY

EXHIBIT

FILED UNDER SEAL

PAGES CC-1 to CC-12

CONFIDENTIAL

ATTORNEYS' EYES ONLY

EXHIBIT

FILED UNDER SEAL

PAGES DD-1 to DD-6

CONFIDENTIAL

ATTORNEYS' EYES ONLY

EXHIBIT

FILED UNDER SEAL

⑲日本国特許庁（JP）　⑪実用新案出願公告

⑫実用新案公報（Y2）　昭63－32344

㉛Int.Cl.⁴	識別記号	庁内整理番号	㉔㊹公告
F 02 B 67/00		Z－6624－3G	昭和63年(1988)8月29日

（全4頁）

㊵考案の名称　汎用内燃機関

前置審査に係属中　㉑実　願　昭57－53279　㊺公　開　昭58－156123
㉒出　願　昭57(1982)4月13日　㊸昭58(1983)10月18日

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審査官　熊沢　昶紀

㊻参考文献　実開　昭56－66031（J-P，U）　実公　昭38－15601（JP，Y1）
実公　昭47－24184（JP，Y1）

1

㊼実用新案登録請求の範囲

シリンダを水平よりやや上に傾け、吸排気弁の配置を頭上弁式とした汎用内燃機関において、吸排気弁を略水平に支持すると共に、ヘツドカバーをシリンダヘツドに対し略水平方向に着脱可能に備え、燃料タンクをクランクケースとシリンダの上方に配置してそのクランクケースとシリンダに支持させ、キヤブレータをシリンダヘツドの一側に配置してシリンダヘツドの吸気口と接続すると共に、シリンダヘツドより上でエアクリーナをキヤブレータの上方に配置してキヤブレータと接続し、同じくシリンダヘツドより上でエアクリーナと反対側にマフラを配置してシリンダヘツドの排気口と接続することによつて、シリンダヘツドおよびヘツドカバーより上でエアクリーナとマフラを左右に振分けて配置し、上記燃料タンクとエアクリーナとマフラの各上面を略そろえると共に、クランクケースのクランク軸突出面を含む垂直面と、その反対側のフアンカバーの外側面を含む垂直面との間に上記燃料タンク・キヤブレータ・エアクリーナ及びマフラを略位置させた汎用内燃機関。

考案の詳細な説明

本考案は農作業、土木作業その他各種作業の動力源として使用される汎用内燃機関に関する。この種の内燃機関は小型・軽量であるばかりでなく、多様な使用目的に対応できるように、例えば機関本体部分は共通でも、例えばクランクシヤフト、エアクリーナ、マフラなどは用途に合つたものを備え、又使用環境・条件等の相違から生じる機関各部分の維持手入れが容易であることも必要である。具体的な定期点検項目としては、潤滑油の点検・補給・交換、エアクリーナ・点火プラグ・燃料タンク・ストレーナ・コンタクトブレーカ・キヤブレータ・燃焼室等の清掃、及びタペツト・吸排気弁・ピストンリング・シリンダ・点火時期等の交換調整がある。

2

本考案は汎用内燃機関において必要な上記の要件を略満足できる内燃機関を得ることを目的とする。

汎用内燃機関において、シリンダを水平よりやや上に傾けることにより機関全体の高さを低くして小型化と使用時の安定を図つたものがある。本考案も上記シリンダが傾斜している型式で且つ吸排気弁の配置が頭上弁式の汎用内燃機関を基体とするもので、図面に示すようにクランクケース1とシリンダ2は一体に形成され、シリンダ2は水平よりやや上に傾斜している。そのシリンダ2の上端面を覆つたシリンダヘツド3の頂面に吸気弁4と排気弁5を並べて略水平に支持し、又上記シリンダヘツド3の頂面に点火プラグ6をシリンダ傾斜角度と略平行の方向に取付けている。そして

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吸排気弁用ロツカアーム７を覆うヘツドカバー８を、シリンダヘツド３に対し略水平方向に着脱できるように備えている。ヘツドカバー８は図に省略したボルトによつて固着される。

燃料タンク９をクランクケース１とシリンダ２の上方に配置し、ステー１０（タンク下半面保護板を兼用している）を介してクランクケース１とシリンダ２にそれぞれボルト１１で固着して支持している。

第２図・第３図に示すように、キヤブレータ１２をシリンダヘツド３の一側に配置してシリンダヘツド３の吸気口３Ａに連設し、シリンダヘツド３より上でそのキヤブレータ１２の上方にエアクリーナ１３を配置してキヤブレータ１２と連設している。実施例は、エアクリーナ１３とエルボ形吸気管１４を一体に形成し、その吸気管１４をエアクリーナ取付ステーに兼用している。又その吸気管１４をキヤブレータ１２に固着するボルト１５を延長してシリンダヘツド３にねじ込むことによりキヤブレータ１２とエアクリーナ１３を共締め固着しているが、キヤブレータ１２及びエアクリーナ１３の取付け構造に限定はない。

そしてシリンダヘツド３より上でエアクリーナ１３と反対側にマフラ１６を配置してシリンダヘツド３の排気口３Ｂに排気管１７を介して連設している。

図中１８はピストン、１９はクランク軸、２０はカム軸、２１はタペツト、２２はプツシユロツド、２３はフアンカバー、２４はクランクケースカバーを示す。

上記燃料タンク９とエアクリーナ１３とマフラ１６の各上面は、略同じ高さにそろつている。又クランクケース１のクランク軸突出面（クランクケースカバー２４の外側面）を含む垂直面と、その反対側のフアンカバー２３の外側面を含む垂直面との間に、上記燃料タンク９・キヤブレータ１２・エアクリーナ１３及びマフラ１６を略位置させている。

点火プラグ６の清掃交換の際の着脱を容易にするために、第２図に示すようにエアクリーナ１３とマフラ１６の間を若干空けておくを可とする。

エアクリーナ１３は、油を含浸させたウレタンフオームを濾過材１３Ａに用い、下面開口１３Ｂから吸気する構造である。ヘツドカバー８にブリーザチヤンバ２５が設けられ、そのチヤンバ２５はチユーブ２６でエアクリーナ１３に連結されている。

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従つてクランク室１Ａは通路２７・ロツカアーム室８Ａ・ブリーザチヤンバ２５・チユーブ２６を経てエアクリーナ１３に連通する。２８はブリーザバルブ、２９，３０は油戻し穴である。

本考案汎用内燃機関は上記のように、水平よりやや上に傾いているシリンダ２・シリンダヘツド３に対し、ヘツドカバー８を略水平方向に着脱できるようにしたから、ヘツドカバー８を外すのみでタペツト部が現れ、吸排気弁４，５が水平に支持されているから、タペツト部の間隙は上下方向を向いていてタペツト調整が容易である。またシリンダ２・シリンダヘツド３・ヘツドカバー８を上記のように配置したことにより、吸排気弁４，５を始めとしてブリーザバルブ２８・点火プラグ６・キヤブレータ１２等がシリンダヘツド側の側面に集中し、それらの部品の調整点検が容易である。燃料タンク９は、一体に形成されているクランクケース１とシリンダ２にのみ支持させたから、他部品例えばシリンダヘツド３、キヤブレータ１２等を清掃等のために取外すとき、タンク９まで外す必要がなくて迅速容易に着脱できる。

キヤブレータ１２及びマフラ１６は、シリンダヘツド３の両側にそれぞれ配置し、エアクリーナ１３はキヤブレータ１２の上方に配置したから、それらの部品１２，１３，１６は互いに干渉することなく個々に着脱できて、前記各部の保守点検作業を容易にする効果がある。

燃料タンク９は前記のようにクランクケース１と傾斜しているシリンダ２の上方に、エアクリーナ１３及びマフラ１６はシリンダヘツド３の上方にそれぞれ配置して、それらをクランクケース１のクランク軸突出面を含む垂直面と、その反対側のフアンカバー２３の外側面を含む垂直面との間に略収まるように位置させたから、クランクケース１・シリンダ２・シリンダヘツド３・ヘツドカバー８の上方に、燃料タンク９・エアクリーナ１３・マフラ１６を可能な限り大きな容積スペースを保つて設置することができ、又燃料タンク９・エアクリーナ１３・マフラ１６の３部品をコンパクトに配置できてデザイン的にも良好である。

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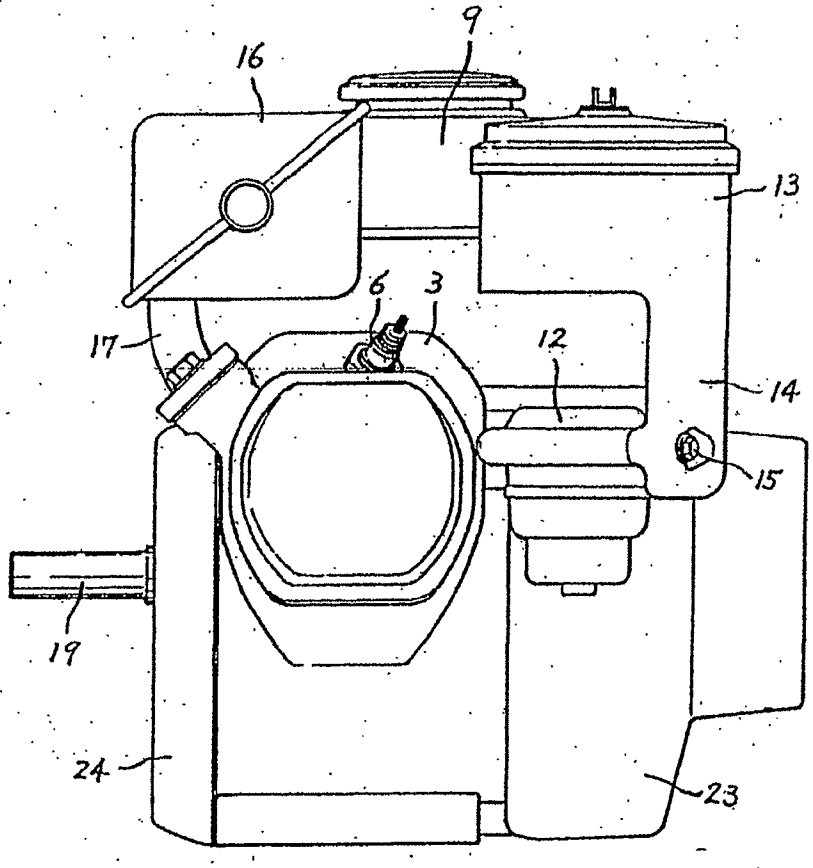
図面の簡単な説明

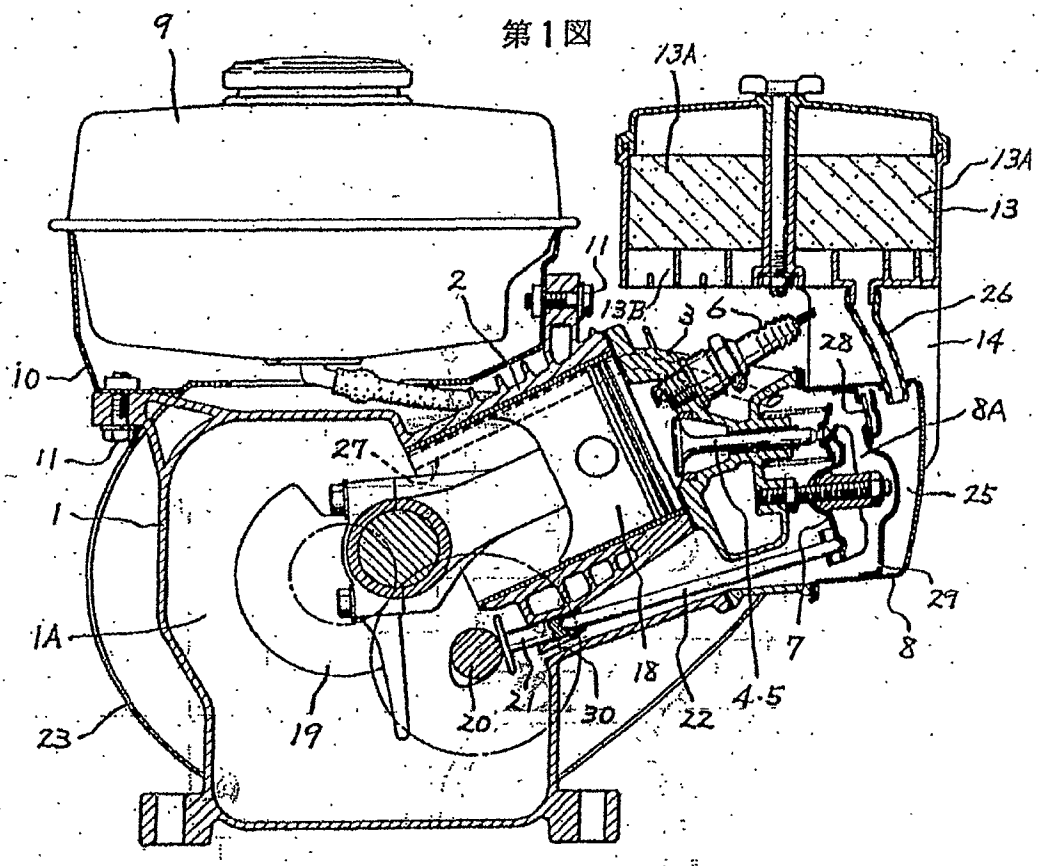
第１図は本考案内燃機関の縦断正面図、第２図は側面図、第３図は一部横断平面図。

１はクランクケース、２はシリンダ、３はシリンダヘッド、４は吸気弁、５は排気弁、６は点火プラグ、７はロッカアーム、８はヘッドカバー、９は燃料タンク、１２はキャブレータ、１３はエアクリーナ、１４は吸気管、１６はマフラ、１７は排気管、１８はピストン、１９はクランク軸。

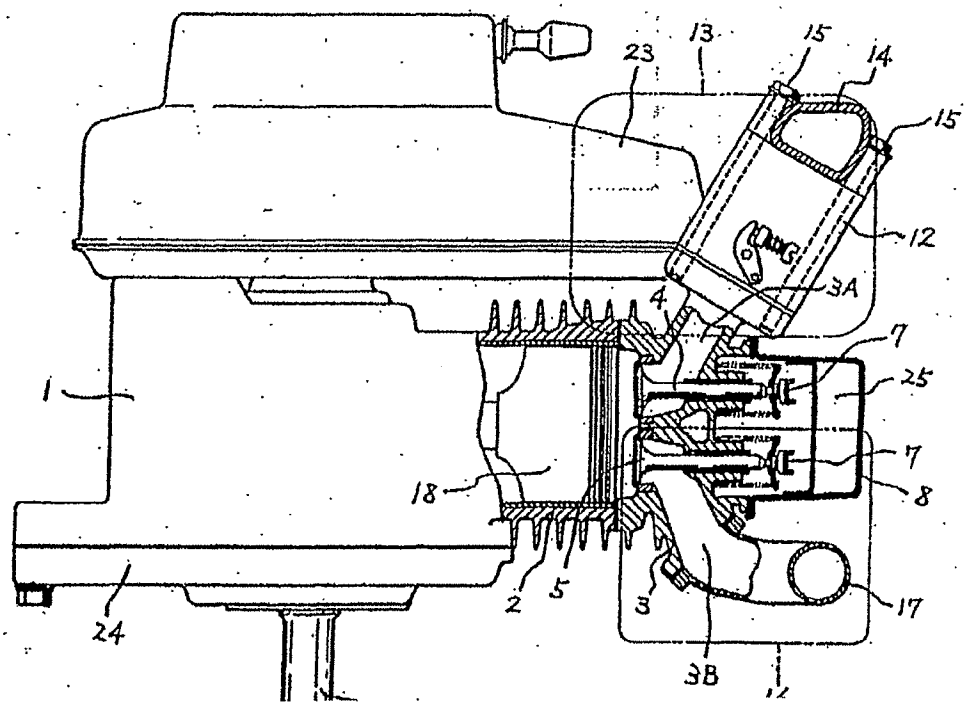
第２図



第1図


9
13A
13A
13
11
2
13B
3
6
26
14
28
10
8A
11
27
25
1
29
1A
7
8
18
4·5
23
19
20
21
30
22

第3図


23
13
15
14
15
12
3A
4
7
25
1
7
18
8
2
5
3
17
24
3B

(19) Patent Office of Japan (JP)

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(54) Title of the Innovation: GENERAL-PURPOSE INTERNAL COMBUSTION ENGINE

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(74) Agent: Patent attorney, Takeshi FUKUDA	
Examiner: Mr. Kumazawa	

(56) References cited by the examiner: UM S56-66031 (JP, U); UM S38-15601 (JP, Y1); UM S47-24184 (JP, Y1)

(57) Claims:

A general-purpose internal combustion engine with a cylinder inclined slightly upward from the horizontal direction and with intake and exhaust valve system in an overhead arrangement, characterized in that said intake and exhaust valve system is supported in a substantially horizontal position, said engine further comprising: a head cover that is removably installed in a substantially horizontal position relative to said cylinder head; a fuel tank that is located above said crankcase and cylinder and is supported by said crankcase and cylinder; a carburetor located on one side of said cylinder head and is connected to a suction port of the cylinder head; an air cleaner located above said cylinder head and over said carburetor and is connected to the latter; a muffler that is also positioned above said cylinder head but on the side thereof opposite to said air cleaner and that is connected to an exhaust port of said cylinder head, whereby the air cleaner and the muffler are located above the cylinder head and the head cover and on the left and right sides thereof, respectively; the upper surfaces of the fuel tank, air cleaner, and muffler are arranged to be substantially flush with one another; and the fuel tank, carburetor, air cleaner, and muffler are arranged substantially between a vertical surface that includes a crankshaft protrusion surface of the crankcase and a vertical surface that includes an outer surface of a fan cover located on the opposite side.

Detailed Description of the Innovation

This model is related to general purpose internal combustion engines that are used as sources of power for agricultural work, civil engineering work, and other work of all kinds. Internal combustion engines of this kind are not only compact and lightweight, but also adaptable to a wide variety of applications. For example, such engines needs to have a common main body, but can be equipped with different crankshafts, air cleaners, mufflers, or other equipments suited to the particular use. Further, such engines needs to allow for easy maintenance and care of different engine parts as made necessary by different environments and conditions of use. Specific items for periodic inspection include: inspection, replenishing, and change of lubricants; cleaning of air cleaners, spark plugs, fuel tanks, strainers, contact breakers, carburetors, and combustion chambers; and replacement and adjustment of tappets, intake and exhaust valves, piston rings, cylinders, ignition timing, and so on.

The purpose of this model is to provide an internal combustion engine that fulfills the above requirements necessary for general purpose internal combustion engines.

There is a general purpose internal combustion engines in which the cylinder is tilted slightly upward from the horizontal direction to reduce the height of the engine, thereby downsizing the engine and stabilizing the engine during use. This model is also based on a general purpose internal combustion engine format that has cylinders angled in this way, and intake and exhaust valves in an overhead arrangement. As shown in the drawings, the crankcase 1 and cylinder 2 are formed as a single body, with the cylinder 2 angled slightly upward from the horizontal direction. The surface of the upper end of the cylinder 2 is covered by the top surface of the cylinder head 3, on which the intake valve 4 and exhaust valve 5 are located side by side and supported substantially horizontally, and on which the spark plug 6 is also attached at an angle that makes it substantially parallel to the angle of the cylinder. The head cover 8, which covers the rocker arm 7 for the intake and exhaust valves, is detachably connected in a substantially horizontal manner with respect to cylinder head 3. The head cover 8 is fixed in place by bolts that are omitted from the figure.

The fuel tank 9 is placed above the crankcase 1 and cylinder, and is fixed in place and supportedly connected by bolt 11 to the crankcase 1 and cylinder 2 through a stay 10 (which is also used as a protective plate over the surface of the bottom half of the tank).

As shown in Figs. 2 and 3, the carburetor 12, which is positioned to one side of the cylinder head 3, interconnects with intake port 3A on cylinder head 3, while the air cleaner 13, which is positioned over the carburetor 12 above the cylinder head 3, interconnects with the carburetor 12. An embodiment has the air cleaner

13 and elbow-shaped intake pipe 14 formed as a single body, and the intake pipe 14 is also used as an air cleaner mounting stay. The bolt 15 that fixes the intake pipe 14 in place onto the carburetor 12 is lengthened so that it screws into the cylinder head 3, thereby fastening both the carburetor 12 and the air cleaner 13 in place together, but this does not suggest any limitation on the mounting structure of the carburetor 12 and air cleaner 13.

The muffler 16, which is positioned above the cylinder head 3 and on the opposite side of the cylinder head 3 from the air cleaner 13, interconnects with the exhaust port 3B on the cylinder head 3 by means of an exhaust pipe 17.

Reference numeral 18 in the drawings indicates the piston, 19 the crankshaft, 20 the camshaft, 21 the tappet, 22 the pushrod, 23 the fan cover, and 24 the crankcase cover.

The upper surfaces of the fuel tank 9, air cleaner 13, and muffler 16 noted above are arranged at substantially the same height. The fuel tank 9, carburetor 12, air cleaner 13, and muffler 16 are positioned substantially between the vertical surface that includes the crankshaft protrusion surface (the outer surface of the crankcase cover 24) of the crankcase 1 and the vertical surface that includes the outer surface of the fan cover 23 located on the opposite side.

Some space can be left open between the air cleaner 13 and the muffler 16, as shown in Fig. 2, so that removal of the spark plug 6 for cleaning and replacement can be made easier.

The air cleaner 13 is constructed to utilize oil-soaked urethane foam as the filter material 13A and draw in air from the opening 13B on the lower surface of the air cleaner 13. The head cover 8 contains the breather chamber 25, which is coupled to the air cleaner 13 by means of the tube 26.

Consequently, the crankcase 1A is interconnected with the air cleaner 13 through the passage 27, rocker arm 8A, breather chamber 25, and tube 26. Reference numeral 28 designates the breather valve, while 29 and 30 are oil return ports.

This general purpose internal combustion engine model is made with the head cover 8 detachable in a substantially horizontal manner with respect to the cylinder 2 and cylinder head 3 that are angled somewhat upward from the horizontal direction, as described above. Therefore, the tappet area is revealed simply by removing the head cover 8, and because the intake and exhaust valves 4 and 5 are supported horizontally, the space in the tappet area extends in a vertical direction such that tappet adjustment is made easier. The arrangement of the cylinder 2, cylinder head 3, and head cover 8 as described above means that the intake and exhaust valves 4 and 5, as well as the breather valve 28, spark plug 6, carburetor 12 and other parts are clustered together on a side surface on the cylinder head such that adjustment and inspection of those

parts are made easier. The fuel tank 9 is supported only by the crankcase 1 and cylinder 2, which are formed as a single body, so that when other parts, such as the cylinder head 3 or the carburetor 12, are removed for cleaning or other purposes, it is not necessary to remove the tank 9, and those parts can be attached or detached fast and easily.

The carburetor 12 and muffler 16 are positioned on the respective sides of the cylinder head 3, and the air cleaner 13 is positioned above the carburetor 12. Therefore, those parts 12, 13, and 16 can be detached and installed without interfering with each other. This has the effect of making maintenance and inspection work on the above-mentioned parts easy.

The fuel tank 9 is positioned above the crankcase 1 and the inclined cylinder 2, as described above, and the air cleaner 13 and muffler 16 are both positioned above the cylinder head 3. They are positioned in such a way that they fit substantially between the vertical surface that includes the crankshaft protrusion surface of the crankcase 1 and the vertical surface that includes the outer surface of the fan cover 23 located on the opposite side. Thus, the fuel tank 9, air cleaner 13, and muffler 16 can be positioned in a space having a volume as large as possible above the crankcase 1, cylinder 2, cylinder head 3, and head cover 8. This is favorable from the design standpoint, since the aforementioned three parts (the fuel tank 9, air cleaner 13, and muffler 16) can be arranged compactly.

Brief description of the drawings

Fig. 1 is a front view in longitudinal cross-section of this internal combustion engine model. Fig. 2 is a side view, and Fig. 3 is a transverse partially sectional plan view.

1 is the crankcase, 2 the cylinder, 3 the cylinder head, 4 the intake valve, 5 the exhaust valve, 6 the spark plug, 7 the rocker arm, 8 the head cover, 9 the fuel tank, 12 the carburetor, 13 the air cleaner, 14 the intake pipe, 16 the muffler, 17 the exhaust pipe, 18 the piston, and 19 the crankshaft.

PAGES FF-1 to FF-5

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PAGES GG-1 to GG-11

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