XIV EUROPEAN ROTORCRAFT FORUM

Paper N° 28

THE PATENT DOCUMENT
AN UNDERESTIMATED INFORMATION VEHICLE

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The Patent Document,

an underestimated Information Vehicle

1. Abstract

An important issue, when the designer is called to take care of a technical problem, whether it's the design of a new machine or of a part of it, is the easy access to the bulk of technical information available on the current subject.

Among the different "information vehicles" offered to the designer, patent documents are the most important ones.

The subjects dealt with in patent documents are often published nowhere else, except as internal private reports in the applicant firm.

Patents are published with very strict time limits, so they are available sooner than technical magazines.

Retrieval of the information is quick and easy, through an international classification system, consisting of roughly 350 classes in the aeronautic field.

Patent databases facilitate the access to all this information.

Patent information helps to avoid duplication of work, to forecast new technological trends and to determine the patentability of the internally developed inventions.

To illustrate the preceding statements and to better show the suitability of the patent information system to gain a wider knowledge of a well defined problem, peculiar to the helicopter domain, a selection of the many different solutions to counter the torque of the main rotor in a single rotor helicopter is presented, taking advantage of the related patent literature, consisting of ± 500 documents.

2. Introduction - Technical information is important

Engineers and researchers can improve their performance by making themselves better informed about the most up-to-date state of the art in their specific technical field. The knowledge of the state of the art keeps the specialist in touch with the trends developing in his field of interest.

If the information is readily available, we can avoid the waste of time and money represented by the duplication of the work already done by somebody else.

In the meantime a spectrum of all the solutions proposed by other searchers can often be helpful to spot the general approach to a problem, or the unexploited ways to get or to optimize a solution.

Once the information has been collected, to be useful it has to be classified in some way, to be retrieved when necessary, and stored.

Owing to our personal data bank having some, not yet well identified, limits, due to the somewhat fixed dimension of our skull, it is clear that a part of the technical information must be stored somewhere else, still bearing in mind the need of an easy and accurate access.

Owing to their number (many million) patents present the same problem of storing, classifying, retrieving, so it's easy, and reasonable, to take advantage of the solutions already put forward for the patent system, and use the tools tailored to it (patent classification system, patent collections, patent data bases) to solve our problem.

Once the importance of the technical information is realized, we can look to the different information vehicles available to us.

Among the classic ones (proceedings of congresses or conferences, technical magazines, and so on), patents are a very powerful information carrier, featuring well defined and useful advantages.

It's customary to observe the patent document as a juridical act assessing legal rights on an invention (an object, a manufacturing process, a method and so on), but it's less usual for many people to see the other facet of it, even more important from a technical oriented standpoint, as an information vehicle.

3. Description - The patent document is a valid information carrier

As a matter of fact, the patent document can be seen as one of the most important stores of technical knowledge available.

The information given by the patent document is :

a) complete
b) presented in a uniform way
c) often in more than one language
d) quickly published
e) classified in a homogeneous, finely subdivided system
f) easy to retrieve

These quite peculiar characters are worthy of a closer examination.

One of the conditions to the validity of a patent is that the invention must be clearly described, in such a way that an expert of that particuliar field could be able to understand and reproduce it.

The patent document must be completed with all the drawings necessary to be fully understood by the reader. Even more, the structure of the presentation of the information in the patent document is quite uniform, making possible an easier access to it, and also the language barrier can be often overcome, taking advantage of the fact that many inventions are patented in different countries, and so in different languages too, and it's often possible to find a patent in a known language corresponding to another patent written in a less accessible idiom.

Owing to its character of a legal protection act, it is in the interest of the inventor to apply for a patent as soon as possible, to prevent any risk of being preceded by somebody else.

In addition, very strict time limits exist to ensure that a patent application is published and so made openly available to everybody.

The result is that patents are usually the first document published on a certain issue, and, even more important, the content of many patents is never published anywhere else, except as internal, private, report in the applicant firm.

The question can now arise of quantifying the amount of information made available through patents. To stay limited to our field of interest, looking at the last 8 years, there are roughly 100 new documents per year strictly dealing with helicopters, bearing in mind that a subject connected with helicopters but not limited to it, for instance a particuliar of the structure, or of the controls, or others, finds its place in the general groups of aviation structures or flying controls, and so on.

The aviation field counts an average of 800 new patents per year, but again some items currently connected with aviation, but common also to the other fields, are classified in more general groups, and do not enter in this count.

Looking broadly at the world of patents, about 950.000 documents are published every year in more or less 80 countries, describing around 350.000 inventions, so that on average almost 3 patents are published for every invention.

The total number of patents since 1850 is now over 40 million.

It makes a mass of information available and is quite often underestimated by engineers and scientists. Of course such a big amount of documents need an efficient retrieval system to be effectively exploited. This exists in the form of an "International Patent Classification" in which all the peculiarities of the various fields are carefully specified and finely subdivided into groups, each defined by an alpha-numeric symbol, and subject to periodic revisions to keep pace with the evolution of technology in the different domains.

If necessary, new subclasses can be opened at any moment to help to better characterize a new aspect of a certain domain. The "International Patent Classification" is a hierarchical system with approximatively 60.000 categories.

A "catchword index" makes it easier to find the right classification symbol for every conceivable technical subject.

In the aviation field around 350 classes exist, containing a total of about 90.000 documents, including the almost 9.000 patents strictly related to rotorcrafts, arranged in 65 subclasses.

A certain amount of this mass of documents is now quite old, but it doesn't mean these patents can be peacefully overlooked; as an example, if we refer to the class of the rotor blades, and in particular to composite blades, an item not new but not very old either, we can see that applications for patents describing rotor blades made of fiberglass fabric impregnated with thermosetting resin were already actual in 1944 and 1949, see US 2.630.868 and US 2.588.570 granted to General Electric and Autogyro Company of America (Fig. 1,2).

It happens sometimes that interesting and valid ideas showed in a patent are not brought forward due to limits of the available technology or economic reasons, until the technical evolution makes them feasible or economic, and they are sorted out again.

An access to patent literature can be through data bases, where the search can be performed using key-words, particular codes, classification symbols, names of the inventors, and so on.

These data bases usually provide you with bibliographical data, or at best an abstract of the invention. The full text of patents is always available in public patent libraries. Most industrialized countries have such libraries in their territory.

To illustrate the preceding statements and to better show the suitability of the patent literature to gain a wider knowledge of a well defined problem, peculiar to the helicopter domain, a selection of the many different solutions to counter the main rotor torque in a single rotor helicopter is presented, taking advantage of the related patent literature, consisting of around 500 documents.

Of course the most obvious solution, the classic tail rotor, won't be taken into account.

4. Example - The anti-torque alternatives

Let's state in advance that the following is only a selection of the most relevant or curious approaches to the cited anti-torques need, and the selected documents have been ordered in the scheme hereunder :

(a) Fenestron
(b) Non classical rotor
(c) Non axisymmetric thrust
(d) Tail propulsion propeller with slip stream deflection
(e) Tail jet
(f) Down wash immersed aerodynamic surfaces
(g) Magnus effect acting tail boom
(gl) in combination with tail jet modulation (NOTAR)

(a) The fenestron is today a very well known solution, owing to its use on a number of Aérospatiale designs, we only look a little back in time to spot its birth.

The patent FR 1.511.006, applied for in 1966 in the name of Mr. Mouille, Sud-Aviation, shows a fenestron arrangement, associated with a propulsion propeller, fig. 3.

US 3.212.583, United Aircraft, 1964, deals with a "control force fan", fig. 4, and, going back to 1944, US 2.473.329 to Borg-Warner Corporation, already showed a similar solution, but with a fixed pitch impeller associated with control louvers, fig. 5.

Nevertheless, one year before GB 572.417, applied for in 1943 by Weir Ltd., later Cierva Autogyro Comp., fig. 6, shows a pitch controllable sort of fenestron, suggesting also in addition the possibility of tilting it in such a way to use it as a pusher propeller at a speed where the rudder equipped fin could bear the anti-torque duty.

(b) A non classical tail rotor is the conical rotor of US 3.589.647, fig. 7, filed in 1969 by Boeing, suitable for generating lateral and axial forces, with the additional possibility of changing the cone angle, fig. 8.

Dornier-Werke suggests in its patent GB 1.118.117, 1965, that a tail propulsive rotor with cyclic and collective pitch adjustments could be a solution to the requirements of either an anti-torque device or a propulsive device, fig. 9.

DT 1.136.580 by Bölkow in 1960 shows a tail rotor which can be stopped and stowed, with one or two blades, fig. 10.

US 2.788.075, Autogyro Company of America, 1952, claiming an English priority in 1944, shows a paddle wheel tail rotor, fig. 11, which can also be doubled, fig. 12.

A similar paddle wheel, but with vertical axis, also known as a "Voith-Schneider" propeller, is shown in FR 1.017.976 fig. 13, by the Cierva Autogyro Company, the European counterpart of the Autogyro Company of America, in 1947.

(c) A longitudinal force not on the plane of symmetry of the machine, but with some moment arm to create a moment around the yaw axis, can give an anti-torque effect.

US 3.698.666 to SIAI-Marchetti in 1970 shows an application of that idea, fig. 14, even if only as a relief for a still present tail rotor.

The tail rotor disappears in GB 895.590, fig. 15, by Agusta, 1960 (Italian priority 1959), where the pitch of the propellers is reversible, so that it is possible to generate a pure torque, with no longitudinal unbalance.

Mr. Pitcairn, of the Autogyro Company of America, taught in US 2.407.327, fig. 16, in 1942, the use of an offset propeller, just as Mr. Bennet, of the same firm, did in 1940, US 2.317.340, showing single and double propeller arrangements, fig. 17, 18.

(d) A pusher propeller and associated deflection system, to get the amount of lateral force needed to counteract the main rotor torque, is showed in US 4.660785 by Mr. Munsky, 1985, fig. 19, an additional side force is created by modulating a lateral airflow through two doors at the end of the tail boom.

A set of three patents, US 3.260.482, US 3.241.791 and US 3.222.012, fig. 20, 21, 22, from Piasecki Aircraft Corp., two in the name of Mr. Frank Piasecki himself, show different arrangements of shrouded tail propellers with control vanes to obtain lateral and vertical forces.

(e) A tail jet, either cold, from an impeller, or warm, from exhaust gases, can be used for propulsion and as anti-torque device, if deflected in a suitable way. US 3.957.226, by Boeing, 1975, shows such a solution, fig. 23. In US 3.510.087, by Mr. Strickland, 1968, we see an helicopter driven by the cold stream of air from a blower impinging on a turbine, fig. 24. Part of the air is discharged laterally at the end of the tail boom, and some vanes control the flow.

GB 1.223.602, by Sud-Aviation, 1967, describes two solutions, the first one using a jet of compressed air discharged laterally, fig. 25, the second one with an internally vented split rudder, fig. 26.

CH 467.191 by M.A.N. Turbo, 1967 (German priority 1966) shows how the exhaust gas of the turbine engine can be used to generale a lateral force, fig. 27, and such an idea is already present in US 3.189.302, by Mr. Bullinger, 1963, fig. 28, even if only as a back-up emergency system.

Sud-Aviation again in 1962 applied for patent FR 1.298.518, where two ways to deflect an axial flow are shown, fig. 29.

Lockheed in two patents, both of 1960, US 3.047.254 and US 3.015.460, shows two possible systems, the first one with two doors, fig. 30, the second with a swinging nozzle, fig. 31.

Aerotecnica, a Spanish company, has patents on a tilting nozzle, DE 1.009.492 (Spanish priority 1955), fig. 32, and on deflecting vanes, GB 818.358, 1955, fig. 33.

A large side opening is shown in US 2.784.792, by Mr. Avery, 1952, fig. 34.

A well known name, Mr. Hiller, presents in US 2.481.749, 1946, his version of the system, fig. 35.

In its patent of 1944, US 2.518.697, United Aircraft gives a multiple solution, where the airflow used to cool the engine is directed backwards. The engine exhaust may operate an ejector to help the fan. Control vanes, fig. 36, a rotating adjustable nozzle or an ejector arrangement, fig. 37, provide the necessary lateral force.

A sort of blown rudder, like that seen previously, is proposed by Mr. Whiting in US 2.433.251, 1944, fig. 38.

In 1943 Mr. Gazda already suggested in US 2.486.272 the use of an anti-torque reaction jet of compressed exhaust gas, fig. 39.

One year before, in 1942, Weir Ltd., in GB 563.427, showed the use of a blower operated by the engine exhaust gas, to direct a flow of air on a discharging lateral nozzle, with or without the use of an ejector, fig. 40.

Another famous name, that of Mr. Focke, signs patent FR 883.462 (German priority 1940), where one of the first jet deflection systems is showed, fig. 41, here again the tip of the tail boom, with the directing vanes, can turn about the longitudinal axis.

(f) The presence of a down-wash gives the possibility to interact with it using aerodynamic surfaces to get a lateral force leading to an anti-torque effect.

US 4.462.559, by Mr. Garza, 1982, shows a tail aileron complete with a trimming tab, and a rudder at the end, fig. 42.

Mr. Miller in his patent US 3.432.119, 1966, suggests the use of two side surfaces in addition to a retractable drag surface on which the airflow due to the translation will impinge, fig. 43.

FR 1.356.307, 1964, in the name of Mr. Breteau, fig. 44, shows again vertical ailerons in the down-wash, like Mr. Kirchoff, in 1945, US 2.437.324, fig. 45, with his egg-shaped machine.

An interesting solution, with the fuselage shaped as a vertical wing, is presented by Mr. Coats and Mr. Hafner, in their patents GB 501.014 and GB 448.703 of 1937 and 1934, with split flaps on the lower part of the fuselage, fig. 46, or a combination of leading and/or trailing edge devices, fig. 47. On this last one the flow on the fuselage is reversed, because the machine is actually an autogyro.

(g) Another way to take advantage of the down-wash to create a lateral force on the tail boom is to shape the airflow on it by various means.

In US 3.211.398 to Power Jets, 1963 (British priority 1961), double blowing slots are provided on both sides of the fuselage, at the front and rear parts of it, fig. 48. A valve system controls the effect of the blowing.

A similar idea is mentioned in US 3.059.877, to United Aircraft Corp., 1961, where the exhaust gas is brought in the tail boom and discharged through a plurality of slots, fig. 49.

A real Flettner's rotor is presented in US 2.452.355, to Borg-Warner Corp., 1944, where the complete cylindrical tail boom rotates, creating a lateral force via Magnus effect, fig. 50.

(gl) A combination of the previous Magnus effect via tangential blowing and the use of a tail jet is the well known NOTAR (NO TAil Rotor) system.

Patent US 4.200.252, 1977, to Summa Corp., describes the system, now close to certification, fig. 51.

Already in 1972 Lockheed filed patent US 3.807.662, with a similar concept, fig. 52, but different details.

5. Conclusions

An information system practically ignored by researchers and technicians has been presented. Special features and advantages of the patent system for spreading information among the scientific and technical community have been pointed out.

The potential of this system has been showed through data on the amount of the documents available and through a relevant example pertaining to the field of helicopter design.

6. References

- P. Vermeesch : "Oktrooi informatie : een venster op de wereld van innovatie" in "Het Ingenieursblad", vol. 56, 4, 1987.

- Patent Collection of the European Patent Office.

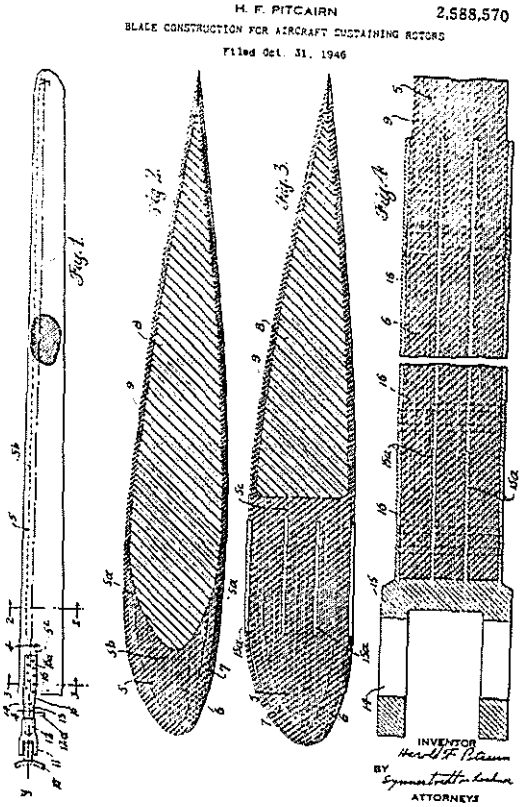


Fig. 1

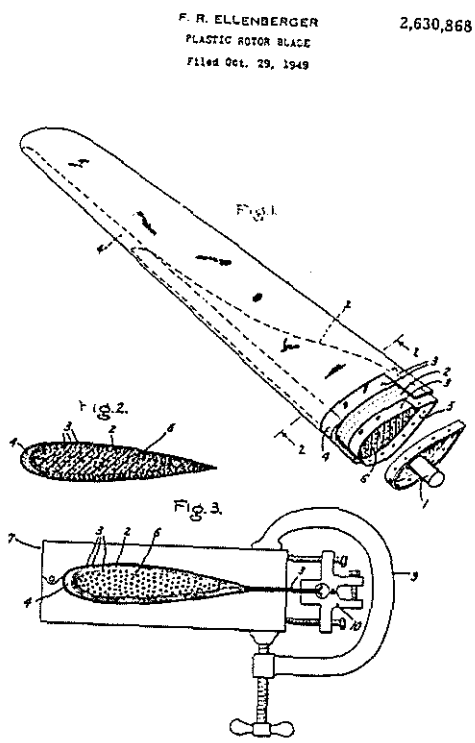


Fig. 2

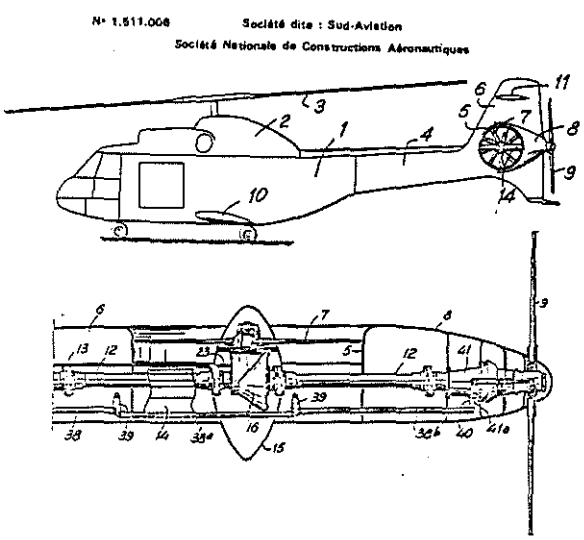


Fig. 3

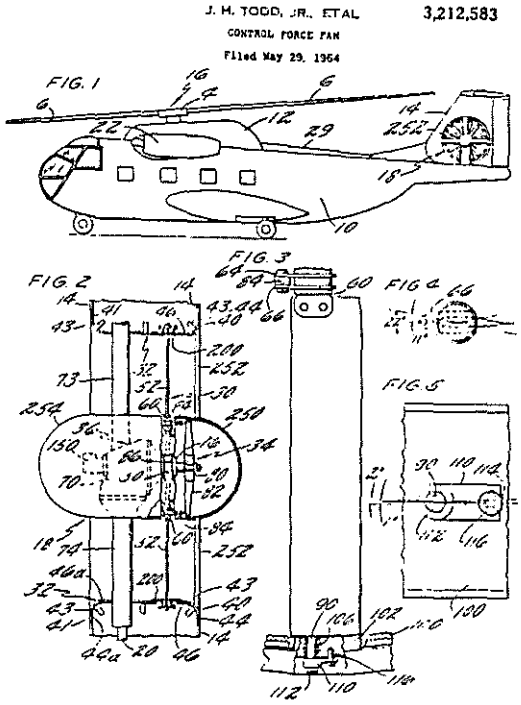


Fig. 4

J. N. CANDLER 2,473,329

TAIL ROTOR FOR HELICOPTERS

Filed Dec. 15, 1944

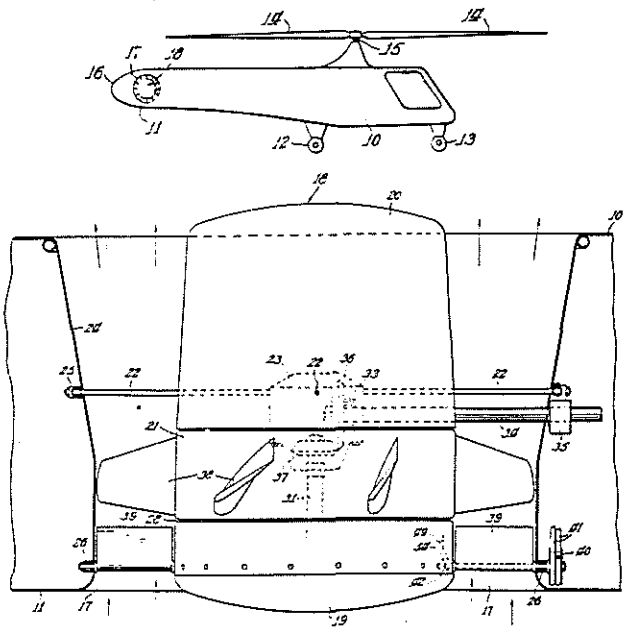


Fig. 5

572.417 COMPLETE SPECIFICATION

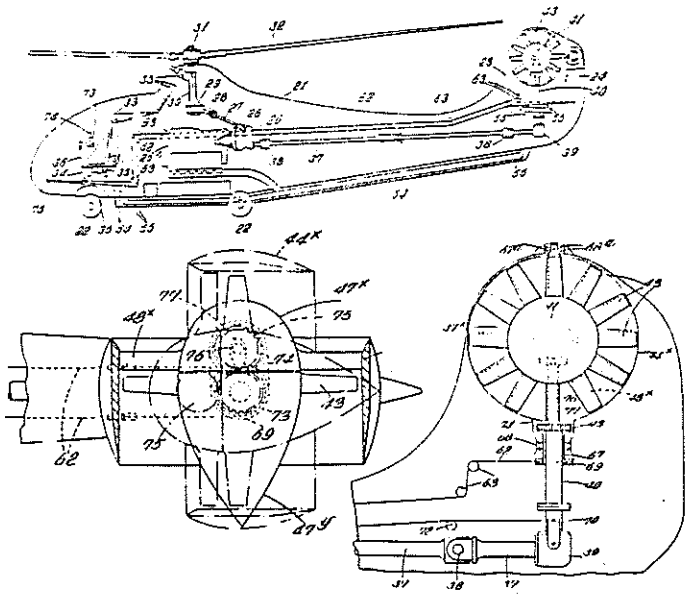


Fig. 6

3,589,647

SHEET 1 OF 3

Fig. 1.

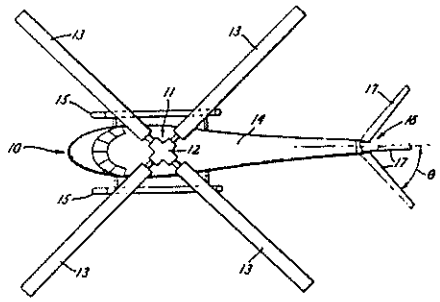


Fig. 2.

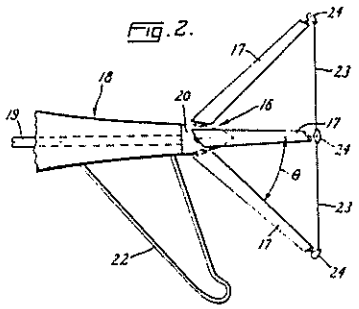


Fig. 7

Fig. 4.

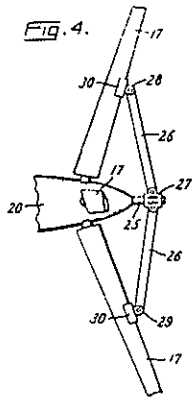


Fig. 4a.

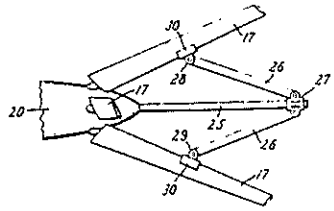


Fig. 8

1118117 COMPLETE SPECIFICATION

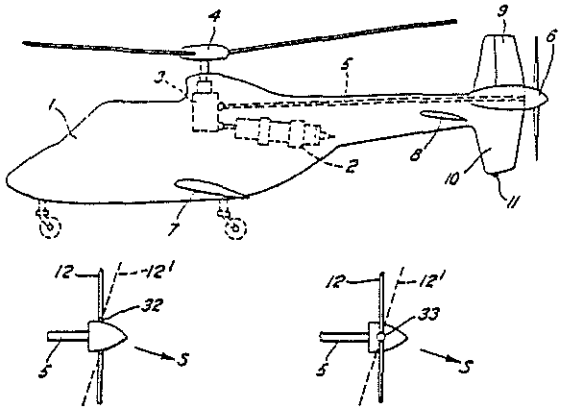


Fig. 9

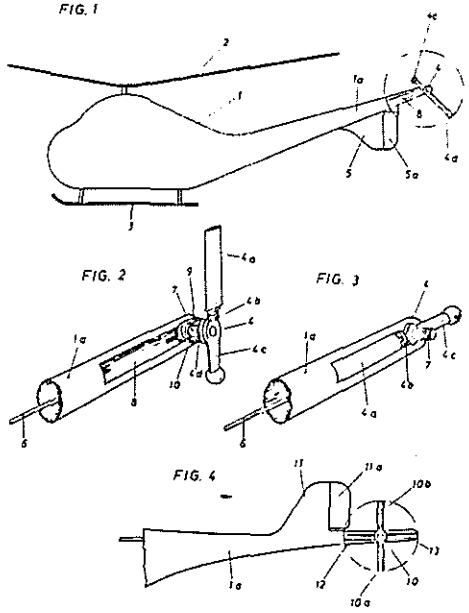


Fig. 10

C. G. PULLIN ET AL 2,788,075

HELICOPTER WITH PADDLE WHEEL TYPE TAIL ROTOR

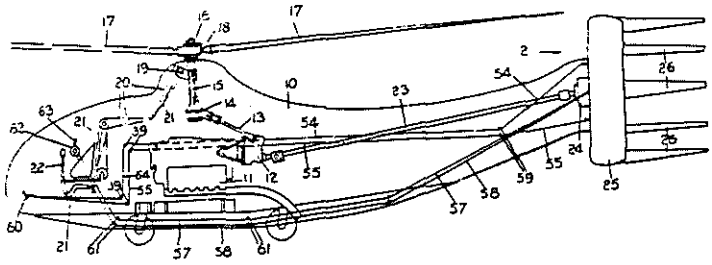


Fig. 11

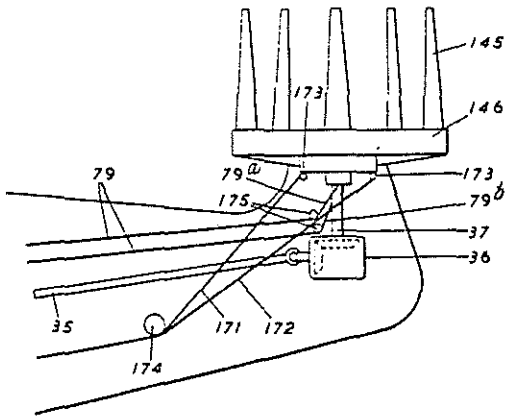


Fig. 13

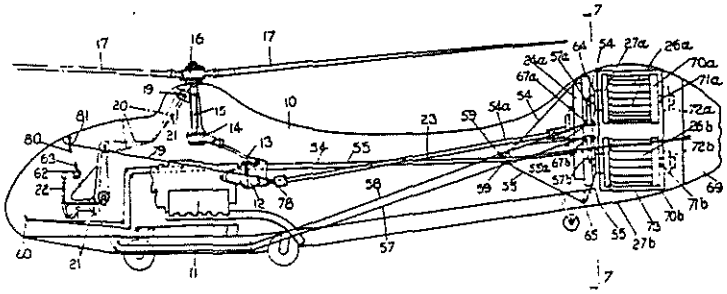
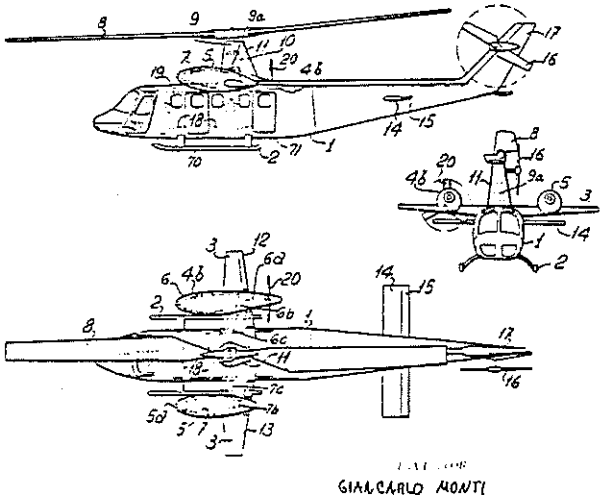


Fig. 12

3,698,666



GIANCARLO MONTI

Fig. 14

895590 COMPLETE SPECIFICATION

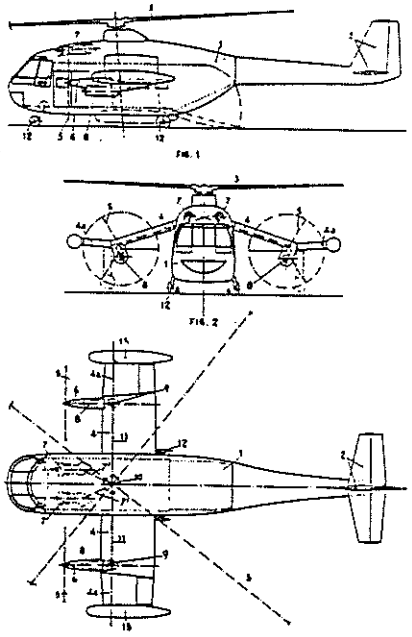


Fig. 15

H. F. PITCAIRN 2,407,327

AIRCRAFT WITH POWER DRIVEN ROTOR

Filed March 24, 1942

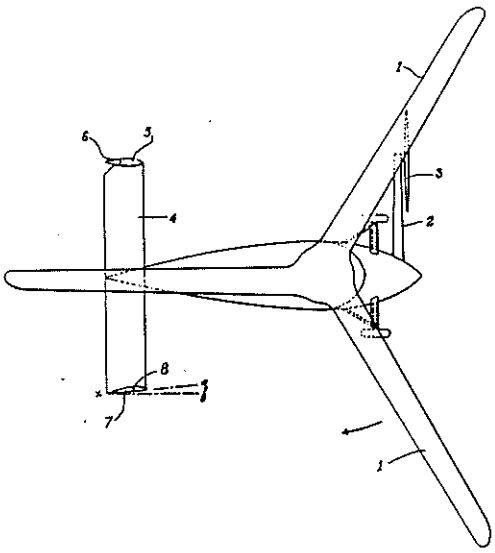


Fig. 16

J. A. J. BENNETT 2,317,340

HELICOPTER

Filed Aug. 23, 1940 7 Sheets-Sheet 1

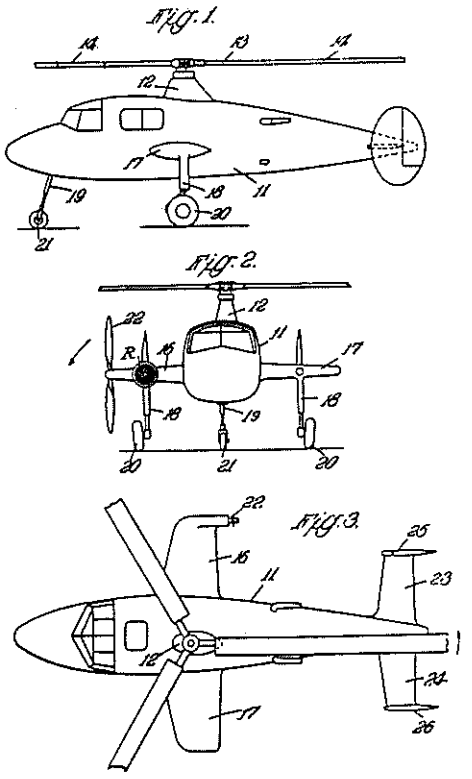


Fig. 17

J. A. J. BENNETT 2,317,340

HELICOPTER

Filed Aug. 23, 1940 7 Sheets-Sheet 5

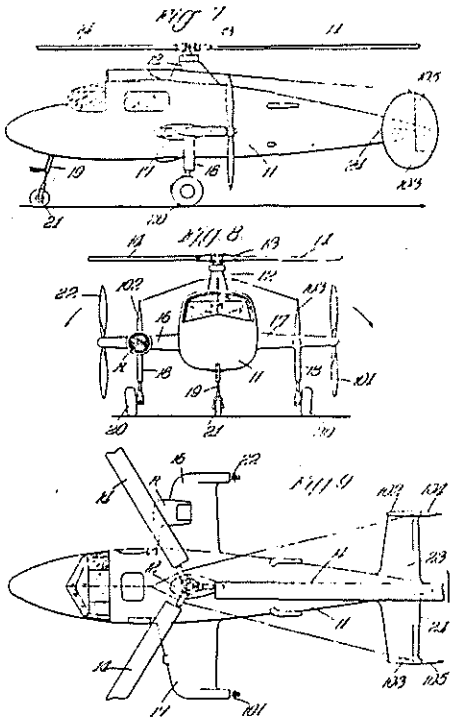


Fig. 18

U.S. Patent 4,660,785

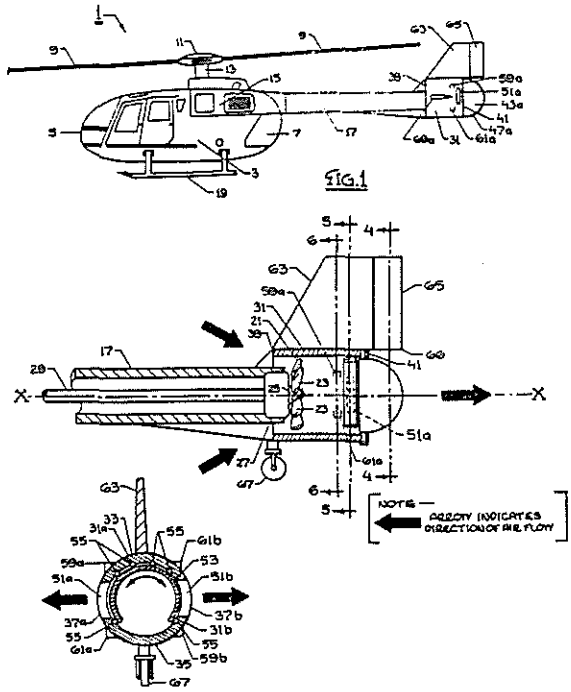


Fig. 19

O. STROUKOFF 3,260,482

DIRECTIONAL CONTROL ASSEMBLY

Filed Dec. 3, 1964

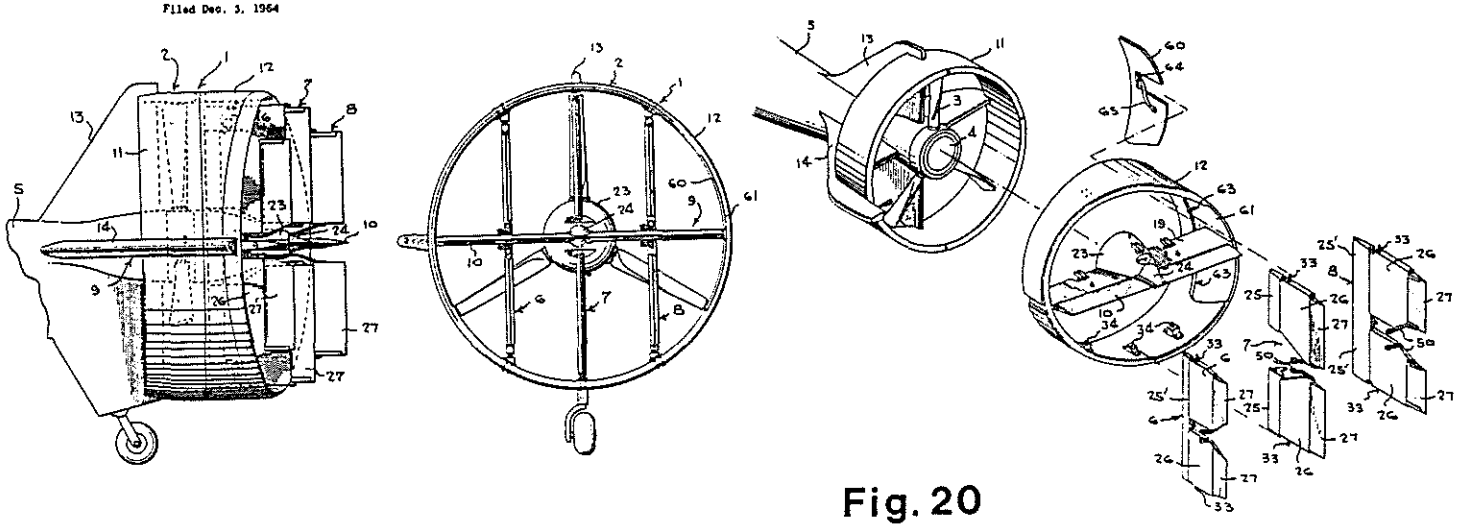
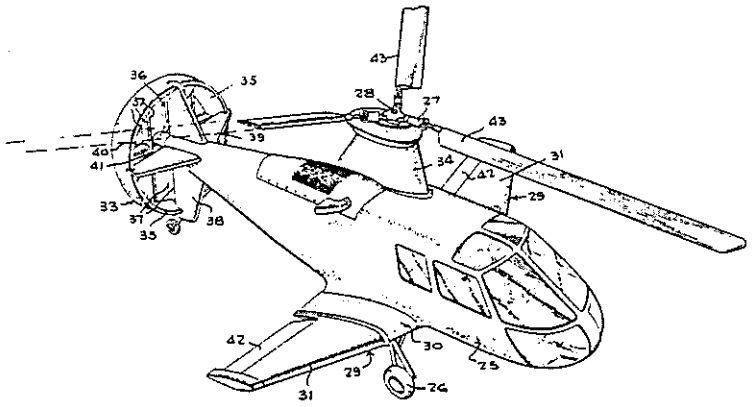


Fig. 20

F. N. PIASECKI 3,241,791

COMPOUND HELICOPTER WITH SHROUDED TAIL PROPELLER

Filed April 3, 1964



INVENTOR

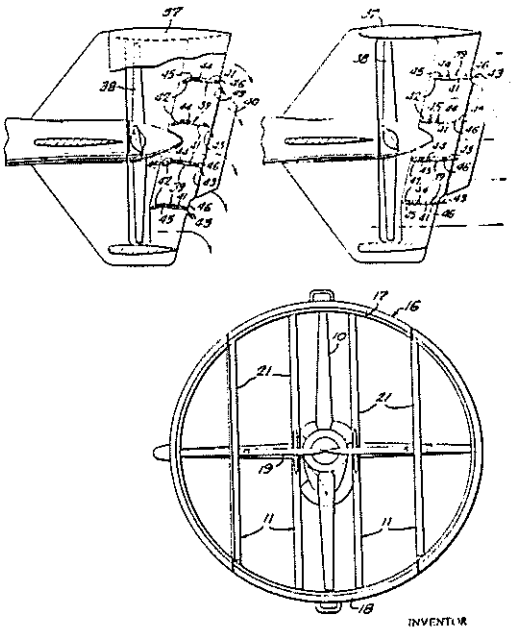
FRANK N. PIASECKI

Fig. 21

F. N. PIASECKI 3,222,012

SLIP STREAM DEFLECTOR ASSEMBLY FOR AIRCRAFT

Filed Aug. 29, 1963



INVENTOR

Frank N. Piasecki

Fig. 22

U.S. Patent 3,957,226

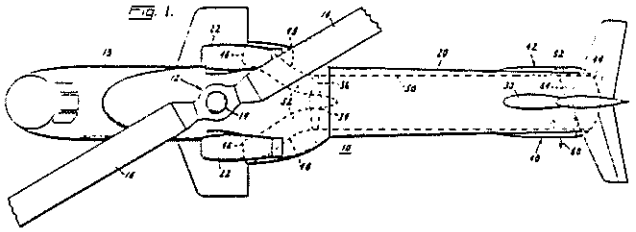


Fig. 1.

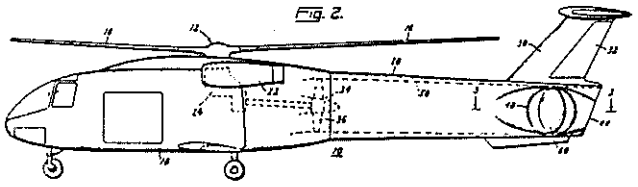


Fig. 2.

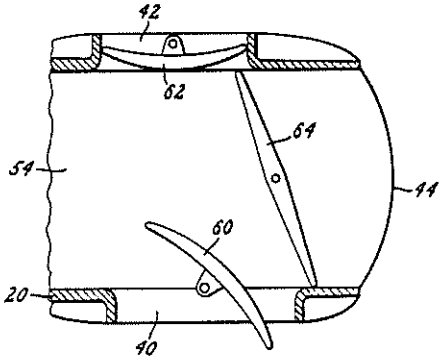
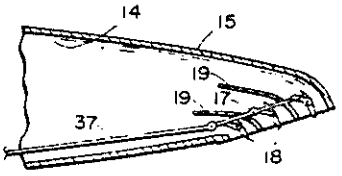


Fig. 23

3,510,087



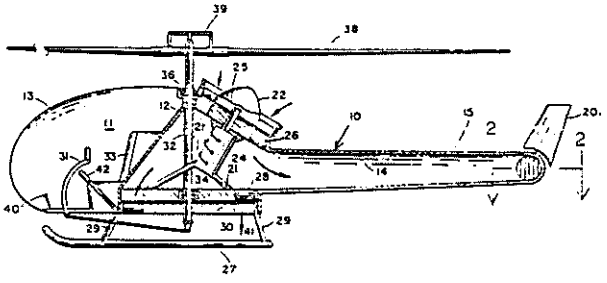


Fig. 24

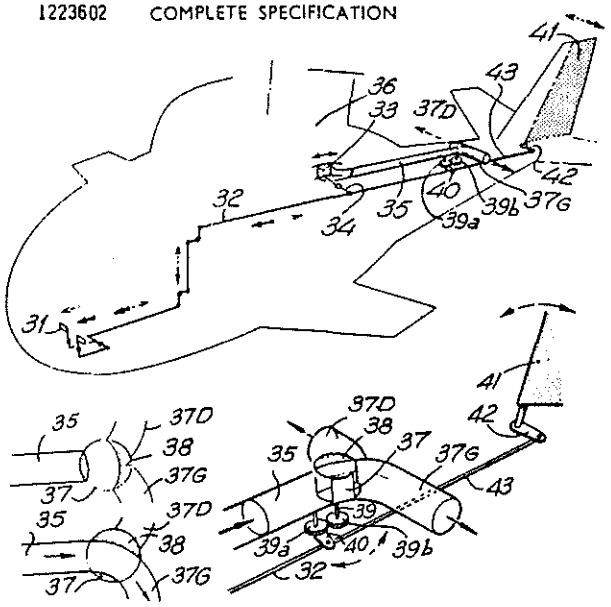


Fig. 25

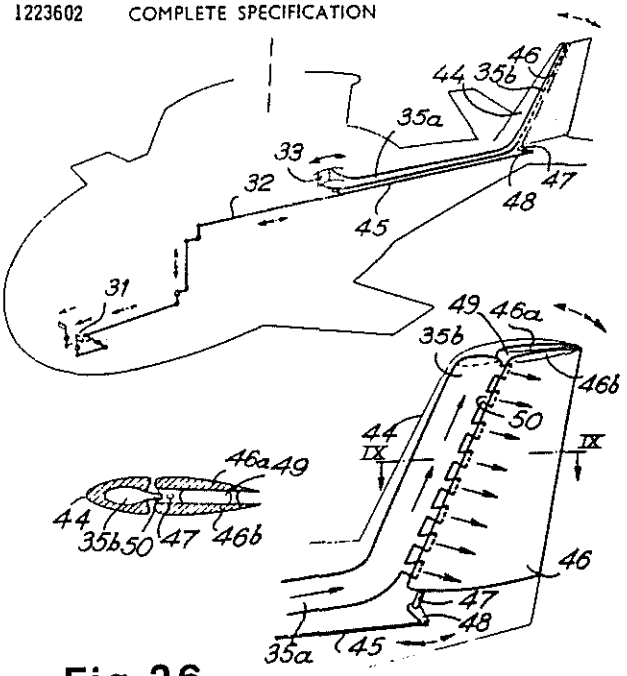


Fig. 26

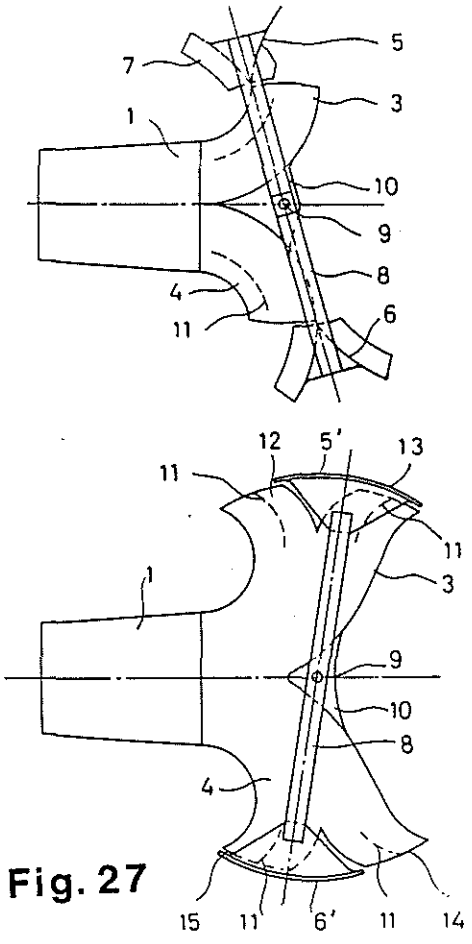


Fig. 27

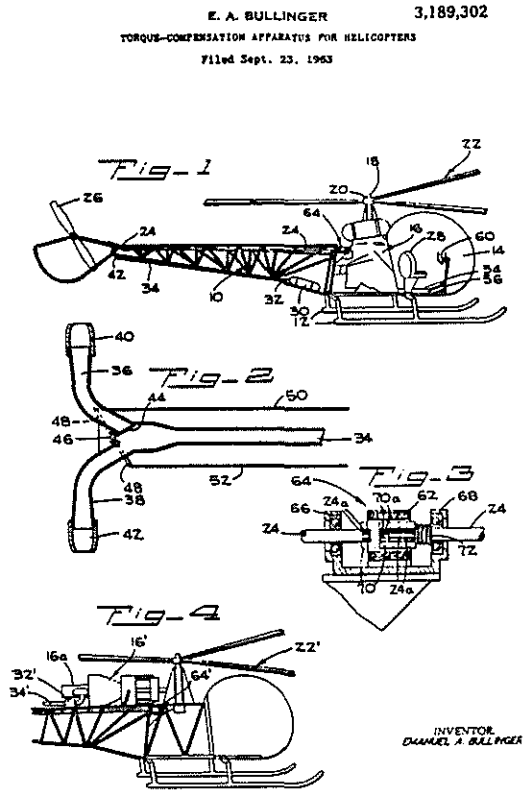


Fig. 28

N° 1 298 518 Société Anonyme dite : Sud-Aviation,
Société Nationale de Constructions Aéronautiques

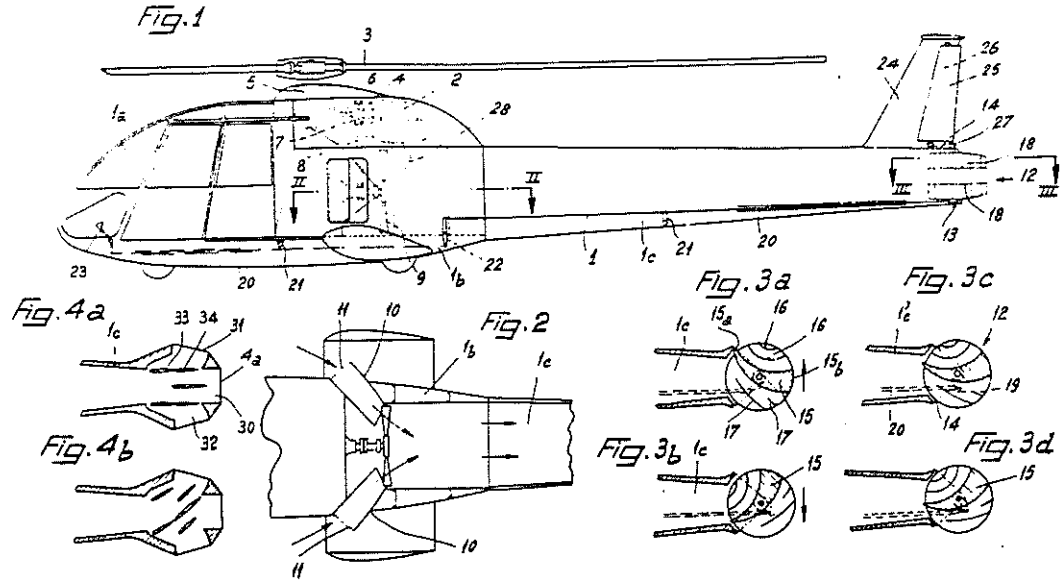
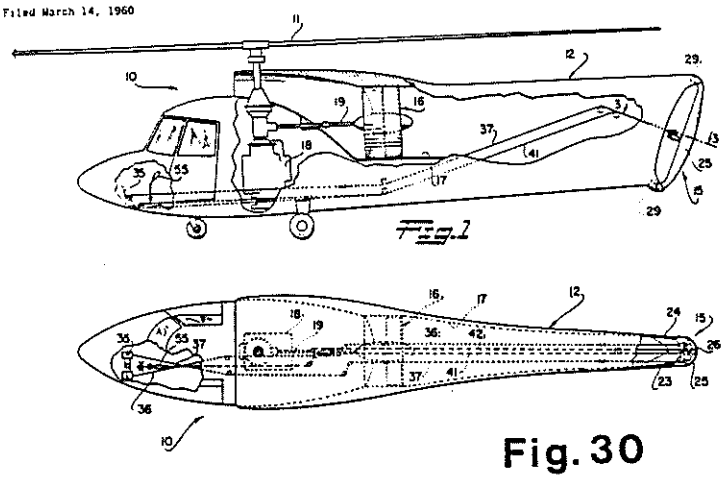


Fig. 29

C. K. SPEARMAN ETAL 3,047,254
CONTROL MEANS FOR VEHICLE
Filed March 14, 1960



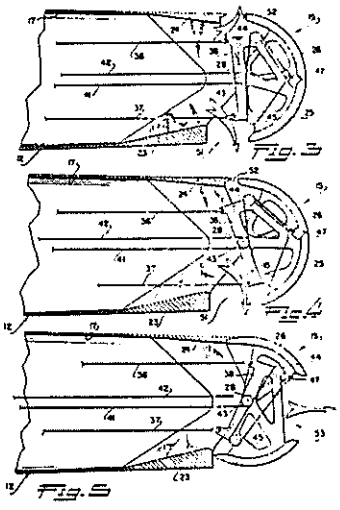
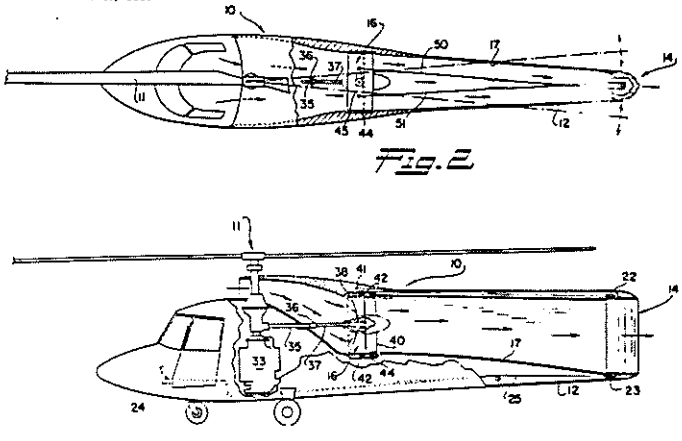


Fig. 30

C. H. CHRISTENSON 3,015,460
AIRCRAFT YAW CONTROL
Filed Jan. 27, 1960



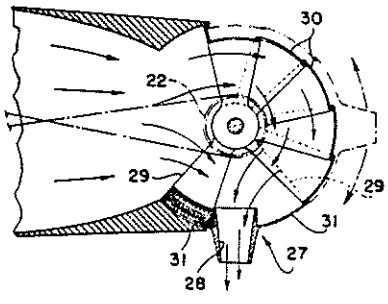


Fig. 31

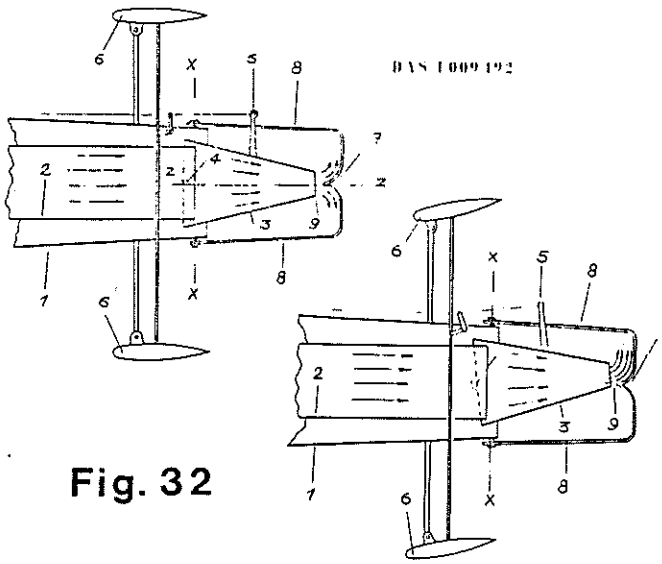


Fig. 32

818,358 COMPLETE SPECIFICATION
1 SHEET This drawing is a reproduction of the Original on a reduced scale.

Fig. 1

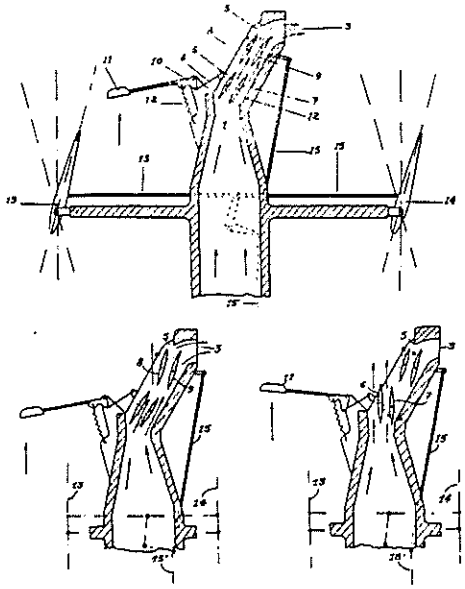


Fig. 33

H. T. AVERY 2,784,792

FIG. 2.

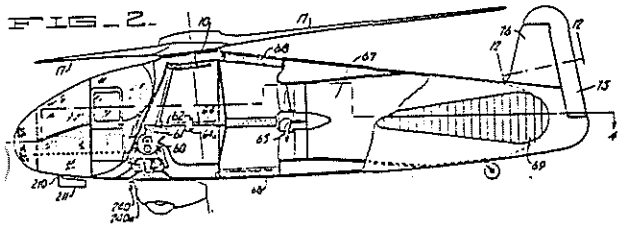


FIG. 3.

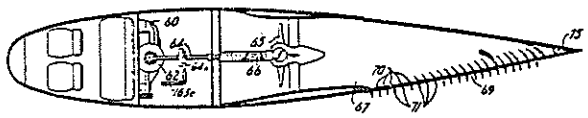


Fig. 34

S. HILLER, JR 2,481,749

REACTION JET TORQUE COMPENSATION FOR HELICOPTERS

Filed Nov. 25, 1946

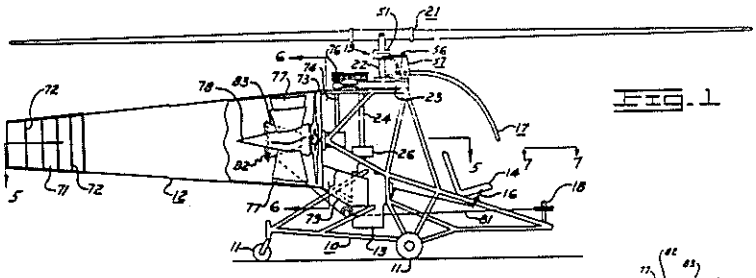


FIG. 1

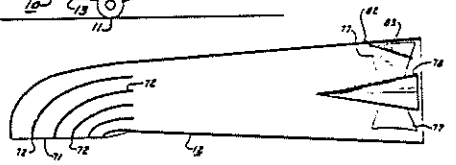


Fig. 35

Fig. 1.

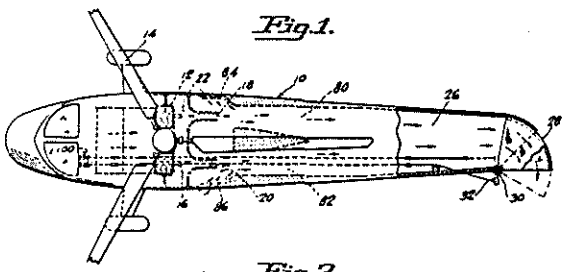
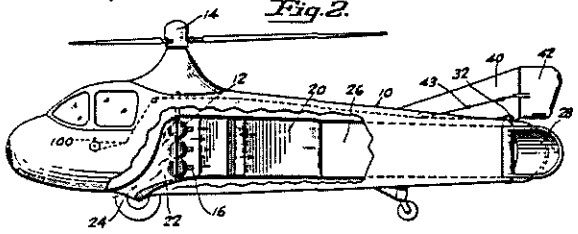


Fig. 2.



J. G. LEE 2,518,697

HELICOPTER WITH ANTITORQUE TAIL JET

Filed Oct. 30, 1944

Fig. 4.

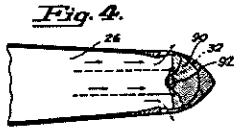


Fig. 3.

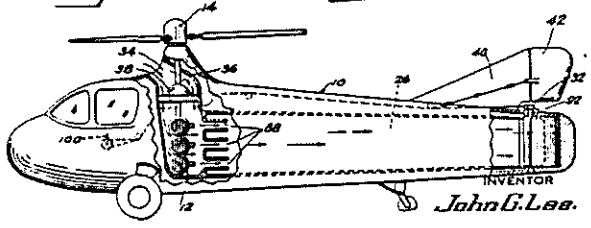


Fig. 36

J. G. LEE 2,518,697

HELICOPTER WITH ANTITORQUE TAIL JET

Filed Oct. 30, 1944 2 Sheets-Sheet 2

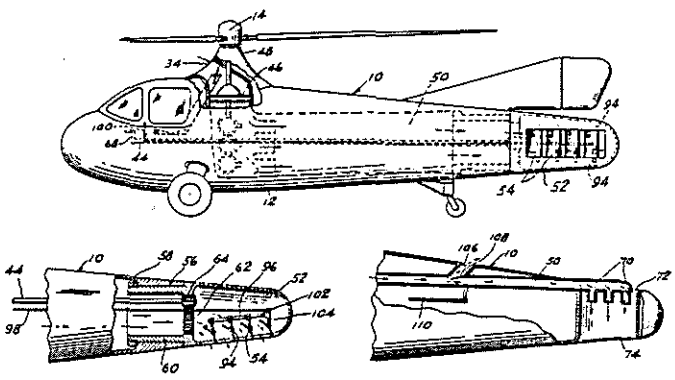


Fig. 37

C. S. WHITING 2,433,251

ANTITORQUE MEANS FOR HELICOPTERS

Filed June 5, 1944

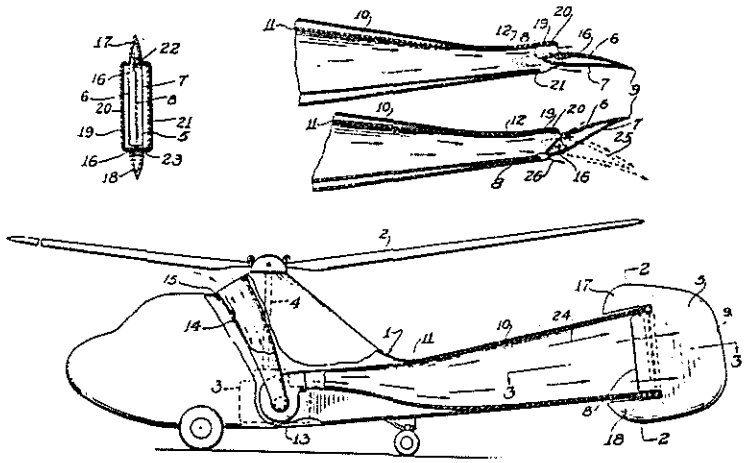


Fig. 38

A. GAZDA 2,486,272

HELICOPTER WITH ANTITORQUE REACTION JET

Filed Dec. 14, 1943 3 Sheets-Sheet 3

FIG. 5.

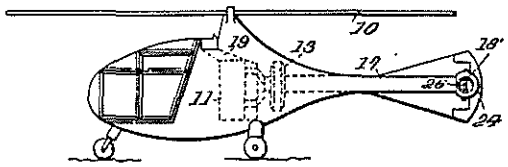


FIG. 6.

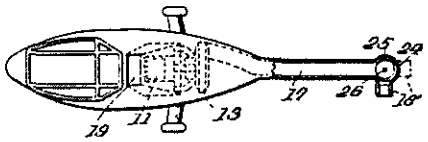


FIG. 7.

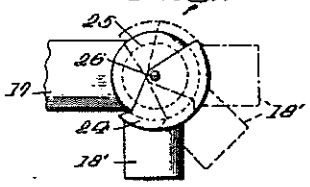
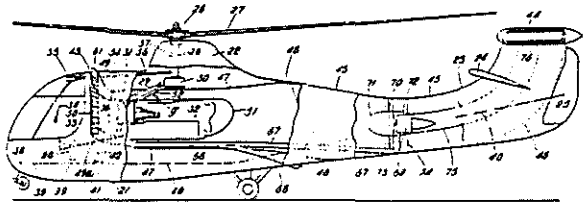


Fig. 39

563,427 COMPLETE SPECIFICATION



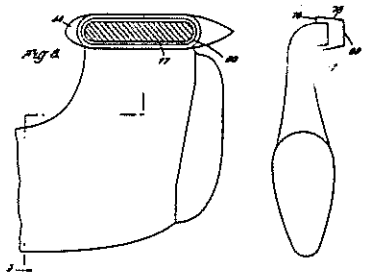


Fig. 40

N° 883.462 M. Focke

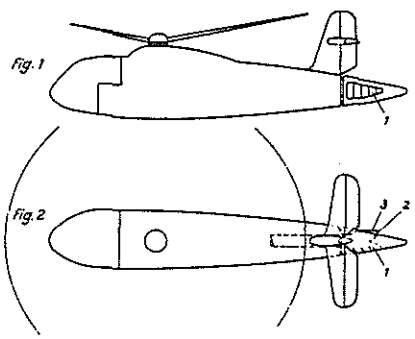
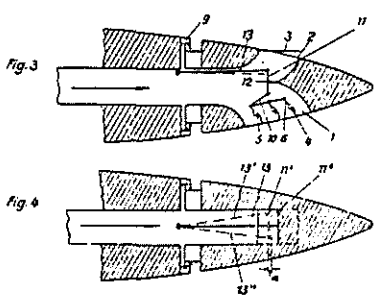


Fig. 41



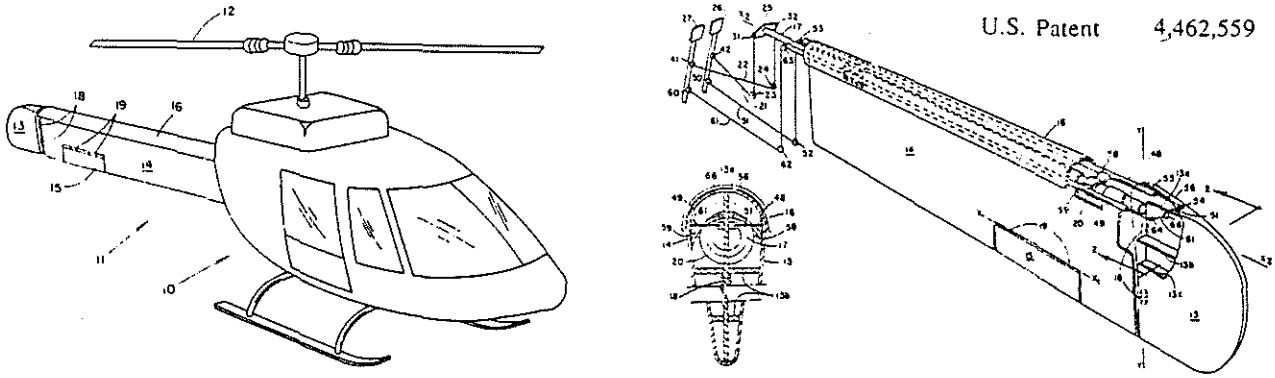
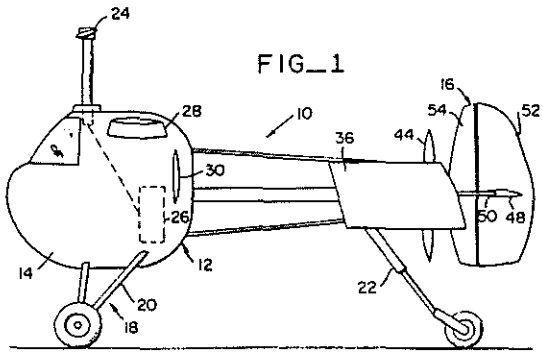


Fig. 42

E. W. MILLER 3,432,119
HELICOPTER
Filed Oct. 24, 1966 Sheet 1 of 2

FIG_1



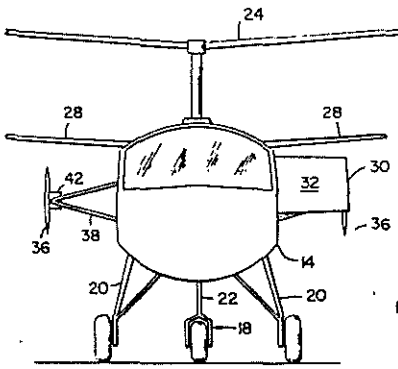


FIG_2

INVENTOR
EDWARD W. MILLER

Fig. 43

N° 1.356.307 M. Breteau

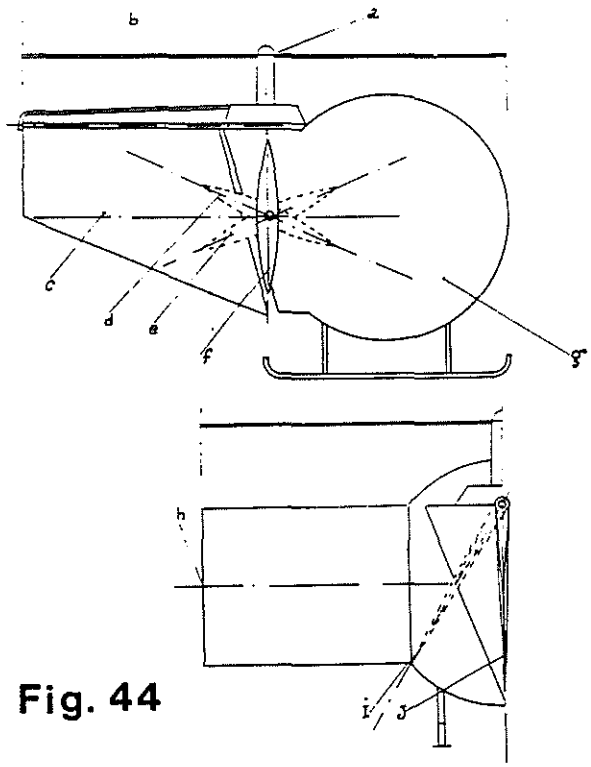


Fig. 44

E. L. KIRCHOFF 2,437,324
HELICOPTER STEERING SURFACE CONTROL
Filed Feb. 16, 1945

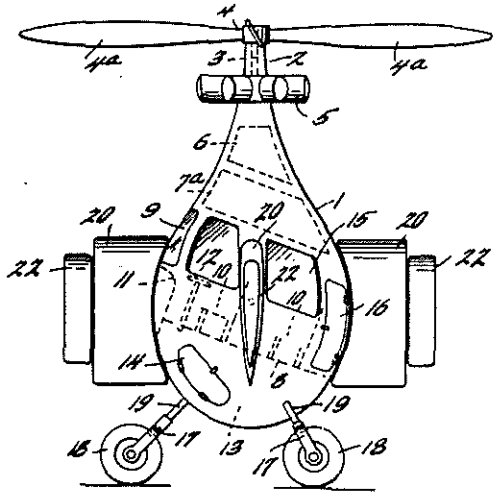


Fig. 45

501,014 COMPLETE SPECIFICATION

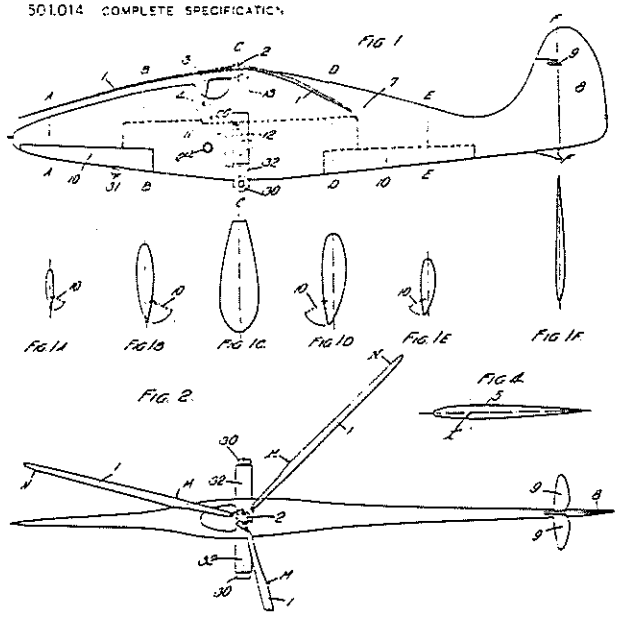


Fig. 46

448 703 COMPLETE SPECIFICATION

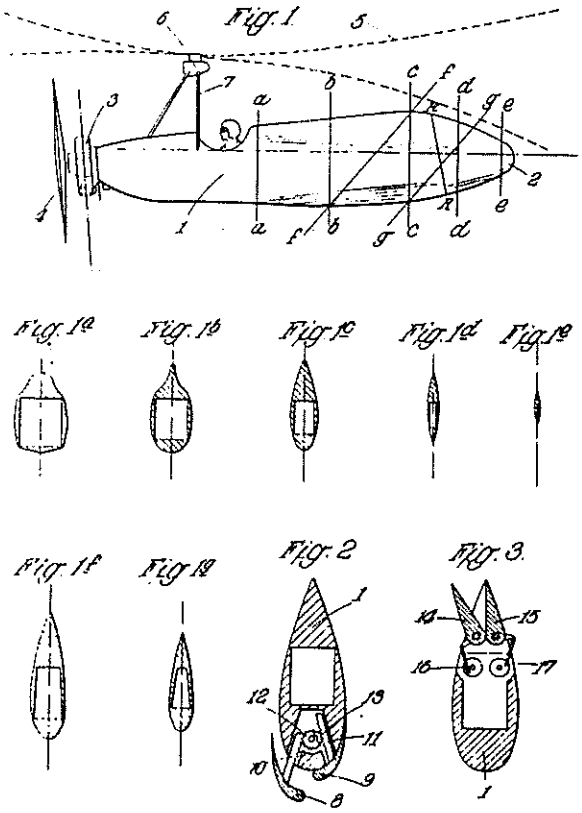


Fig. 47

I. M. DAVIDSON 3,211,398

HELICOPTERS

Filed Sept. 3, 1963

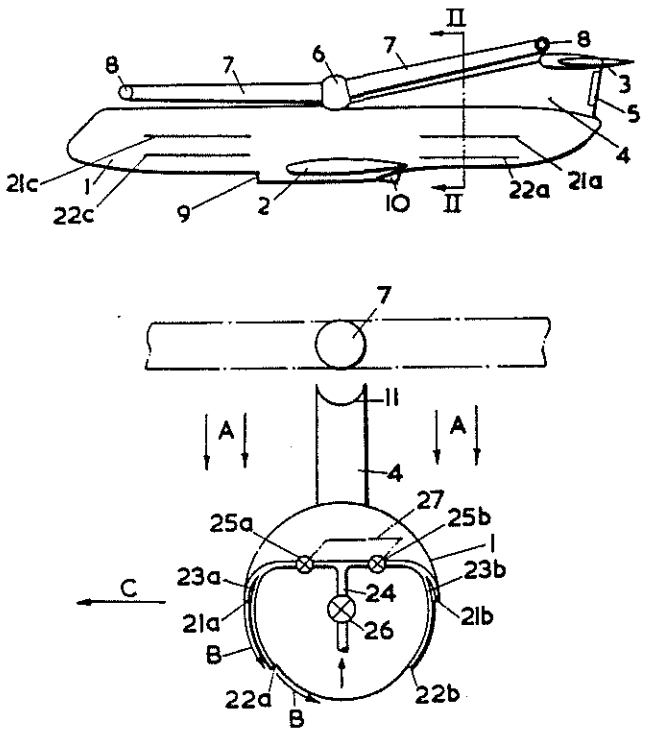


Fig. 48

J. G. LEE 3,059,877

HELICOPTER ANTI-TORQUE DEVICE

Filed Aug. 11, 1961

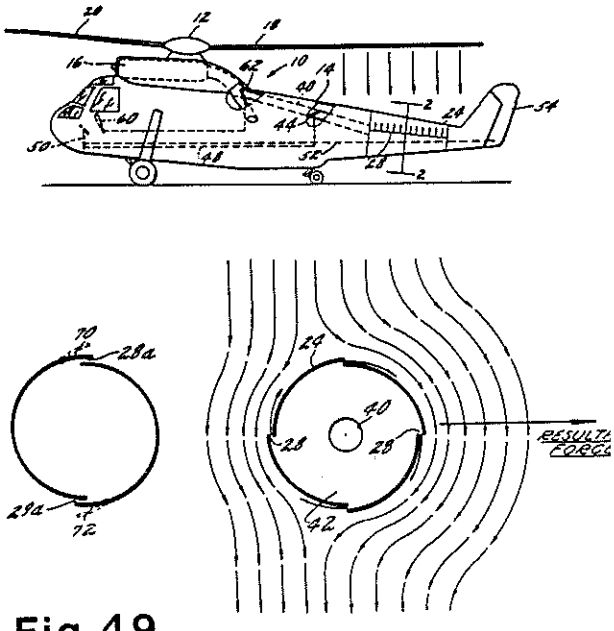
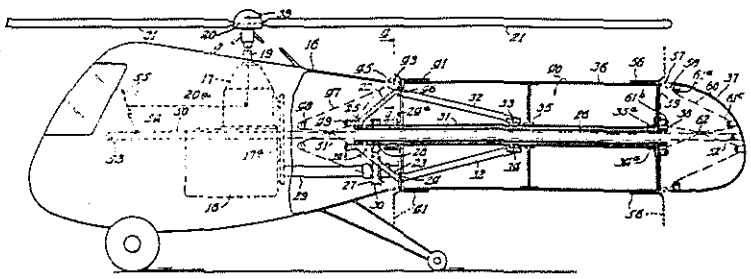


Fig. 49

J. N. CANDLER 2,452,355

TORQUE CONTROL FOR HELICOPTERS

Filed Sept. 11, 1944



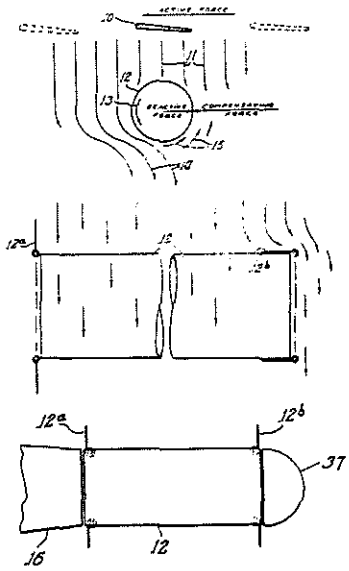
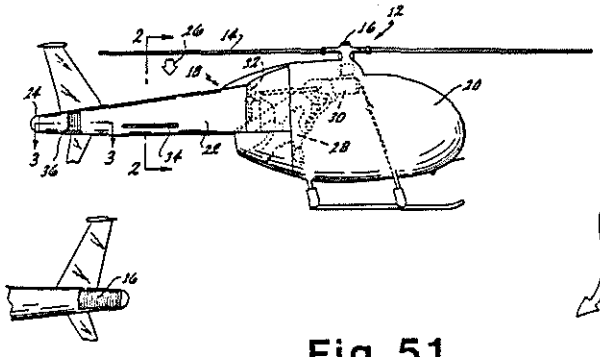
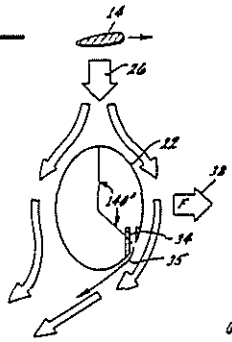
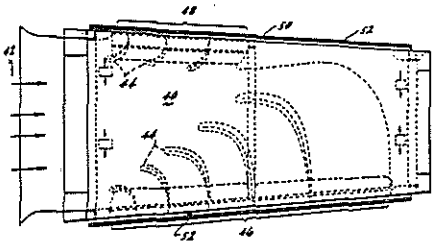


Fig. 50

U.S. Patent 4,200,252







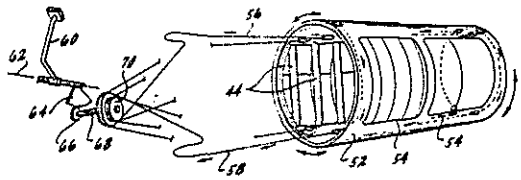
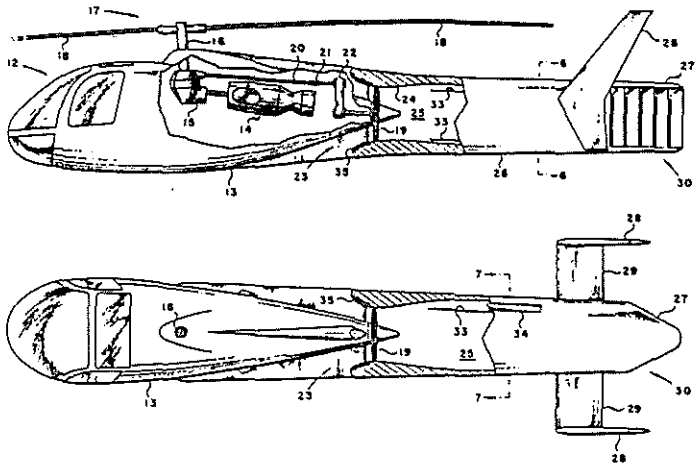
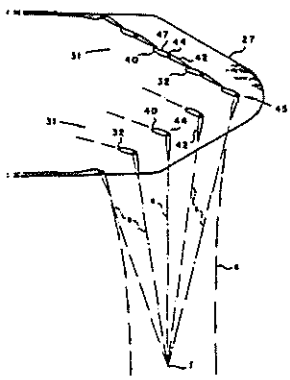
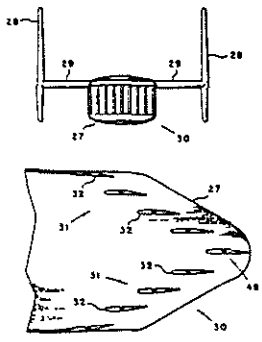


Fig. 51

3,807,662







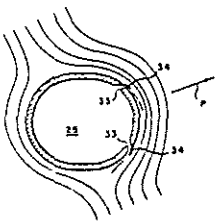


Fig. 52