Discussion on Film

Following the paper, Mr PIASECKI exhibited a cinematograph film entitled "A Review of Military Service Helicopters," illustrating the take-off, manoeuvring and landing of several types, and their effectiveness in service He added that his paper was so long that he had cut out technical details, but he invited the meeting to discuss technical problems during or after the showing of the film

The types illustrated included the first machine built by himself and his colleagues, a single-rotor, three-bladed, articulated hub machine of 90 h p , and a tandem-rotor machine of 525 h p He said that on one occasion, with the latter machine, he had lifted 18 people—but not for very far

In connection with an illustration of a helicopter lifting a heavy log suspended on a long rope, he was asked whether such a long rope below the machine was manageable He replied that at first it was found to be difficult , sometimes the log would be ahead of the cockpit during flight, and at other times behind it On one occasion it had been necessary to jettison the log

When asked how heavy the machines became and what weight they carried, he pointed to one of the machines illustrated in the film which carried one ton When asked whether there were military requirements going up to something like 50 tons, and whether such a weight could be lifted by the tandem-rotor helicopter, he said there was nothing firm on that concept Much would depend on range , for a short lift he felt that the jet type of machine would be more applicable He would not think it unreasonable to carry 100,000 lbs of pay load over long distances, but at the present stage of development it would be quite a job to produce a machine for such a service However, he did not think the development of a machine having a gross weight in the vicinity of 250,000 lbs, would be impossible

Replying to a question concerning increased speed and its significance to the military mind, he said he could not speak for the military authorities, but in his opinion, where loads had to be carried over considerable distances, higher speed would be of real economic significance On the other hand, for a short distance of (say) three or four miles, when the take-off and acceleration represented a considerable proportion of the total time of flight, he imagined that higher speed would not be significant

The film depicted the use of inflated floats just above the wheels of the undercarriage, to enable the helicopter to rest on the water They were inflated during flight by the crew, using CO_2 bottles Mr PIASECKI mentioned that a new type of nozzle had been developed for the CO_2 bottle which enabled the outside air to be used to assist injection

Some examples were shown of damaged helicopter rotor blades in Korea, due to bullets passing through them Mr PIASECKI said that he did not know of any helicopter having been brought down due to damage of its rotor components by fire from the ground It was difficult to obtain reports on that matter Several machines had been brought down due to gun fire having damaged, for example, the fuel tank or the cabin structure Some rotor blades had been hit by gun fire, but so far not to the extent at which a fracture became inevitable

He added that recently one of his Company's machines had lost one of the blades from its rear rotor when at a height between 100 and 200 feet, but that it had made a successful landing

When asked whether emphasis was being placed by the military on increased forward speed, he said that that depended on the particular functions it was desired to perform In anti-submarine operations, for example, endurance was more important than high speed On the other hand, a survey by helicopters did require high speed, as did also transport over more than short distances

Replying to a question as to whether he had flown helicopters by night, Mr PIASECKI said he had, and that the machines were built to fly in any kind of weather

Commenting on the manoeuvring qualities of helicopters, as illustrated in his film, Mr PIASECKI said the 525 h p machine could move sideways at 15 m p h , which was a valuable feature when landing on a deck

A speaker commented that the twin-rotor system gave a much greater stability than the single-rotor system, and he asked what was the range of the centre of gravity position in relation to the distance between rotor axes Mr PIASECKI replied that one of the machines illustrated gave a c g travel of one-tenth of the distance between rotors That was quite remarkable , in actual inches it was probably more than the c g travel of the B-17 bomber

Replying to a further question, he said the Captain of the aircraft sat on the port side, to enable him to see the hatch, which was on the starboard side

The gross weight of the 525 h p machine was 4,550 lbs In the case of the next version the gross weight was greater , it was to carry 10 people, including the pilot Its range would be more than 350 miles, and the maximum altitude would be about 13,000 feet

Asked if there were a military requirement for the rapid folding of blades, he said there was, and his Company had received several requests to provide for the rapid folding of blades, both manually and by power They had designed several methods for the power folding of blades

Mr PIASECKI was asked whether any requirement had been stated in terms of time and men , for example, was it a requirement that two men should fold the rotor blades within five minutes ? He replied that the rapid folding of blades was particularly important on board ship, so that the machines could be stowed immediately on landing on the deck He felt sure that the time required for folding could be reduced to below one minute

General Discussion

Mr R Hafner (*Member*) (*The Bristol Aeroplane Co Ltd*) Mr PIASECKI's paper has been of great interest to us all He has made a very good case for the helicopter generally, showing all the advantages of this type of aircraft Indeed he has been extremely successful in " selling " us the helicopter

However, there is one feature which I have missed from the paper We all know that Mr PIASECKI has done much pioneering work on the tandem-rotor helicopter and we should therefore be very interested to hear more of the case that he wishes to make for that type in particular No doubt he has good reasons to believe in the tandem configuration, as is evident from the illustrations of his paper, which were almost entirely devoted to this type

In order to indicate the kind of reasoning which we might hope to get from Mr PIASECKI, may I explain my own engineering philosophy on the matter I take perhaps a more general view I am not particularly single-rotor or multi-rotor minded As I see it, we want as few rotors as possible from the point of view of mechanical simplicity If the rotor is driven from the tip (ram jets, etc) then a single-rotor helicopter is the most obvious solution for all sizes of helicopters If, on the other hand, the rotor is not tip driven then one is forced to compensate for the rotor torque by suitable means, preferably by the use of another rotor We know of various types of twin rotor configurations The " penny-farthing " type of helicopter comprises two rotors of different sizes In this type the two rotors rotate necessarily at different speeds, this producing two distinct major exciting frequencies Another configuration comprises two rotors of equal size In this case the rotors rotate at the same speed and have conseqently only one major exciting frequency There is thus a good case for two rotors of equal size The question arises now should these two rotors be placed, co-axially, or side by side, or in tandem ? The co-axial arrangement gives only one effective rotor disc and suffers consequently from high induced losses, especially in hovering flight The side by side configuration is attractive from the point of view of induced flow, particularly at forward speed In this configuration, however, there is to be considered the weight and the drag of the lateral rotor supports The tandem configuration is particularly neat and compact from the point of view of drag and structure weight, and furthermore it has been pointed out to-night that this arrangement is not sensitive to fore and aft c g travel

This is the kind of argument which I feel is particularly useful in comparing various rotor configurations and I hope Mr PIASECKI will let us have his thinking on these lines

In conclusion I would like to thank him for a very interesting paper

Mr Piasecki On philosophy I do not like to argue, because I do not think it is good for anyone in the helicopter business to say that there is *a* configuration

At one time we were the only organisation using the tandem configuration, but I am glad to see there are now others coming in with us

As to the advantage of our particular type over others, I think the first factors are gross weight and overall size Although machines have been designed by us and flown by others in the very small sizes, the twin-rotor machine really does not show to much advantage in the small sizes I think the gross weight advantage starts about where the HUP class starts I have actual data, taking all these factors into account The Navy gave a competitor of ours an engine and a specification, and gave us the same engine and specification, as well as some money and a time limit The HUP was our particular design for the particular case The Navy tested both machines, and our machine won on most of the factors in the competition, but there were certain areas of performance in which the other design, a single tail rotor design, was superior However, from the overall standpoint, the functional design and performance—factors such as high speed, c g travel, and pay load as a percentage of gross weight—the tandem-rotor machine stood above the single-rotor machine I do not think I could better express the advantages of the tandem in a given weight and size

It may be that when we get beyond our present thinking in regard to size, if we go beyond 50,000 or 100,000 lbs , or perhaps even further than those figures envisage, we shall have to go to more rotors in order to provide greater endurance or flights of greater distances I think the jet engine shows itself to be a good type for sheer endurance as it is now

But whatever the designs may be, we are very happy to take the best design Our tandem work was born in that way In 1943 the Navy arranged a competition for the A S W problem, and we designed one of each configuration To us the tandem design proved to be superior, and that is why we chose that machine

Mr J Shapiro (*Founder Member—Technical Consultant*) Mr PIASECKI has mentioned a point which I always feel deserves emphasis, that although today the helicopter is more complicated than formerly and involves greater cost of production, we know more about the ways and means of making it into a mass-produced machine similar to the automobile Can he say from experience that mass production methods are applicable in the sense that the very much higher inspection requirements do not militate against those methods ?

Secondly, I should like to hear his views on the possibilities of or the outlook in respect of the convertible helicopter type, and particularly on the combined type

Thirdly, has there been any more thinking on the matter of towing helicopters by a fixed wing aircraft ?

Mr Piasecki Unfortunately in our country we have not been able to get down to real mass production methods and reduction of costs as the result of increased demands , that is because of the military problems Military machines are wanted in groups and they are wanted quickly, and therefore we cannot take full advantage of the principles of mass production As a matter of fact the numbers of units in a batch lot are small, being more or less experimental groups So that I have no data which will confirm that the increased volume will reduce costs The increased training of personnel and the tremendous organisation required to expand from a 10 million dollar to a 300 million dollar industry has resulted in costs going up So that I have nothing encouraging to say in that connection, although I have great hopes

However, I can say this to you gentlemen, that the number of parts is a very important factor in the cost The production programmes have shown that more than 60 per cent of the cost in real production are absorbed just by handling and inspecting the various parts The proper cataloguing and shifting of them, losing them and replacing them, absorb a large part of the costs So that any reduction we can make in the number of parts required will have a tremendous influence on the cost factor

About convertible and combined aircraft, I think it has been recognised generally in former discussions of the rotary wing field in this country and in ours that there are about four classes of vertical lift machines The first is that of pure helicopters, the second is the combined (we have chosen a compound), the third is the convertible and the last one is the induced The combined machine is one in which the helicopter is retained and additional parts are added to allow it to go to higher speeds by unloading

the rotor, so that in the air it is partly supported by wings and driven forward by propellers, the landing gear and other parts being retractable in order to avoid excessive drag The convertible type is one in which the lifting device for the helicopter condition is converted into a forward propulsive device, or the vertical lift device is retracted or made smaller, or something is done with it so that it is not in the air stream The induced type is that in which the vertical lift is achieved, not by direct rotating parts, but by (say) rocket or very high power jets

In regard to high speed vertical lift aircraft I think the types used should depend upon the speeds required To choose a speed higher than you need would penalise you in respect of pay load and cost So that when considering higher speeds for vertical lift machines you must examine the requirements carefully I would say that the speeds required of the various types would be something of this order —

I	Pure helicopter	0—170—190 m p h
II	Combined (Compound)	0—250 m p h
III	Convertible	0—550 m p h
IV	Induced	Supersonic

Mr Fitzwilliams (*Founder Member*) (*Westland Aircraft Ltd*) May I ask if Mr PIASECKI would dilate on the speed of 190 m p h for the pure helicopter ?

Mr Piasecki I should think you could do that better than I !

With regard to towing, a series of tests was made by the military operations men of the Air Force, and some very interesting results were achieved The tests were made with the H-5 helicopter at speeds equal to the helicopter's normal top speed, and even more The proper arrangement of the bridle in relation to the helicopter c g was investigated very thoroughly, and many things had to be done about load, and so one , and we had to have locks on some of the controls However, the tests were stopped because the machine crashed, due to part of the cable becoming wound up in the rotor

Major-General R H Bower, C B , C B E (*Director of Land/Air Warfare*) I have nothing profound to contribute to this discussion, but I do wish to thank the Helicopter Association of Great Britain very much indeed for having allowed me to come here

Since last year, when I had the privilege of attending your dinner, two things have happened In the first place, our first delivery of helicopters will shortly be with us Secondly, we have to learn to fly them It shakes me just a little when I see these wonderful helicopters and their performance, and when I ask the test pilots of Westland's or the Bristol Company whether the ordinary chaps can fly them, and when they reply " Of course they can " But who is the ordinary chap ? In the Army he is a sergeant, and he will have to fly the helicopters The excellent pilots who have taken me around the countryside are accustomed to flying helicopters and they think that anybody can fly them in their sleep, and that there is no problem But we have to train men to fly them, and I say that the men in the Army will do it But I would ask, will you please make your helicopters so simple that I can carry out my promise ?

VOTE OF THANKS TO MR F N PIASECKI

Dr J A J Bennett (*Founder Member*) (*Fairey Aviation Ltd*) We are all very much indebted to Mr PIASECKI for coming here this evening and giving us a glimpse of the American outlook on helicopters He has played a prominent part in the gradual development of the helicopter industry, and it looks as though very shortly it will become just another billion dollar industry in the United States

The " Flying Banana " has emerged from the experimental stage with marked success and is now generally recognised as an important instrument of defence Mr PIASECKI is to be congratulated on having made such a great achievement with his machines and on having reached such a leading position in the helicopter field I think I am right in saying that the Piasecki helicopter has made a name as great as that of the Lockheed " Constellation " If that is so, as I have read recently in the press, I think it is a remarkable achievement

It gives me very great pleasure to propose a vote of thanks to Mr PIASECKI for his most stimulating lecture, and I invite you, ladies and gentlemen, to accord that vote of thanks with enthusiasm

(The vote of thanks was heartily accorded)

Mr Piasecki I thank you, ladies and gentlemen, for the kind reception you have given to the kind remarks made by Dr BENNETT