DISCUSSION

The **Chairman** said that they had heard an extremely interesting lecture, in which MR NISBET had gone into details of the many difficulties and problems encountered and how they had been overcome He invited Mr W H PAINE to open the discussion

Mr W H Paine (*Westland Aircraft Ltd*), who thanked the Author for an excellent lecture, said that the helicopter was one of the best fatigue machines ever designed Therefore, the sort of development problems that came with it were stupendous and, as the Author had said in his concluding remarks, occupied a colossal amount of work, time and effort

He would be interested to know whether the Author had obtained any correlation between all the theoretical work he had put into ground resonance and the actual practical work with which he had really solved the problem

Dealing with ground resonance in the earlier part of his lecture, the Author said that he had solved the ground resonance problem by a combination of damper pressures and undercarriage pressures, but Mr PAINE said he also believed that the undercarriage pressures were mostly fortuitous because they came out from considerations of the drop test—in other words, the 12 ft per sec landing case He would be interested to know what the Author's reactions would be if it had not come out that way and he had had to go into a long palaver to try to balance the two

An interesting point in the paper was the use of excess pressure oils in preference to greases in bearings Bearings were quite a problem in control forces and he believed that one American firm at least was tackling it with a form of hydraulic bearing

In a reference to heterodyning, he said that presumably the noise problem that worried the pilot was simply a combination of frequencies He asked whether the Author had got any tail rotor blade stress measurements and had found out what the effect of these frequencies would be on the life of the tail rotors

Another very interesting point is the use of Vee belts as a slipping clutch This is an interesting adaption of a very old principle to use it as a slipping clutch, and he recalled that it could be used in quite a lot of other places Was the nylon cord necessary because the belts were being worn out when used as a slipping clutch, or was it because there was an overspeeding of the belts all the time ?

He asked what type of measurement the Author had done on the cooling fan Was it actually the frequency of the blades ? He would be interested to know what type of instrumentation had been used—*e g*, strain gauges on blades, and slip rings

A rather more controversial problem, which was at present being discussed quite considerably in the industry, concerned the virtues of ground running and long-term intensive endurance flying The Author had spoken of doing 200 hours on the ground in the early days and then coming back to a more normal type of Type Test His own experience was that tied-down ground running was not really representative of actual flight conditions, quite a different set of vibrations would build up in the aircraft It might perhaps be necessary to come right away from any form of intensive ground running, anyway, for probelms in transmissions and in the aircraft in general

The Author had twice mentioned using mains frequency as a time base Did he really think that it was sufficiently accurate ?

MR NISBET in reply, said he must admit that at the stage of curing the Skeeter, the correlation of technical information and practical information was not complete, but it was now such that with the H T P and putting a tank on top of the hub, it was possible to say quite safely that the machine was free from ground resonance as a result of the practical and theoretical work which had been carried out It was not possible to go any deeper into the question during discussion, the mathematics were very involved

On undercarriage damping, he said that had it been found that the damping required for a 12 ft per second landing was greater than that required for prevention of ground resonance Had this not been the case the problem then would have been to make the fuselage or centre section strong enough to take the higher reactions resulting As it was, they were fortunate The figures were approximately 2,000 lb per foot per second for the 12 ft per second case and, in turn, about 1,500 lb as a minimum for ground resonance

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On the question of bearings and extreme pressure oils, he said that undoubtedly an extreme pressure oil was at the moment much better than any grease, although sodium based greases had been in use for a number of years The sodium based greases, however, suffered from the effects of water and turned into soap

A problem on the tail rotor was the question of making any real sense out of strain gauges applied to a wooden structure From the frequencies in the tail shaft they had been able to diagnose the heterodyning and in turn cure it by fitting a two-blade instead of a three-blade tail rotor

The reason for the use of the nylon belts was not the pulley size but belt stretch Before nylon cord belts were available belts were stretching and wearing out In a number of cases, the belts had spun off

The fan vibration instrumentation was not as complicated as Mr PAINE had suggested, and a simple vibrograph had been used to measure vibration frequency

When considering ground running versus flight testing, it had to be remembered that the Skeeter had developed in parallel with helicopter techniques and the 200 hours was run before there was a helicopter type test He heartily agreed that flying, and intensive flying as required in the type test, was the only possible way of ensuring that the helicopter was safe

In reply to the question concerning mains frequency, he said that he was fortunate to have a friend in the power house, to whom he telephoned and who could say exactly what was the frequency at the time it was being used

Lt -Col C D S Kennedy (*Companion Member*) (*Light Aircraft School, Middle Wallop*), said that there had never yet been a British two-seater helicopter in support of the British Army (although there were larger sizes in service), and he must apologise therefore if he looked abroad for parallels The types of which he had very slight experience, with the American Army in Korea and with the French Army, had left one major impression on him—that they could do a terrific amount more than they were designed to do

One began with a specification, and somebody would prove that the aircraft did not fulfil it on test It was then taken into an area of operations and did about twice as much as envisaged He had seen American light helicopters wriggling out of most surprising places under adverse climatic conditions, presumably due to pilot technique and the fact that risks were accepted in the field The overloads that were carried on two-seater helicopters were remarkable What he deduced was that, given a two-seater helicopter, the user would inevitably abuse it by hanging more on it For instance he prophesied that within a few years somebody would say " Let's hang two stretcher pods on the outside of the Skeeter " He therefore asked the Author to what extent such overloads were catered for in the design

His second point concerned the type of structure on which to put awkward military loads The skid undercarriage seemed the obvious answer, but he understood that it was associated with peculiar resonance troubles when used with a fully-articulated three-blade rotor He had therefore taken heart when the French Army had shown him a light helicopter with that undercarriage/rotor combination, which they said to be free of resonance He asked the Author to say something about the possibility of a helicopter designed with a wheeled undercarriage being later changed to skids

The **Author,** in reply to the question concerning the rugged nature of the helicopter and the abuses to which it was subjected, said that the Skeeter controls had been designed particularly for the type of work described The normal control movement of the azimuth column was within a 4-in box and there was a control range of 12-in available, which made it possible to put quite a lot of equipment around the machine in emergency Obviously, more and more power would always be demanded from the engine If, for example, there was a 500 h p engine in the Skeeter, people would load it up until that limit was reached and it could not lift any more This was where the rocket boost was of particular advantage It could be fitted simply to a Skeeter to give that little extra bit—or quite large amount, if required—of power for a relatively short time Although the Skeeter looked relatively light and the undercarriage looked light, it was all quite strong

He was in favour of skid undercarriages, particularly for landings on rough or ploughed fields and when conditions of that nature were encountered one could easily run into trouble with a normal undercarriage He felt, therefore, that the skid undercarriage was something for the future and could be completely confirmed on

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the helicopter by full-scale ground resonance testing by the method described earlier This would completely confirm any theoretical investigation In other words, he supported the advisability of a full-scale resonance test on a helicopter, in order to verify any analytical results , this being the only conclusive method of demonstrating freedom from this malady

Dr H Roberts (*Founder Member*) (*Fairey Aviation Co Ltd*), said that the first thing that impressed him was the slide showing the progress and performance of the Skeeter over the years There was a big lesson to be learnt When one worked it out, the power had gone up by 40 per cent over a period of seven years, and performance had gone up enormously The lesson to be learnt was that on all helicopters, and particularly small ones on which one began with marginal power, the gain per increase of power was enormous and well worth getting This point should be rammed home all the time There was little point in producing marginal powered helicopters One got so much more for the extra little power

He suggested that the Author had done less than justice to the enormous amount of work which had been done by himself and the Development Department of his company Having had the privilege himself of working with them for a short while, he knew something of the state of affairs five years ago Whereas the Author had spoken of 40 men doing the work over a period of five years, most of it had been done in the last four years, which represented even greater progress per year

A greater tribute could have been paid to the pilots, who risked their lives so willingly, on many of the ground resonance tests On one occasion he had seen a rather bad example of ground resonance and what happened to the unfortunate pilot and the poor aeroplane Any pilot who willingly " stuck his neck out " to cope with things like that very well deserved a tribute from everyone

Dr ROBERTS said that many years ago, oddly enough, he had something to do with the computer for ground resonance The computer in question was born over a drink in a " pub " at Southampton A certain gentleman who came to see him said " I have a wonderful device for representing electrically non-linear mechanical systems What use can I make of it ?" It was a heaven-sent opportunity, and he suggested to the man that the ground resonance problem was perhaps one very well worthwhile to tackle A year later not much progress had been made, but it was pleasing to see how much progress had been made in the last four years and the very great success which had attended its completion

They had heard less about blades than anything else on the aeroplane He did not know whether this was because of commercial security, or whether the Author would like to amplify this particular aspect He recollected that there had been a certain amount of difficulty with blades, and he gathered that Saunders-Roe were advocating a metal blade conception It would be interesting to hear a little about this and its progress

He was rather shaken, as were others, by the apparent crudity of the spinning rig The actual control station seemed very glamorous but the actual control rig appeared to have been thrown together and some of the bits left out It raised the obvious question of whether, when dealing with such crude rigs, the results were really genuine and worthwhile or whether they tended to be misleading

He knew that Saunders-Roe had always been rather fond of friction dampers, but from time to time over the years there had been a lot of criticism of them because it was a little difficult to ensure repeatability of the pull-off load and also the equality of pull-off load between blades He was in fact surprised that that particular system was still in use and that there had not been a change-over to hydraulic dampers

Speaking of the heterodyning of the tail rotor, he recalled being present on a famous occasion when a two-blade rotor was borrowed from B E A Those who returned it in pieces two days later were a little unpopular, but in the end the experiment proved worth while and he was happy that Saunders-Roe had reached their solution successfully It was a happy one to reach They had tried everything and had little success At the time, they never knew why the two-bladed rotor worked Perhaps the reason had been discovered since

The paper said that the rocket system used for the Skeeter required only a small amount of modification He would have thought that it needed special blades, apart from anything else One really could not simply take away a standard blade and put in a piece of tube He asked whether it was always possible to get firing on all three simultaneously or whether there were occasions when one or more of the three had not worked, thereby causing rather great out of balance

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The **Author,** in reply, said he was sorry if he had not given the pilots the full credit for the work carried out on the ground resonance experiments The omission was not intentional, for the pilots had done a wonderful job of work He must, in addition, pay tribute to those who operated the snubbing equipment, and who worked in equal danger

Commenting on Dr ROBERTS' remarks concerning performance and horse power he said that in the first helicopter to fly in this country, the pilot was allowed to wear only a pair of plimsoles and overalls, his normal clothing being too heavy for the machine to take off from the ground This showed how great had been the development, for it was now possible to wear normal clothing in the helicopter !

In the development of composite rotor blades in particular, Saunders-Roe had found methods of controlling the C G , first and second moments during the building of the blades He did not wish to go into any great detail but wanted to point out that on a bonded metal blade such as they were developing, the control of the C G first and second moment, shape, etc , must be achieved before final assembly There was no opportunity for a second thought or a second chance They had now managed to develop satisfactory blade control techniques They had two sets of metal blades, on both of which this control had been such that blades were run without even the tabs being adjusted

He had particularly avoided the subject of metal blades because it was one in which development was still proceeding His company had carried out a considerable amount of work on this type of blade They were strain gauging blades to run on the rotor test with a form of harmonic pitch oscillation to simulate stresses measured in flight The remarks in the paper were limited particularly to finished products

As far as the appearance of the rotor test tower was concerned, he could assure Dr Roberts that the lift and torque measuring mechanisms together with the rotor controls had proved to be very accurate It was in fact possible to detect lift changes in the order of 5 lb They had not bothered about the outside appearance of the rotor test tower

Arguments comparing friction and hydraulic dampers would go on for ever Dampers with raw rubber in them instead of hydraulic fluid had been tried Nevertheless, friction dampers had been developed to quite a high standard of efficiency and were operating for 30—40 hours without a single adjustment Experiments are still continuing to further improve their life This was not to say that they were not experimenting with hydraulic dampers, but it was far better to play with the devil one knew

Dealing with the question of rocket boost, he said that the blades used were standard Skeeter blades The only major modification consisted of shortening the length of the blade proper to ensure that when the rocket motor was fitted the blades did not interfere with the tail rotor ! The rocket fuel feed piping was led down the existing spar tube using simple plastic spacing pieces

On the question of the effects of uneven running of the motors they had been fortunate enough to have the very case of one, two and three running during the development flying, and surprisingly little vibration was felt in the aircraft, and no ill effects were found on controls

Captain J A Cameron (*Member*) (*British European Airways*), said he had noticed in the film that the Skeeter Mk V was fitted with central collective pitch sticks He hoped it was not the intention of the company to continue with this arrangement, for it had been the cause of a fatal accident in this country, admittedly on another type of helicopter He was a keen advocate of standardisation, but it must be standardisation with safety

The **Author,** in reply, said that here was one of the things he had wished to emphasise, particularly in his concluding remarks It was quite essential to achieve standardisation of the pilot's compartment layout—instrument panel shape, control ranges and positions, and so on On the Skeeter, the collective pitch levers were in the centre when the captain of the aircraft flew from the port side Admittedly the starboard lever was in the pilot's wrong hand, but nevertheless it was the reasonable thing to do in the early stages

On the latest Mk VI aircraft and in future aircraft, all collective levers would be on the left-hand side of each seat Great care had been taken in the Skeeter to make certain that the control layout was very similar to those of other aircraft, so that when

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the machine was used as a trainer the pupil would not have great difficulty in converting from one aircraft to the other

Captain CAMERON'S remarks served particularly to endorse the point that the sooner there was standardisation of pilots' requirements the better it would be

The **Chairman,** in summing up, said the fact that there were no further contributors to the discussion, and that the lecture had not provoked the rather heated arguments which were sometimes forthcoming, showed that the lecturer had really " done his stuff " very well This was a great tribute to Mr NISBET who had handled his subject with no mean skill

When recalling the necessity occasionally to ensure that whilst a pilot was clothed he wore the minimum of clothing, the lecturer had been harking back to the 1937 period when the Weir W 5 was first persuaded to get into the air The first British helicopter to fly had only a 50 h p engine In those days hopes were high, following successful earlier flights on the W 1, 2, 3 and 4 series of Autogiro, that an easy to fly, and economical rotary wing aircraft would result He would not say those early hopes had been dashed to the ground, but they had not yet been fulfilled for the modern helicopter made rather extravagant demands on power , costs were exceptionally high, and pilotage called for professional skill

One point from the discussion which should be stressed was the tremendous amount of development work that had gone into making the Skeeter what it was today It was in 1947, or thereabouts, when the first mark of Skeeter was flown, but looking back it hardly seemed so long ago Those with roots in the rotary-wing movement were well aware that nothing worthwhile resulted without the expenditure of much sweat and many tears

In that way experience was born They had listened tonight to a lecture which could not have been put across more clearly, and which certainly had been handled by somebody with a very detailed and intimate knowledge of his subject

He paid a special tribute to Mr NISBET for coming to the rescue of the Association and giving his talk at rather short notice He had done himself and the Association proud

The Chairman said he was sure that he would be voicing the regret of those who knew him that Harold Bolas, one of our early members and a leading technician with Saunders-Roe on helicopter development work, had recently died

In extending a welcome to visitors, for the Association liked to feel that other people were taking a hearty and active interest in its affairs, the Chairman invited them to take up membership of the Association, which depended on new members for its continued day-to-day working

He thanked Mr NISBET for his lecture and for showing what had been done by Saunders-Roe and expressed the wish that he and his associates and the company behind them would have a large measure of success and be able to sell many of their products in a field which, as far as the British helicopter was concerned, was virtually untapped and had world-wide possibilities

The vote of thanks to the Author was carried by acclamation

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