Discussion.

Sir Leopold Savile.

Sir LEOPOLD SAVILE thought it was quite time that such a Paper should be presented to The Institution and discussed, and he felt sure that the view expressed in the concluding words of the Paper would be welcomed and endorsed by many members of The Institution. His excuse for saying anything on the Paper did not rest on large personal experience, but when Civil Engineer-in-Chief at the Admiralty he had been a member of an Inter-Departmental Works Committee, on which the Chief Engineers of the War Office, the Air Ministry, the Admiralty, and the Office of Works, conferred; and where possible, convenient, and economical, arrangements had been made for those departments to carry out works for each other. In that way he had been responsible, whilst at the Admiralty, for the construction of an aerodrome and a seaplane base at Malta and also at Singapore—two places where the sites available for the construction of aerodromes differed as widely as possible. At Malta there was a more or less flat plain on limestone rock with a light covering of soil, and practically all that it had been necessary to do in order to construct the landing-ground was to remove a large number of stone walls, level off certain hummocks of rock, and lay, where the rock was exposed, some surfacing of sand or broken stone. There was also the advantage there of having the seaplane base in close proximity to the aerodrome, so that the two could be worked together with great convenience. He had been brought into connection with Singapore in the early stages because Wing-Commander (now Group-Captain) Hewlett had gone out to Singapore to select a site for the aerodrome and seaplane base there at the same time that he had been there in connection with selection of a site for the projected naval base, and they had collaborated in the selection of a site. In the first instance the conditions had not appeared to be inviting. The site selected had consisted largely of rubber plantation on undulating ground, with swamps in between. At a later stage, at the request of the Air Ministry, the Admiralty had carried out the earlier part of the construction of the aerodrome. It had been necessary to dig up all the rubber trees and level off the ground by filling the swamps, and eventually the whole surface had been turfed over with lalang grass, which grew quickly and formed a good surface. When he saw that aerodrome early in 1932 he did not think there was much to complain of; it made a very good landing-ground, though no doubt the surfacing would not be quite good enough for the very heavy machines which were gradually being introduced, so that some

special means might have to be adopted shortly to produce a better surface. He believed that, apart from the Author, the fairly large Committee set up by the Royal Institute of British Architects included only one engineer, and, in view of what the Author said as to the need for engineering ability and experience in the construction of aerodromes, he thought it was a pity that more members of The Institution had not been invited to collaborate. The Committee had already issued an interesting preliminary report, but he thought their final report would be strengthened if more engineers collaborated in its preparation. He would like to ask the Author the following question:—If money were no object, what would be the ideal lay-out for an aerodrome? The tentative suggestion which he would make was that an ideal aerodrome might be a circle, say of 1,000 yards

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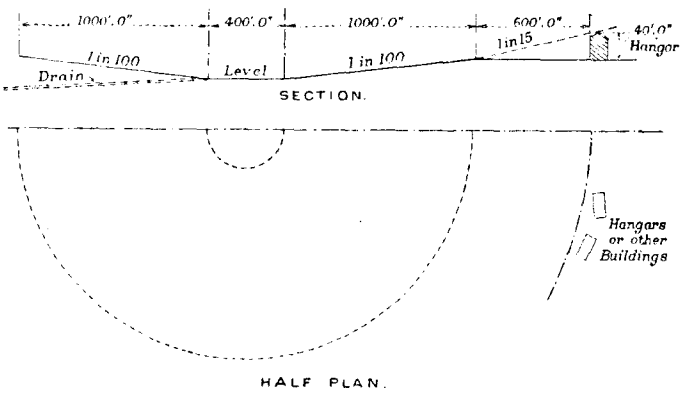
Fig. 9.



diameter, in the form of a saucer, with a level circle of about 100 to 200 yards diameter in the centre, and with a slope of, say, 1 in 100 all round, so that from whatever direction an aeroplane might come it would run down the surface and up on the other side against the wind (*Fig. 9*). In the same way, going out it would run down and then go off the other side. Water draining towards the central circular part could be taken away by drains; and, of course, beyond the perimeter of the circle it would be arranged that nothing within a 1-in-15 slope should interrupt taking-off or landing; for example, there would have to be no trees creating an obstruction: that would mean that buildings connected with the aerodrome would, if they were 40 feet high, have to be 600 feet away. He would like to know whether such an arrangement would be ideal, and, if not, what else would be better. As to the surfacing of the ground, ordinary turf was not always good enough, while concrete was

Sir Leopold Savile.

unnecessarily hard and not altogether convenient, besides being very expensive. He thought the suggestion of bituminous soil was a very good one. Comparing the costs in the case of an aerodrome of 800 yards diameter, the whole would not be surfaced for a very long time, runways being provided, but to surface the whole area at 8*s*. per square yard would cost £200,000, whereas with bituminous soil at 2*s*. 4*d*. per square yard it would cost only £56,000 to £57,000. Possibly an improvement might be something between the two, namely, a bottom of stone with, say, 3 inches of bituminous soil on top, the cost of which, he thought, could reasonably be estimated at 4*s*. per square yard. Though that would cost £100,000 for the whole area, only runways, say, 100 feet wide would have to be made in the first instance.

Brigadier-General Wace.

Brigadier-General E. G. WACE remarked that on p. 185 the Author described the method of surfacing by mixing the top layer of soil with bitumen emulsion, and stated that it had been employed to a fairly large extent in America and to a limited extent in England. Information which General Wace had obtained from colleagues in America and Canada, and by personal inspection of a number of aerodromes there, was that they had not yet started to apply bitumen emulsion to the soil of the aerodrome. In several cases they had treated imported road-metal with ordinary bitumen emulsion, and he had seen only one case in which the natural soil was treated with an oil. Perhaps the Author had better information than he had, but if not he would like to emphasize the point that the initiative in treating the natural soil with emulsion had come from Britain. In America the problem of surfacing aerodromes had so far received very different treatment from that which it had been given in Europe. In the United States and Canada the most popular method of surfacing had been to construct aprons and runways by methods and with materials similar to those used in road-construction. At Roosevelt Field, Long Island, vast quantities of imported clean gravel had been grouted, rolled, and consolidated to a depth of 3 inches. At St. Hubert, outside Montreal, the runways were of imported limestone, consolidated and grouted with bitumen emulsion. Immense quantities of broken stone, gravel, clinker, and other aggregates, had been transported to the aerodromes and bound with bituminous materials. In most cases the surfaces had been laid by the grouting or penetration method, but a considerable area had also been laid by the "mix-in-place" system of construction. In California especially road oils had been used, possibly owing to the peculiar climate. In Europe the transport of aggregates to aerodromes had usually been regarded as impracticable, chiefly owing to the cost, and consequently greater progress had been made in the direction of binding the

existing surface material. It had been convincingly shown that bitumen in emulsion form was the most efficient type of bituminous material for that purpose. Bitumen emulsions designed for normal road-making purposes were unsuitable for mixing with aggregates containing a large proportion of fine material, because the break of the emulsion took place before it could be satisfactorily distributed throughout the mass. It had been necessary, therefore, to develop a special bitumen emulsion which possessed sufficient stability to allow adequate mixing with a fine graded aggregate and which broke completely on the loss of its water-content. That occurred only through evaporation, and therefore in this country it was a slow process. After a long period of experimental work, an emulsion possessing the necessary characteristics had been perfected, and it might be of interest to record that the existing surface material of ten aerodromes in England had been successfully treated with that emulsion during the last 3 years, the areas so treated ranging from 40,000 to 2,000 square yards. The success achieved had resulted in similar work being undertaken in France, Switzerland, India, and elsewhere, and the experimental work done in connection with aerodromes had led to the adoption of the same process for the surfacing of footpaths, playgrounds, parking-places, cycle-tracks and roads carrying moderate traffic, not only in this country but also in France, Germany, Belgium, Denmark, Sweden, Algeria, India, Malaya, Australia, Mexico, Canada, and the United States of America. The advantage of being able to form durable surfaces of the right type without the expense of importing aggregates needed no emphasis. In the specification given in the Appendix to the Paper it was mentioned that all kinds of natural soil could be used with the exception of clean sand and stiff clay. He agreed that no method had so far been developed for dealing with stiff clay, and he also agreed that clean sand was more difficult to treat than some other aggregates, but he suggested that clean sand should not be classed with clay as an unsuitable aggregate for that purpose. Clean sand could, as stated in the specification, be improved by the addition of fine material, but its suitability for surfacing of the kind in question depended largely upon its natural stability, which, in turn, was largely dependent on its grading. Good work had been done with coarse sand containing a proportion of fine clean grains. In the specification the depth of treatment called for ranged from 6 inches to 8 inches or more, consolidated. Recent experience had indicated that those thicknesses might safely be reduced, and that on a firm and well-drained base a consolidated thickness of 4 inches was satisfactory. He knew of one short length of road, done by the Royal Engineer Board, which carried successfully an 18-ton Foden lorry, and that was

Brigadier-General Wace.

Brigadier-General Wace.

4 inches thick and with a base of only the natural soil (a sandy gravel). In the last paragraph of the specification it was stated that the surface was to be sealed with a final coating of bitumen emulsion and chippings when it had become well consolidated and did not show undue marking under the roller. His own experience was that the stage when the surface should be sealed was not reached until it had dried throughout its full thickness. Sealing was liable to lock moisture in the surface, and, if the sealing coat was applied before all the water of the mixture had escaped, there was a risk that some water would remain permanently in the surface, with detrimental results.

Mr. Manning.

Mr. G. P. MANNING wished to make a few remarks on hangars of reinforced concrete, mainly from the point of view of permanence. He exhibited a lantern-slide of a seaplane hangar built in Copenhagen in 1921, and then thought capable of accommodating any aircraft, naval or military, likely to be built for many years to come. The main members were reinforced-concrete arches, having a span of 158 feet and a rise of 38 feet, and the door opening was 20 feet high and about 110 feet long at the top. The fact that it would not take a single really large modern aircraft showed the development that had taken place in the last 12 years. He had recently seen some projected designs for reinforced-concrete hangars with the cantilever type of roof, and he must say he did not consider them as good for that type of work as the arch. The main purlins in the building shown in the slide were of reinforced concrete. There were about half a dozen of them. The small purlins at the top were of timber. The idea of having the main purlins in reinforced concrete was to make the whole thing act as a wind girder, and two of them acted as supports for overhead cranes. In the case of the cantilever type of hangar roof, which he had seen advocated, the main tension members stood well above the roof. They were of very small section; they were full of steel, which made them difficult to concrete properly; and, although they might be pre-stressed to some extent, they were under considerable tension. That meant, particularly if they were made in rapid-hardening cement, that they were bound to show a number of cracks, and, if they were exposed to the weather, in 10 or 12 years their surfaces would expose the steel. The 160 feet span of the hangar he had referred to was nowhere near the limit; 200 feet or even 300 feet would be quite feasible. With the arch there were a few fairly big members, not overcrowded with steel, which could easily be concreted. In the particular design shown the main members were actually under the roof-covering, so that they were not exposed to the weather. He would always advocate reinforced-concrete design of fairly large members for exposed work such as that in question, in preference to anything

of the cantilever type, which had slender tension members exposed. In the structure illustrated by the lantern-slide the ribs were true arches, supported on piles at each end. The one drawback was, of course, that the span could not be increased as the opening of a cantilever could; but its advantage in the matter of permanence was, he thought, important. Mr. Manning.

Mr. C. P. HUNTER felt strongly that Civil Engineers should now take up the question of airport building. He had been responsible for Portsmouth airport as contractor, and had received great assistance from the municipal engineering department. He would be very pleased to see more civil engineers on the Committee to which reference was made on p. 171. The Author said: "the top soil and vegetable mould should be stripped from the site and carefully laid aside for use in the final topping of the surface. The Author's experience is that workmen are often careless in this respect, and careful supervision is necessary to ensure that top soil does not become mixed with subsoil, as it is essential, if grass is to be grown, that it should be planted in suitable top soil." If members would realize for a moment the moving of thousands of tons of soil in carrying out that plan, and the manner in which the soil would get in the way when big surfacing ploughs were put to work, they would understand his disagreement with the Author on that point. He had done it in the case of his own aerodrome, which was on his farm, and naturally he had been anxious to please his bailiff by keeping as much of the good soil at the top as possible. It had cost him quite double what it would have cost otherwise—£3,000—and he had not got, as a result, anything worth that expenditure, as compared with what he would have got if he had done there what he had done everywhere else, namely, produce turf on any soil which happened to be present. Having during his life laid down more than half a million acres to grass, he had some knowledge how to grow grass—or rather clover, for clover was the essential thing on a good aerodrome. The mat which clover made helped to support big aircraft. One of the most valuable points in the Paper was the emphasis laid on the necessity for allowing time for construction. An aerodrome could not be matured in 6 months, as some city engineers imagined. But it could not be expected that 4 years would be allowed. At Portsmouth the airport had cost £129,000, most of which had been spent on acquiring the land. The interest on that money was a very important consideration. But, given 18 months or so, the ameliorating agencies of Nature—frost and snow and so on—could do their work, and with the addition of suitable manures it was possible to make clover grow anywhere it was wanted. He submitted that, in these days of economy, that was a very important point. Mr. Hunter.

Mr. Hunter. He had come from Chester to make it, because he thought there was a danger that the stipulation would creep into engineers' specifications that soil should be laid aside and the ground surfaced, and then the soil put back, which meant two handlings; and in this country the kind of weather which lent itself to spreading the soil in the ideal condition in which it should be spread, that was in a mealy, powdery state, did not often occur.

Major Mealing. Major R. H. S. MEALING expressed, on behalf of Colonel Shelmerdine, the Director of Civil Aviation, his regret that he was unable to be present. For his own part he thought the Paper was a little overdue, as for a long time a Paper had been needed which really laid down the requirements for an aerodrome from the engineering point of view. At the Air Ministry, as Chief Technical Assistant, he had been responsible some time ago for drawing up the requirements for an aerodrome purely from the flying point of view. Quite naturally, he had had people from all over the country, particularly municipal engineers, asking "How do I put these requirements into practice?" He thought people generally did not realize, as did those who were in close touch with aviation, what a big advance would be made in the next few years, in spite of the present financial depression. He would like to emphasize, from the Air Ministry point of view, the absolute necessity of spreading a knowledge of the requirements of aerodromes so far as the engineering work was concerned. The Committee set up by the Royal Institute of British Architects had taken up the subject 2 years or more ago, and he wished that The Institution of Civil Engineers had gone into the matter sooner. In one of the Author's slides—probably an American one—a machine had been shown coming in over a tree at an angle of 1 in 7. The absolute minimum British figure was 1 in 10, and preferably 1 in 15. He had been expecting the question to be asked why such large areas were necessary for aerodromes, and whether the machine of the future, such as the autogyro, would not be able to get in and out of a back garden. It might be possible for a machine of that type to do much better than was done at present; nevertheless, for a long time to come it would be impossible to reduce the size of an aerodrome, for the simple reason that, whether a machine required a large area to land upon or not, the traffic at certain aerodromes—and he thought the statement would be applicable to many in the future—was increasing at such a rate that, even if a large area was not required for landing and taking off, the area required for manœuvring grew every year. That remark was especially applicable to Croydon, which he thought could be taken as quite a fair example. He was grateful that neither the Author nor any speaker had referred to elevated aerodromes. Though once he had had to deal with that matter nearly every day

at the Air Ministry, he would have been at a loss to answer any question about it. In spite of all the projects that had been put forward, he had not yet seen one which met the requirements of existing aircraft, and, as far as could be seen, of the machines of the immediate future. Major Mealing.

Mr. G. Percy Trentham considered that the Author was to be congratulated on having found a new application for soil. To the civil engineer or contractor soil was a substance which had neither stability nor strength, and credit was due to the Author for enabling a property to be given to it which would render it useful in many other spheres as well as aerodrome construction. It would be useful if the Author could state the quantity of binder required for a given depth of soil, e.g., the number of gallons per square yard 6 inches or 8 inches deep. Had the Author treated any large areas of turf by spreading clean screened clinker of small gauge and rolling it in? He had had some experience of that in the case of large playing-fields; and golfers knew that screen-graded clinker well rolled in made a distinct improvement in the bearing properties of turf. The preparation of sites for aerodromes was a class of work requiring a larger percentage of unskilled labour than any other. In the industry with which he was connected nine out of twenty employees were out of work, and any one who was in a position to influence work could not do better than select the preparation of aerodrome sites for future use. As had been mentioned by Mr. Hunter, the longer the time given to the preparation of an aerodrome, the better would the result be. Mr. Trentham.

Mr. John Dower remarked that, as Secretary of the Aerodromes Committee of the Royal Institute of British Architects, he wished to thank the Author not only for his Paper but also for the valuable and constant assistance which he had given to the Committee. It was not for him, as an architect and a town-planner, to go at all closely into the purely engineering problems presented by aerodromes. He did not find anything in the Paper with which to disagree, and he only wished that space had allowed of rather fuller treatment of several matters. The Author appeared to be a believer in the all-way landing-field, and, so far as this country was concerned, normally in the grass-surfaced landing-field, though he wisely refused to anticipate the surfacing needs of the very unpredictable future development of aviation. The objection to the all-way landing-field for large aircraft was the large area required and the consequent difficulty of finding sites near the centres of cities. That difficulty had driven designers, especially in America, to analyse the all-way landing-field into its essential components. On the normally accepted basis which the Author mentioned, namely, that aircraft could safely Mr. Dower.

Mr. Dower. land or rise up to 22½ degrees out of the wind, the field might be replaced by landing-strips, normally four in number and at 45 degrees to each other. The landing-strips would have the same general requirements as the all-way landing-field as a whole, except that they would be only 400 to 600 feet wide. So long as each landing-strip had easy and direct connection with the points of service and control, the strips might be disposed in a variety of patterns, as suggested or permitted by each site. He felt that this "strip analysis," if he might so term it, of any project, in relation to all the facts about any possible site, was of great value and importance. It should be the basis for determining what approaches to the field most needed protection against possible obstructions, and also for determining what positions should be allocated to the aerodrome buildings. It should be the means of securing sound economy in improvement and surfacing, whether that surfacing were grass or artificial. But he did not think—and on this point he believed he was in agreement with the Author—that the development of the idea of landing-strips should normally involve any radical departure from the "fool-proof" simplicity of the all-way landing-field based on some approximation to circular or square shape. On the all-way landing-field the intersecting strips would be superimposed; into its central area the landing-strips would merge; from its edges they would radiate outwards towards the clear "flight-ways" and provide additional run for the larger aircraft which needed it. He regarded grass surfacing as being, for the main part of the aerodrome, both broadly adequate and economically necessary for the majority of British aerodromes for a good many years to come. The most persistent difficulty with grass arose on the heavily-used surfaces immediately adjoining the buildings and the paved aprons. Taxying routes for the aircraft approaching or leaving the apron tended automatically to establish themselves, and patches of grass quickly deteriorated into rutted and pot-holed dust, loose earth, and mud. Treatment with oil or bitumen, as described by the Author, or other artificial surfacing, might become necessary, but he thought that gradual extension of the artificially-surfaced area was unsatisfactory as a general solution, for it simply pushed the bad patches farther out by stages from the buildings and the apron. Sometimes the trouble was aggravated by water draining off the concrete apron on to the grass and making patches of it extremely soft and muddy, but in ordinary circumstances that could be cured by proper marginal drainage. It seemed to him that the best general preventive was to control and vary frequently the traffic routes on and off the apron; as soon as any patch showed deterioration it should be railed off and cultivated back into good condition. A good deal

was to be hoped for from the substitution of tail wheels for tail skids. Mr. Dower.
In the matter of guiding principles for the lay-out and construction of aerodrome buildings he thought engineers and architects were on common ground. He would like to suggest three points by way of addition to or comment on the Author's list. It seemed to him that safety considerations must be paramount, and that all buildings should therefore be as low as possible. Multi-storey planning was quite unsuitable, and all unnecessary sky-line features, such as masts and towers, should be excluded. The second point was traffic-speed. Very careful planning was needed to get passengers, staff, freight, and machines of all kinds into and out of the air and off and on the field without any clashing or waste of time. The third point was adaptability. As the Author indicated, every building should be planned for ready extension and alteration. In that respect it seemed to him that steel-frame construction, with light removable partitions and casings, had great advantages over reinforced concrete, which was difficult to alter and costly to demolish. Standardization of trusses and other structural units, uniformity of large rectangular bays, and general simplicity of shapes adopted, were all desirable. In conclusion he would like to urge the need for close co-operation at all stages of aerodrome work between engineers, architects, town-planners, and other professional advisers, all of whom should contribute, in consultation, to the essential master plan of which the Author spoke. For the present, selection and reservation of sites and initial ground improvements were likely to demand more activity, in this country at any rate, than elaborate schemes of building; so that the town-planner, the site-planner, and the ground engineer would get more chance of immediate employment, while the architect and the structural engineer must be content to advise and scheme and wait until better times for execution. At the moment, town-planning, as the Author indicated, could give aviation the greatest assistance. The reservation of an adequate number of suitable aerodrome sites all over the country, and the protection both of those sites and of existing aerodromes against obstruction, by the "zoning" limitation of surrounding development, were the essential needs, which only the wise operation of regional and local planning schemes could satisfy. He wondered whether it was too much to hope that a group of representative engineers, town-planners, architects, and others might, in co-operation with the Air Ministry and other Government departments, work out some national master plan, co-ordinating and guiding regional and local schemes, to secure a thorough nation-wide provision for the groundwork of aviation.

Sir CYRIL KIRKPATRICK remarked that he took a great interest Sir Cyril Kirkpatrick.
in the subject of the Paper, his grandfather having been one of the

Sir Cyril Kirkpatrick.

pioneers in starting the Aerial Transit Navigation Company in 1843. He had been struck by the fact that so few members of The Institution had taken part in the discussion. The reason was, he thought, that they had not as yet had the opportunity of taking part in such work. The Institution had among its members men with engineering experience of all kinds, including everything which appertained to the making of aerodromes, but somehow or other they had been rather out of it. He believed that if the Air Ministry felt that civil engineers should come more into this problem, which had really become something of great importance, and made application to the Council, they would obtain every possible assistance, and leading engineers, and indeed all the corporate members, would co-operate with them in every possible way.

The Author.

The AUTHOR, in reply, remarked that he was glad that Sir Leopold Savile had made the point, for the information of the taxpayer, that one Government department carried out work for another if it happened to have staff in the locality, so as to save the taxpayer the expense of sending special staffs to remote parts of the earth. With regard to Sir Leopold's question concerning the ideal aerodrome, there were really many points other than the shape and contour to be taken into consideration. In selecting a site for an aerodrome the ideal had always to yield to what was practicable, but, other things being equal, he would prefer an aerodrome square in plan, with buildings along one side, from which side the ground sloped gently downwards in the direction of the prevailing wind. That would permit of landings normally taking place up the slope, and a uniform slope downwards to the farther side of the aerodrome would be ideal from a drainage point of view. The saucer shape was designed apparently to provide, for all directions of the wind, a retarding upward slope for aircraft to land into and a downward slope to take off from, but those laudable objects would be obtained at the expense of certain practical difficulties. It was extremely unlikely that a natural site even approximating to the formation indicated would be forthcoming, particularly as geographical position usually greatly limited the choice of ground; and the conversion of an average site would involve moving some 500,000 cubic yards of earth, as well as expensive drainage work. In certain directions of the wind there would be the disadvantage of a long taxi-run up a retarding slope of 1 in 100 into the hangars, and since, in order to gain the advantage of the longest possible run, landings must take place along a diametral line, the landing of two or more aircraft together might present difficulties. Landing on the downward slope, as suggested by Sir Leopold Savile, would result in a tendency to gather speed, which would partly nullify the advantage of the

upward slope in bringing aircraft to rest. With regard to artificial surfacing, his idea for the treatment of natural soil by the methods described had been obtained from American papers, and he believed the Air Ministry had been the first body in this country to think of the application of those methods to aerodromes. He had experimented with both asphaltic road oils and bitumen emulsions, and was interested to hear from Brigadier-General Wace that the successful use of the latter had extended to other countries. The statement on p. 185 was intended to refer to the method, not necessarily the medium, employed for binding and consolidating the soil. He could not agree that treatment to a depth of 4 inches was sufficient for runways except under very favourable circumstances; if the ground were bad, the treatment must certainly be carried deeper. With regard to hangar construction, he did not like the waste of space due to the insufficient height at each end of the arched section shown by Mr. Manning. Whether reinforced-concrete or steel construction should be employed for hangars was a debatable question. His own view was—and Mr. Dower had referred to the same point—that flexibility was really essential in the present state of aviation. He did not like tying himself down to a hangar which could not be altered or moved to another site. He had had experience of moving hangars from one site to another and of extending hangars in not only height and also in length, which of course was fairly easy. That was not possible with reinforced-concrete construction. With regard to Mr. Hunter's remarks, he was strongly of opinion that the day would come when turf would not stand the intense traffic of an airport, at all events not for the large portion of the surface which formed the immediate approaches to the hangars. He could not agree that in levelling operations it was generally unnecessary to preserve the top soil for reuse in order to grow a satisfactory turf. Experience had shown the disastrous results of neglect of that precaution when dealing with heavy clay subsoil on aerodromes subjected to intense traffic. Major Mealing had referred to the elevated aerodrome. In the Paper he had said that he felt the airport of the future would be on the ground and not in the air. As to the quantity of bitumen to be mixed with a square yard of soil, he would not like to give any figure; it depended very largely on the bitumen emulsion used, and also on the character of the soil, so that it was impossible to be dogmatic. He had tried rolling screened clinker into turf so as to consolidate it; it was a very usual method to adopt for improving soggy surfaces, but he did not think it would provide more than a temporary solution. He thanked Mr. Dower for his generous appreciation of the work which he had been privileged to do as a member of the Aerodromes Committee. He felt that that Committee

The Author.

The Author. had done very useful work, and their report, which would be issued shortly, should be interesting and instructive. As to safety, as Mr. Dower had indicated, all buildings on an aerodrome and in its vicinity should be regarded as obstructions and be kept as low as possible. In the case of one aerodrome of which he had experience all the roofs were flat, to minimize obstruction.

Correspondence.

Brigadier-General Biddulph. Brigadier-General H. BIDDULPH, R.E., considered that the Author had done good service in summarizing briefly the essential points to be observed in the construction of a satisfactory aerodrome, based on first-hand knowledge of the factors involved and experience acquired during many years. He would emphasize the importance which the Author attached, very rightly, to methods of preparation and maintenance of landing-grounds, for in the past it had been overlooked sometimes. Several years ago the vital importance of this matter impressed itself very forcibly at the Air Ministry, on account of the intense use of Service aerodromes, the increasing weight of machines resulting in wear and tear of the grounds to a destructive extent, with consequent damage to machines in many instances. A variety of experiments had been made on soils of different characters, including very heavy clay, and it had been found that treatment with bituminous emulsion was successful in every case, provided that the instructions were carried out. The essential things were :—

Ascertaining the emulsion best suited to the soil in question.

Mixing the emulsion thoroughly with the soil to a depth of not less than 8 to 9 inches (it was essential that the depth should be greater than that to which any tail-skid could cut).

Protecting from rain, during construction, the successive portions of the surface under treatment.

Constructing ample and numerous drains (usually French drains) to carry off at once all surface water, special attention being always paid to the line of junction between the apron and the treated surface.

In one case of very heavy clay extremely good results had been obtained by burning the clay thoroughly to a depth of 8 or 9 inches, waterproofing the surface, and dealing with the surface drainage as in other cases. The results obtained by those methods, combined with unified control of all " land " and " engineering " operations,