The Hammond Organ

By Sir James Barrett, K.B.E., C.B., C.M.G.

A GENEROUS but anonymous donor has just presented a Hammond organ to the University of Melbourne; and as I am interested in music, especially orchestral music, I am glad to testify to the excellent results obtained from it. The instrument itself is about the size of a small harmonium; it has two manuals and a pedal register, and a foot lever for producing variation in volume. When used fully, the volume of tone is very great, but the musical beauty of the instrument lies even more in the solo stops or arrangements. The clarionet stop produces something superior to any clarionet I have heard, and the volume of tone can be altered at pleasure. The oboe and violin equivalents are very satisfactory.

By combining the various overtones it is obvious that any instrument can be imitated and even improved. The only adverse criticism I have heard is that when the instrument is used fortissimo it is apt to produce a somewhat raucous tone, but that is a matter for the organist to rectify. As the instrument costs about £800, it seems unlikely that many expensive pipe organs will be built in future; and I have no doubt that the Hammond organ represents the commencement of a new development in music.

The following account of the mechanism was kindly furnished me by the professor of physics in the University of Western Australia, Dr. A. D. Ross:

"A synchronous motor rotates at constant speed a shaft provided with sixty-one iron disks, each fitted with a series of projections like teeth. The speed of rotation and the number of projections is such that for any disk the number of projections passing a given point per second is equal to the frequency of the note represented by the disk. When a key of the keyboard is depressed, a magnet is brought close up to the circumference of the associated disk. The passage of the projections of the iron disk causes periodic fluctuations in the magnetic field of the magnet, and consequent induced current in a coil wound on the pole piece of the magnet. The electromotive force for this current varies harmonically, so that the current when supplied to a loud speaker gives a sine-wave movement to the speaker diaphragm and therefore a pure tone. (Unfortunately the material of the diaphragm has its own natural harmonics which are introduced to a slight extent into the tone, and this is one of the chief practical defects in the instrument.)

"When the key middle C of the keyboard is depressed, not only is a magnet brought up to the disk corresponding to frequency 256, but other magnets to the disks for 512, 768, 1024, etc. (the overtones). Each gives alternating electromotive forces with the above-mentioned periodicities, and resultant currents. These currents all pass through separate variable resistances, controlled by the draw-stops (each of which can be moved in or out in eight stages) and so one can utilize the series of electromotive forces corresponding to frequencies 256, 768, etc., in any desired degree of intensity. When the electromotive forces, so adjusted, are applied to a circuit, a current flows with fluctuations corresponding to all the effects superposed. This is amplified and transmitted to the loud speakers, which must produce a sound which has the same fluctuations and is the combination tone with the several harmonics present in the arranged proportions.

"The sounds given out by orchestral instruments have been investigated by recording the air pressure fluctuations in each wave. These waves are then analysed by Fourier analysis, either mathematically or experimentally, and the harmonics present are found and their relative intensities. (The problem is identical with that of tidal analysis.)

"The Hammond organ can undoubtedly produce a wealth of tone shades different from those of any known instruments. I found it most interesting when experimenting with it to alter a tone in a series of steps (each of which was in itself practically imperceptible) from that of a clarinet to that of the flute or oboe."

Industrial Use of Electric Batteries

ELECTRICAL engineers have recently been considering the relative merits of vehicles driven by electric batteries and of those driven by petrol. Considerable difference of opinion exists on this point, and so the paper by Dr. Strohe, of Cologne, a translation of which appears in *World Power* of June, is of value as he gives the results of practical tests on the two classes of vehicle.

Dr. Strohe summarizes the relative performances of an electric and a petrol vehicle as follows. Electric vehicles have a life of twenty years and their maintenance costs are five per cent. Petrol vehicles have a life of ten years and their maintenance costs are ten per cent. The 'fuel' costs of the latter are about four times greater than that of the former. The capital cost of the large electric vehicle is now lower than that of a petrol vehicle of similar loading capacity, and in addition the oil required is less and the tires last longer. The economic advantages, therefore, are in favour of the electric vehicle. The results show that the daily performance of an electric commercial vehicle after several years' use lies between 18 and 24 miles, and it can double this distance on one battery charge. Electrical vehicles are now available with speeds up to twenty miles per hour; but the radius can be extended by increasing the size of the battery. Increasing the size of the batteries is only advantageous when the