already been made with the problem. Dirac and Pryce have shown that such a relativistic classical theory of a point electron is possible, taking into account exactly its interaction with the field of electro-magnetic radiation. This success has been extended by Bhabha himself to particles with charge, spin and dipoles, and to such particles moving also in 'meson' fields—that is, fields of the type that arise when the particles interact with each other by continual creation and reabsorption of mesons or heavy electrons of either sign, as appears to be the habit of protons and neutrons. The development of this exact classical theory appears to be a step of great importance, although it has not yet been successfully incorporated in the quantum theory. It is, of course, possible that the extended formulation necessary for this step is so profound that it will turn out to require the fixing of the at present arbitrary inertial masses and dipole strengths attributed to the fundamental particles, which survive in the present exact classical theory—perhaps somewhat after the manner of Eddington's generalized theory. This is a problem for the future: discussion of Eddington's generalizations lies outside the range covered by Bhabha's address.

The programme for the formulation of a relativistic quantum theory contemplated in Bhabha's address is, as we have seen, as yet incompleted and perhaps incompletable. None the less, it is of great interest to pause a moment and consider what sort of world of fundamental particles it could provide us with, and how they would satisfy the requirements of observation. We shall give full weight to all considerations of maximum allowable simplicity, such as assuming that the fundamental particles only have charges $\pm e$ or zero, and no electric dipole moment in a co-ordinate system in which they are at rest, and that particles of unobserved type do not exist unless, of course, their existence follows theoretically from the existence of particles of a type required by observation. On this basis the completed programme would provide us with a set of light 'point' particles—electrons, positrons and neutrinos with charges $-e$, $+e$ and 0 respectively, all with spin $\frac{1}{2}\hbar$ and obeying the Fermi-Dirac statistics. The electron and positrons have identical masses and magnetic dipole moments, but the actual values are not fixed by the programme, nor are the mass and dipole moment of the neutrino, which may differ from those of the electron. The mass of the neutrino is required by observation to be very small compared with that of the electron, and may well be zero. The light particles interact with each other through their electromagnetic fields.

The programme provides us also with a set of heavy 'point' particles—protons (negative protons) and neutrinos of charges e, $-e$ and 0, spin $\frac{1}{2}\hbar$ and obeying the Fermi-Dirac statistics. The protons and negative protons have identical masses and magnetic dipole moments, but the actual values are not fixed by the programme, nor are the mass and dipole moment of the neutron, which may (and in fact do) differ from those of the proton. One would not expect to have observed negative protons. The heavy particles interact with each other through both electromagnetic and meson fields.

The programme also provides us with a set or sets of intermediate particles or mesons, the creation and annihilation of which provide the essential meson field mentioned above. Mesons of charge $\pm e$ and a mass about 170 times that of the electron will provide a meson field of essentially the correct characteristics. Such particles can be unstable and capable of spontaneous conversion into a light electron and neutrino. Such instability is required to account for natural β-ray radioactive decay and for the properties of free mesons as observed in the cosmic rays. Further details are as yet scarcely clear.

The fundamental particles of the programme are thus a rather numerous family of a structure not so simple as the purist might desire before attaching to his satisfaction the label *fundamental*. None the less, such a synthesis or enumeration when completed would represent a magnificent advance, not only for the parts of the theory that it tidies up, but also for the untidy ends lying about which it emphasizes—the undetermined inertial masses and magnetic dipole moments with their rather surprisingly queer ratios. It is here that this programme, which one might describe as the classical relativistic-quantal programme, appears to have reached the bounds of its foreseeable development. One may reasonably expect that further progress will require profound reformulation—proceeding possibly, as suggested above, along paths already indicated by Eddington.

NATIONAL FLOUR AND BREAD

THIRD REPORT

From the Scientific Adviser's Division, Ministry of Food

THE first and second reports[1,2] covered the analyses of 622 samples of flour and 459 samples of commercial bread received up to early October 1942. The present report deals with a further 379 samples of flour and 381 samples of bread received in the period ending May 8, 1943.

Quality of Flour

In the period under review, certain changes have been made in the composition of National flour. There has been an increase in the percentage of home-grown wheat used, which at present averages 43·6 per cent. Since mid-March the addition of 2 lb. of skim milk powder per sack has been general (90–95 per cent of the flour is now so fortified) while from February 13, barley or a mixture of groats (dehulled oats) and barley has formed part of the grist.

In May 1942, a start was made on the addition of calcium carbonate (in the form of creta præparata) to flour at the rate of 7 oz. per sack, and at the end of April 1943, approximately 89 per cent of the National flour produced in the United Kingdom was so fortified.

Fibre and B_1. The following table shows the different levels of fibre and B_1 over the 379 samples of flour.

Fibre		B_1	
Value per cent	Per cent of Samples	I.U./gm.	Per cent of Samples
$\nless$ 0·4	9·8	$\ngtr$ 1·20	4·5
0·5	33·8	1·10	23·0
0·55	49·6	1·05	40·1
0·6	61·5	1·00	67·8
0·7	84·5	0·90	92·4
0·8	93·1	0·80	98·0
0·9	97·8		

A correction has been made in the fibre figures to allow for the addition of any Canadian G.R. flour.

The 'national average' figures for fibre and B_1 are now approximately 0·55 per cent and 1·00–1·05 I.U./gm. respectively. The corresponding figures for the period March–October 1942 were 0·7 per cent and 1·05–1·10 I.U./gm.[2]; there has thus been an appreciable reduction in the fibre content and a slight fall in the B_1 content.

The reduction in fibre is due to new methods of milling (foreshadowed in the second report) and represents a definite improvement in the quality and digestibility of the flour[3].

The very slight fall in B_1 is due to the higher percentage of home-grown wheat used and the lower bran content of the flour (as shown by the fibre figures).

The extractions from any added barley and groats have been fixed for the present at 70 and 85 per cent respectively. Laboratory milling tests have shown that at these extractions, the dilution will have no significant effect on the fibre and B_1 of the finished National flour. This has been confirmed by close analysis of the fibre figures of commercial flours received since February 13.

Protein and Riboflavin. The protein content largely depends, of course, on the composition of the grist. The following figures show this:

Grist	Protein content ($N \times 5{\cdot}7$) of National flour Per cent
50 per cent Manitoba No. 1; 30 per cent Manitoba No. 2; 10 per cent Plate; 10 per cent English ..	13·2
70 per cent Manitoba No. 1; 30 per cent English	12·3
All English (2 parts red and 1 part white) ..	8·3

Twenty-two samples of flour taken at random from those received in the period February 12, 1943, to April 4, 1943, and covering large and small mills over the country were examined for protein with the following results:

	Range	Average
Protein	10·7–12·0 per cent	11·3 per cent
Riboflavin	1·4–1·9 μgm./gm.	1·5 μgm./gm.
Fibre	0·25–0·75 per cent	0·50 per cent
B_1	0·8–1·10 I.U./gm.	1·00 I.U./gm.

The average figure of 11·3 per cent is consistent with about 50 per cent English wheat in the grist. The opportunity was also taken to obtain an average figure for the riboflavin content of National flour. Figures are also given for the fibre and B_1 for these 22 samples of flour.

Granularity. Not only the amount but also the size of the bran particles continues to diminish and the following table gives a summary of all the samples examined to date. In every case, correction has been made for any added Canadian G.R. flour:

Sample Nos.	Dates of Examination	Total per cent over 5 silk	Total per cent over 8 silk
1–100/42	1.1.42–19.3.42	11·9	15·0
101–200/42	–16.5.42	10·5	14·9
201–300/42	– 5.7.42	9·3	14·2
301–400/42	–28.8.42	8·4	13·0
401–500/42	–16.10.42	5·5	9·9
501–600/42	–17.12.42	3·8	7·7
601–636/42	–31.12.42	3·5	7·7
1–100/43	–16.2.43	2·4	6·5
101–200/43	– 9.4.43	2·2	6·2
201–250/43	– 6.5.43	1·9	5·8

Aperture No. 5 silk = 0.270 mm.; Aperture No. 8 silk = 0·190 mm.

Conversion Factor, Flour-Bread. Working at the optimum absorption, one sack of 280 lb. of National flour will yield approximately 380 lb. of bread (190 loaves of 2 lb. each), that is, 1 lb. of flour gives 1·36 lb. of bread. Many bakers use up to 1 gallon of water per sack less than the optimum, so that the average figure is probably near enough to 1·34.

Quality of Bread

A report was published recently[4] on the effects on bread quality of the addition of barley and groats to National flour. Both cereals tend to pull down the quality of the bread if present in large amounts. Two standards of bread quality were considered:

1st standard = best quality commercial bread being made in December 1942.
2nd ,, = satisfactory commercial bread.

Using these two standards, the following are roughly the limits of dilution for each diluent, added separately:

	1st standard	2nd standard
Barley		
Hand-baking	6–8 per cent	15 per cent
Machine-baking	5	10
Groats		
Hand-baking	3	6
Machine-baking	2	5

10 per cent barley, for example, gives a loaf smaller in volume with a somewhat harsher crumb of duller colour.

Increasing the percentage of home-grown wheat used will also lower the loaf quality as judged by the baker. The addition of creta præparata and skim milk powder has had no effect on the baking quality of National flour.

The following is a summary of the quality of the 381 commercial samples of bread received from different parts of the country since the second report was written. In brackets are the corresponding percentages for the previous 459 samples of bread examined:

Quality	No. of loaves	Percentage
Good	112	29 (61)
Fair—good	99	26 (22)
Fair	117	31 (13)
Poor	53	14 (5)

It is evident that there has been a fall in the loaf quality of the bread being sold, although nutritionally it has improved. The fall, however, is not greater than what might be expected because the period during which samples were taken covered that when bakers were not accustomed to the new type of flour, which included a high percentage of home-grown wheat and a proportion of barley and/or groats. Both these factors would lower the tolerance of the flour to variations in baking conditions.

The experimental work in this report was carried out in the Laboratories of the Research Association of British Flour Millers, St. Albans.

[1] and [2] NATURE, **149**, 460 (1942); **150**, 538 (1942).
[3] Moran, T., and Pace, J., NATURE, **150**, 224 (1942).
[4] Technical Baking Panel, Ministry of Food; Milling and Baking Press, (April 2, 1943).