

REPORT
OF THE
INDUSTRIAL RESEARCH PLANNING
COMMITTEE

FEBRUARY, 1945

COUNCIL OF SCIENTIFIC AND
INDUSTRIAL RESEARCH

[Price Rs. 3.]

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INTRODUCTION

In accordance with the resolution passed by the Governing Body of the Council of Scientific and Industrial Research at their fifth meeting held at Bangalore on the 1st December 1943, for setting up a Committee that should make a comprehensive survey of the existing facilities for scientific and industrial research in India and report on necessary measures of co-ordination, control, direction and development of such research by various agencies and also on other steps necessary for the planning of such research in post-war India, the constitution of a Committee for the purpose with the following personnel was announced early in 1944 by the then President of the Council, the Hon'ble Sir M. Azizul Haque, C.I.E., D.Litt., Member-in-charge of Commerce and Industries and Civil Supplies Departments of the Government of India :

Appoint-
ment of the
Committee
and per-
sonnel.

Chairman

Sir R. K. Shanmukham Chetty, K.C.I.E.

Members

Dr. Sir Jnan Chandra Ghosh, D.Sc., F.R.A.S.B., Director, Indian Institute of Science, Bangalore.

Lt. Col. S. S. Sokhey, M.D., I.M.S., Director, Haffkine Institute, Bombay.

Mr. Kasturbhai Lalbhai, Ahmedabad.

Sir J. J. Ghandy, C.I.E., M.I.E., F. Inst. P., M.I.S.I., Agent, Tata Iron & Steel Co., Ltd., Jamshedpur.

Prof. S. K. Mitra, M.B.E., D.Sc., Professor of Physics, Calcutta University, Calcutta.

Dr. K. A. Hamied, M.A., Ph.D., A.I.C., F.C.S. (Lond.), "Cipla" Laboratories, Bombay.

Prof. M. Qureshi, M.Sc., Dr. Phil., F.N.I., Head of the Department of Chemistry, Osmania University, Hyderabad (Deccan).

Dr. Sir S. S. Bhatnagar, O.B.E., D.Sc., F.R.S., Director, Council of Scientific and Industrial Research, Delhi.

Mr. J. N. Sen Gupta, M.B.E., M.A., B.L., Industrial Economist and Research Development Officer of the Council of Scientific and Industrial Research, (*Secretary*).

(Dr. Sir S. S. Bhatnagar acted as Secretary of the Committee till the 26th April, 1944).

The specific terms of reference to the Committee were as follows :—

- (a) To make a survey of the existing facilities for the Scientific and Industrial Research existing in India including Indian States—in the universities, research institutions and laboratories attached to industrial and other concerns,
- (b) to plan a scheme of co-ordinated expansion of research activity by private firms, research institutions and States and other research establishments.

Terms of
Reference.

- (c) to report on the steps and measures that should be taken to promote, direct, control and organise such research activities,
- (d) to report on such other steps as may be taken towards industrial and scientific research in post-war India.

Tours and Meetings.

The Committee assembled at Bombay on the 20th March, 1944. At its first meeting it decided to issue in connection with the fact finding part of its inquiry, two sets of questionnaire—one to the various universities, research institutions and Government departments interested in scientific and industrial research and the other to industrial firms (Annexures I & II). In the latter case, the questionnaire was also sent to recognised chambers of commerce and industrial associations. The Committee thereafter visited some of the important centres with a view to have personal discussions with scientists and representatives of universities and industrial and commercial bodies. The list of places visited and the names of the gentlemen who kindly appeared before the Committee are given in an appendix to this report (Annexure III). The work of the Committee was interrupted for a short while on account of the absence of the Chairman in the United States of America on official duties. During this period, a Sub-Committee with Sir J. J. Ghandy, C.I.E., as Chairman carried on the work with special reference to a few special points arising out of the inquiry. When the Committee visited Calcutta, it had the opportunity of meeting the distinguished British scientist Dr. J. D. Bernal, F.R.S., with whom we had a very interesting and illuminating discussion. During the tours we took the opportunity, wherever we could and considered advisable, to visit some important research laboratories to acquaint ourselves with the nature of the work done in these institutions. Special mention may be made in this connection of our visits to the Cotton Technological Laboratory, the Haffkine Institute, the Laboratories of the Department of Chemical Technology, Bombay University and the Bose Research Institute at Calcutta. Most of the other research laboratories of importance in India had already been visited by individual members of the Committee at some time or other. Along with the discussions with representatives of Government departments, universities, Indian State and commercial and industrial organisations and distinguished scientists, we found it necessary from time to time to invite memoranda on specific problems of interest from various official and non-official gentlemen to supplement the information available to the Committee through written replies to the questionnaire and in the course of oral evidence tendered before the Committee.

Three of the members of our Committee, Dr. Sir S. S. Bhatnagar, Dr. Sir J. C. Ghosh and Prof. S. K. Mitra were with us at the earlier stages of our enquiry. On account of their visit abroad we have been deprived of the benefit of their knowledge and advice in the latter stages of our work.

Acknowledgment.

We place on record our gratitude to the gentlemen who readily accepted our invitation to meet the Committee at various places and offered their co-operation in placing all the information sought at the disposal of the Committee and for allowing the facility of helpful consultations with them. We also desire to express our appreciation of the work of our Secretary, Mr. Sen Gupta, whose intimate knowledge of the working of the Council of Scientific and Industrial Research and wide experience of industrial problems have made his services a source of considerable strength to the committee.

SECTION 1.

SOME IMPORTANT MATTERS REGARDING EXISTING RESEARCH FACILITIES.*

In the survey as set forth in Annexure IV an indication is given of the research facilities available in the research organisations belonging to the four main categories, viz: (i) Institutions established under Government auspices (ii) Government-aided Institutions (iii) Research organisations of private industry, and (iv) Universities. These research facilities, however, involve consideration of some important aspects of common interest to the various organisations, relating to such matters as the library facilities available, the research personnel employed by the organisations, their status and emoluments, and the mutual contact between industries and universities. Below are set forth some relevant facts relating to these aspects of the research organisations.

2. A large amount of useful information has been collected by the Committee on this subject and this has been passed on to the Council of Scientific and Industrial Research.

Library facilities.

3. On the subject of research personnel also some interesting data have been collected by the Committee, but as the publication of the same in an incomplete form cannot serve any useful purpose, it has been decided to pass on the information, for the compilation of a National Register of Scientists, to the National Institute of Sciences, India, which has been given a grant of Rs. 10,000 by the Council of Scientific and Industrial Research for a similar purpose.

Research personnel, status and emoluments.

4. Regarding the status and emoluments of the research staff employed in the various research organisations, those working in institutions belonging to the first category appear, generally speaking, to be enjoying better privileges than others employed either in universities or in research organisations set up by industrial firms, at least for the security of service and chances of promotions open to them in Government and aided institutions. Even so, it is generally admitted that the salary or emolument given to a scientist or research worker is far too inadequate to attract the best men. As a matter of fact, the limited prospects of scientific services in India provide an important reason why the best students from the colleges and universities divert to the more lucra-

* We divide research into two categories, viz: Pure or Fundamental and Applied. Applied research is sub-divided into Basic and Specific, the former connoting research on problems of general or long range character, and the latter connoting research on the individual specific problems of industries.

tive professions and competitive services and administrative posts. In the universities, the allowance given to a post-graduate research worker is very often less than Rs. 100 per month and this also, in many cases, is for an indefinite tenure. This undesirable state of things is to a certain extent due to the limited financial resources available to most of the universities in India. As regards industrial firms, there are not many who employ any special staff exclusively for research work. The practice of employing staff exclusively for research is followed by some of the larger chemical manufacturing concerns, the research institutes of the Indian Jute mills Association and the Indian Tea Association and also by the Tata Iron & Steel Co., Ltd., and one or two other firms outside the category of chemical industries. Regarding their emoluments, the chemical assistants who are B.Sc's. are paid an initial salary as low as Rs. 40 per month in some cases, the general level being Rs. 60-75 per month. Only the men at the top are found to be getting a decent salary in the larger industrial firms maintaining research establishments, but they are of the nature of exceptions. The same remark applies to the status of the research staff. Only in the larger firms, the status of the research staff is comparable to similar staff in Government departments; and, in very rare cases, they are given the status of heads of departments or assistant heads of departments. From the information contained in the replies received to our questionnaire there is no indication that except in a few cases there has been an improvement in the status and emoluments of research workers in Government institutions, universities or industries. It must be pointed out that the fixation of the emoluments at a reasonable level and a commensurate improvement of the status of the technical staff must necessarily constitute the condition precedent for attracting and retaining the right type of men.

Contact
between
research
organisa-
tions and
industry.

5. Among the Government, quasi-Government and aided institutions, those engaged in industrial research have contact with industry by having representatives of trade and industries on their advisory and governing bodies. So far as the universities are concerned, only a few of them have developed any contact with industries for the solution of their problems. The method of contact has been largely of the advisory type and in some cases by the "Industrial Research Fellowship" type by which industries pay a lump sum of money to the universities to which they refer their problems for investigation. Prominent examples of this type are the schemes from Attock Oil Co., that were worked out at Lahore and the donation by the Burma Oil Co., for investigations in colloid chemistry, at Calcutta. The several departments of the Calcutta University collaborate also with the industries in and around Calcutta, in the investigation of their problems. Collaboration exists in the technological departments of the Bombay and Nagpur Universities, Benares (Metallurgical Department) and

Travancore Universities where representation is given to the industries on their advisory committees.

6. The industrial firms in India, on their part, have not yet developed any effective contact with the universities. Even those which have some contact make only a casual reference to universities in the recruitment of their staff. There is no contact in the sense of continuous exchange of views on research problems between the industries and the universities and as a result nothing has been done so far to give a concrete shape to this objective and develop any practice that should, on the one hand, help the university men to improve their teaching methods in the light of industrial experience, and, on the other, enable industrialists to improve the quality of their technical staff by putting them through 'refresher' courses at universities and other research institutions. In the matter of offering facilities for practical training to university staff and students, there are just a few firms who have already been providing such facilities, but the majority are favourably disposed to the idea.

7. A review of the researches carried out in India in the pure sciences has been published by the Indian Science Congress Association during its Silver Jubilee Session (1938). Useful pamphlets have been also brought out by the Board of Scientific and Industrial Research and the Inter-University Board giving the subjects of research undertaken in the various universities and research institutions. The general trend of researches and problems studied in pure sciences have not altered materially, and a steady progress of work has been maintained. It might be said that subsequent to the period of the review covered by the Indian Science Congress publication, interest has largely shifted to the study of problems in applied sciences. On the creation of the Board of Scientific and Industrial Research by the Government of India in 1940 many of the investigations in applied science that are now being carried out in the different laboratories are subsidised by the Board. A brief resume of the general outlines of the research work conducted in the several subjects is given in the Annexure V to this report. This will indicate the extent of facilities available for the study of these subjects. Read as a continuation of the monograph on the progress of researches published by the Indian Science Congress Association, this review will give an idea of the volume of work done in India up till now.

Review of
researches
in India.

SECTION II.

BASIC CONSIDERATIONS UNDERLYING THE COMMITTEE'S
APPROACH TO THE ENQUIRY.

Research as
a means to
an end.

8. In considering the terms of reference to the Committee we found it necessary to set forth to ourselves some general considerations that should form the basis of our approach to the enquiry and help the formulation of our proposals. We state them briefly at the very outset so as to facilitate a proper appreciation of our recommendations. Co-ordination and planning of research which constitute the key-note of the terms of reference precluded a purely objective approach to the enquiry in the sense of merely finding out the deficiencies in the present organisational set up of research in India according to the accepted standards of more progressive countries. We need hardly emphasise that an expansion of this kind just for ensuring a structural semblance is inconsistent with planning which postulates a definite objective. India has made some progress in research since World War I, but she lags far behind such countries as the United Kingdom, Germany, United States of America, Japan and the U.S.S.R. The position during the last Great War was considered to be quite unsatisfactory by the Industrial Commission. However, during the two decades which have since followed, a number of research organisations have been set up in India, while the scope and activities of many pre-existing institutions have been broadened. Among the existing organisations which have expanded in the wake of the last Great War, particular mention may be made of the Forest Research Institute, Dehra Dun, the Institute of Science, Bangalore, the Pusa Agricultural Research Institute and the Departments of Applied Sciences in some of the major universities. World War II has taken the position a few steps ahead by the establishment of the Board of Scientific and Industrial Research as the precursor of the present Council of Scientific and Industrial Research, and the establishment of Ordnance Laboratories and the expansion of some of them, notably the laboratories at Cawnpore. It is admitted, however, that to bring research up to the level of the advanced countries India has yet a considerable leeway to make up.

Priority of
Research
and industrial
Development.

9. While the expansion of research activities in India during the last five years has been spurred by the war emergency, it has also revealed many gaps in the present organisation. In facing the problem of future development and co-ordination we found ourselves confronted with some extreme views. It was suggested that a forced expansion of the organisation in the absence of a clearly defined ideal as to the

specific objective to be served by the various research institutes might only result in waste of public funds. It was urged in support of this view that research should follow and not precede the development of industries with the specific object of tackling the problems arising from such development; that organisation of research should, in the fitness of things, be attuned to a definite plan of industrialisation, as otherwise it would be functioning in an atmosphere of unreality not having any live problems to deal with and gradually sink into a state of inanition with only some routine work left on their hands to justify their existence.

10. We recognise the significance of the point sought to be pressed by these extreme views. But we consider them important more as a forcible plea for meeting the obvious necessity of establishing an effective liaison between research and industry than as an argument against further expansion of research organisation, pending the actual establishment of more and newer industries. There is already a large number of industries established in India which not only provide employment for more than ten per cent of the total population, but also constitute a main prop of our national economy. These industries provide an outlet of increasing potentiality for the consumption of the primary products and their stability and expansion is a matter of vital significance to the wider economic interests of the country. The present research activity in India does not represent even the bare minimum whether judged by international standards of the actual requirements of the country in her present state of industrial development. If it has not yet come to occupy a position in the front line of our economic problems, it is more because our large industries which either enjoyed the benefit of tariff protection or had assured markets in and outside India by virtue of their monopoly or quasi-monopoly conditions, have had a smooth sailing in the past and did not worry much about the problem of making continual efforts to consolidate their position against the possible onslaughts of adverse circumstances. The smaller industries had neither the outlook nor the resources for making any serious effort to improve their position by research. Research in its applied aspects has so far remained to be the primary concern of a number of Government Departments, either Central or Provincial, while pure research has rightly continued to be the main concern of the universities and there has been no effective co-ordination between the two.

11. Against the shifting background of the world economy in which profound changes are certain to happen on the termination of the present war, each country is now called upon to change its outlook in regard to the importance of research as an essential aid to holding its own. In countries like the United States of America, Great Britain,

Post-war
economic
prospects.

Australia and Canada, the demands of war have resulted in the building up of huge industrial factories which by all tokens will be engaged fully under peace conditions. The output of these factories would be on an enormous scale. The great advance in technology and in research has resulted in making these industrial organisations highly efficient. The Indian industry of the future will have to compete with these advanced industrial organisations. Such a fundamental change in the post-war position has focussed attention on research even in an advanced country like the United Kingdom. In a Report on Scientific and Industrial Research in Great Britain prepared by the London Chamber of Commerce early in 1944, this point was emphatically urged in the following words :—

“The prospect with which this country is faced is that it will receive less in foodstuffs and raw materials from the rest of the world for the same price and it will, therefore, have to produce more of its needs at home; that even to pay the same amount as before for the smaller quantity, it will have to increase the value of its exports by at least £200,000,000, *i.e.* by about forty per cent. Exports for this country are not a luxury, nor a means of avoiding the internal solution of its domestic problems, such as unemployment. Exports are vitally necessary to enable this country to pay for these imports of foodstuffs and raw materials which this densely populated island must have in order to live and which it cannot produce for itself. It will have to offer its wares to the world in competition with other highly industrialised and efficient nations. In the years between the wars we were spending on research a fraction of the amount being spent in the United States of America, the Union of Socialist Soviet Republics or Germany. This country cannot, therefore, afford to neglect research. Its wares must be attractive, more varied and better value for money. On no other terms can it hope to support the present population of these islands.”

Improved
standard
of living *sine*
qua non of
industrial-
isation

12. In India the paramount necessity of research is felt not only for facilitating an adjustment to post-war conditions but also for promoting the general cause of industrialisation at a time which will be rendered much more difficult by the forces of international competition. In recent international conferences, the attainment of full employment and the betterment of the general standard of living have come to be accepted as the common aim of post-war reconstruction. The realisation of this ideal in a country like India involves industrialisation on an extensive scale not only for securing gainful employment for the millions of our surplus rural population but also for the improvement of living conditions of the masses through a diffusion of purchasing power backed by the production of a larger volume of consumer goods within the country along with the various types of capital goods. Public demand in India is insistent on the initiation of such a policy

and the setting up of various Committees for planning post-War developments by the Government of India and the Provincial and State Governments and more specially the recent creation of a separate portfolio of post-War planning in the Government of India can be taken as unmistakable evidence of both the Government and the people being committed to a policy of rapid industrialisation.

13. In the attainment of this common objective, research is bound to play a part of increasing importance. During the last two decades, the development of industries in India came to be regarded as a phenomenon essentially conditioned by the grant of protective tariff. The grant of protection has, no doubt fostered the establishment of a number of industries in India—some, indeed, on a fairly large scale—and the necessity of a sympathetic and discriminating tariff policy will continue in future for encouraging development of specific industries in furtherance of the cause of industrialisation at an accelerated pace. Even so, it is well to recognise that the protective tariff is by its very nature a temporary expedient calculated to give the initial impetus to an industry and give it support in its infant stages. For most of the industries, it cannot and should not be regarded as a measure of permanent significance. The consumer interests, which have to bear the burden, will demand that the tariff will endure only for a limited period and will not continue longer than is absolutely necessary. The success of the protective tariff is to be measured in a very real sense by the promptitude of the industry in setting its own house in order and achieving the standard of productive efficiency that should dispense with any artificial prop in the form of protection. The capacity of Indian industry to withstand international competition will depend materially on its vision and readiness to implement the latest results of research in a continual effort for improving its productive efficiency by economy in the use of raw materials, utilisation of by-products, reduced power, cost and so on. Research is thus calculated to play the part of a decisive factor in India, as in the more advanced countries, not only for the maintenance of the integrity of our industries against foreign competition but also for the development of new ones for which the opportunities in this country remain imperfectly explored. Only a fraction of India's agricultural, forest, mineral, botanical and zoological resources have been turned to industrial use and there is good reason to believe that the initiation of planned and systematic research in these lines will reveal many potentialities which by useful exploitation would materially augment the national wealth of the country.

Protection
as basis of
industrialisation.

14. The survey of the research organisation in India (vide Annexure IV) makes it abundantly clear that although a number of

research institutions have been in existence for some years industrial research is still in its infancy. The vastness of the country presents by itself a special problem and it has often imposed a serious handicap on our principal research institutions in establishing an effective link with the industrial interests concerned beyond a limited range. A further obstacle to the creation of a suitable research atmosphere has been created by the fact that while industry constitutes a provincial subject, it is beyond the resources of most of the provinces to build up adequate research organisations for catering to the needs of local industries. For all specialised researches of major importance the necessary institutions have had to be set up by the Government of India and these have yet remained much too centralised for meeting the various regional needs. Although some useful researches have been done in these institutions particularly to meet the demands of the war, it is nevertheless a fact that industry, with some rare exceptions, has not become research-minded. The lack of necessary response from industry is at once the cause and the effect of the comparatively poor achievement of our research institutions. This patent and yet significant fact has led us to the conclusion that in the planning of research, the vital need is to bring the research organisations and industry into more intimate contact by the two-fold method of imparting a more practical bias in the outlook and activities of the research organisations and infusing among our industrialists and promoters a better appreciation of the significance of research as a major factor in industry. There must be common realisation on the part of both that research is a means to an end which can bear fruitful results only through effective co-operation between the two. This co-operation must be essentially of a dynamic character as research helping the development of particular industries would widen its own field for further investigations leading to the development of yet more industries. This paramount necessity has influenced our approach to the enquiry and we have prominently kept it in view both in scrutinising the materials placed before us and in formulating our own recommendations.

15. We should, however, make it clear that the liaison between industry and research organisations is required not merely for dealing with the current problems of industries. Another and a more important task that would devolve on the research organisations will be to undertake investigations with the specific object of revealing possibilities of new industries. But the discovery of new possibilities from the technical stand-point alone would not attract the necessary enterprise and ensure their effective utilisation as there are so many other factors involved which would call for a comprehensive scheme of industrial development with Government support vouchsafed to it. Research can yield its best results only when it is backed by a comprehensive industrial plan.

Such planning would not only inspire enthusiasm among the researchers by allaying their fears that the results of their investigations may be indefinitely put in the cold storage, but it would also serve the practical purposes of indicating an order of priority in the various lines of investigation that are to be taken up by research institutions either by themselves or in co-ordination with industry. The planning of a research programme by a central research organisation must depend upon the character of industrial planning. The National Research Council that we recommend (vide Section IV) must work in the closest co-operation with the Department of Industrial Planning so that industry and research will each stimulate the other.

SECTION III.

COMMENTS ON EXISTING RESEARCH ORGANISATION.

16. In reviewing the existing research organisation in India, our attention has been particularly drawn to some of its obvious drawbacks which have prevented it from yielding more substantial results.

Government
Research
Institutes.

17. The first among these is the absence of an effective liaison even between these Government laboratories which are engaged in industrial research—some indeed avowedly set up with such an object—with the particular industries concerned. The contact provided for in the administration of these laboratories, either in the governing bodies or special advisory committees, does not appear to have established intimate relationship by way of fostering the development of any general practice on the part of the industries sought to be benefited by them, of referring their special problems to such laboratories. The replies received from the sugar mills, for instance, do not indicate that the resources of the Imperial Institute of Sugar Technology at Cawnpore have been effectively used. We had not sufficient evidence on our hands to ascertain how far this is attributable to the lack of enterprise on the part of the mills and their apathy towards research or to the competency of the institute for rendering useful and expert technical advice which the resources of the mill could not provide.

Lack of
effective
liaison with
industry.

18. Judged by the standards of corresponding research institutes in England, the deficiencies of our institutions become at once manifest. Though the Cotton Technological Laboratory in Bombay was set up with a limited objective, it could have developed on the lines of the Shirley Institute of Manchester in some ways at least. To illustrate the kind of intimate and effective contact which must be established between industry and specialised research institutes, we

may state in broad outlines the nature of work done at the Shirley Institute.

19. The Shirley Institute was established in 1919 on the basis of an unanimous decision of all sections of the cotton trade in Great Britain (such as cotton growing, spinning, weaving, sizing, bleaching, dyeing, mercerisation and other types of finishing) which agreed to form a research organisation. Even at the very outset, there were over a thousand members. All the members of the Association were invited to send in their problems for investigation. Although at the beginning the response was very poor on account of the reluctance of the members to let others know of their difficulties, this obstacle was soon surmounted when it was found, as a result of work of the various technical sub-committees, that there was an enormous field of research of which real advantage could be taken by the members.

20. The Institute was formed for the solution of problems concerned in every process of the cotton industry from the raw materials to the finished goods. Later on the scope of the Institute was widened to cover other fields, *e.g.*, rayon and silk, having common objects for investigation.

21. The working of the Institute generally relates to problems of two types *viz.*, problems of direct industrial importance and purely scientific research constituting the basis for future applied work. The problems of direct industrial importance fall under the following headings:—

- (1) Researches on improving materials used in and the products produced by industry with existing equipments.
- (2) Improvements of various machinery and appliances and development of new ones for manufacturing, testing and recording purposes.
- (3) Solution of special problems of individual spinners, manufacturers and finishers at their request. (There is a very great demand for such services).
- (4) Problems relating to health of operatives in various sections of the trade.

22. The affairs of the Institute are managed by a representative Council and there is an Executive Committee. The control of research work is divided into various technical sub-committees which deal with different processes in the cotton trade, problems received from the members are discussed in the appropriate sub-committees and those approved are passed on for being worked out in the Institute laboratories, the results obtained being distributed to all the members.

23. An important feature of the organisation is its liaison Department whose main function is to carry out development work. The Liaison Department provides a link between the scientific staff

of the Institute and the technical staff in the trade. The staff of this department are entrusted with the following functions :—

- (1) They visit mills and keep the scientific staff of the Institute informed about the processing problems and difficulties which arise.
- (2) They explain and interpret the research results which have been communicated to the members.
- (3) They co-operate with technical staff in specific mills on request in the investigation of special problems which have been put up to the Institute. (This service is very much in demand).

24. We would emphasise the importance of the kind of liaison work done in the Shirley Institute. None of the specialised research institutes set up by the Government of India has anything of this kind of intimate contact with industry. As a matter of fact, if continuous and effective utilisation of their services by the industries concerned is regarded as the test of their achievements, they would not appear to be much of a success. The reason why despite this drawback the institutes have not come in for serious criticism is that their activities are not always confined to technological research alone; in fact, in the case of the Cotton Technological Laboratory, it is the research problems of agricultural interest that occupy the more prominent place in its research and testing activities. The problems of the industry as such have never been its main concern.

25. Secondly, there is a manifest lack of co-ordination in the research activities of the various organisations in the country *inter se*. It is discernible as much between official institutions as between the latter and research organisations of either universities or private industry. In the Government of India there are now several departments interested in research. The most important among these is the Department of Education, Health and Lands, which, either directly or indirectly through two statutory bodies attached to it, viz., the Imperial Council of Agricultural Research and the Indian Research Fund Association, is mainly responsible for agricultural (including Animal Husbandry), medical and forest research. It is also responsible for the Survey of India and the Zoological and Botanical Surveys. The Labour Department is in charge of the Geological Survey while Meteorology is under the administrative control of the Post and Air Department. The Council of Scientific and Industrial Research is under the newly constituted Planning and Development Department. The War Department also has been very much interested in research during the last five years and under the auspices of this department, some of the ordnance laboratories, particularly those at Cawnpore, which were originally organised mainly for testing work, have taken up research work.

Lack of
inter-de-
partmental
co-ordina-
tion.

26. Whatever may have been the original cause of such a scheme of departmentalised administration of research in the Government of India, it must inevitably lead to certain amount of overlapping which, in the absence of some effective co-ordinating agency at the top, could not ensure the best results. The institutes for cotton, sugar, jute and lac were indeed wholly or partly concerned with technological research, but these were placed under the control or supervision of the Department of Education, Health and Lands, and have continued to be so even after the inauguration of the Council of Scientific and Industrial Research. Among the other institutes (apart from the Surveys which constitute a category by themselves) whose scope was originally contemplated to be confined to agricultural, forest or medical research, not a few have since expanded their activities into channels which rightly belong to the domain of industrial research. Particular mention may be made in this connection of the Indian Forest Research Institute which was founded primarily for the benefit of the Indian Forest Department but has in the course of time so expanded its activities in its utilisation section for dealing with the problems of industry that it can very well rank with a specialised institute set up with the avowed object of industrial research. As a matter of fact, it has a more intimate contact with industry than many of the other specialised institutes. The paper mills in India recognise the services rendered to them by the Institute and it is understood that in appreciation of the co-operation and help offered to the industry, the Paper Makers' Association have been making an annual contribution to the funds of the Institute. The Pusa Agricultural Research Institute also has recently been taking increasing interest in industrial research relating to the utilisation of some waste farm products, manufacture of food preservatives and so on. Special mention may also be made of the Cawnpore Ordnance Laboratories whose recent excursions into the fields of industrial research have already been referred to. Industrial research comes, in a way, within the scope of some of the institute interested in medical and veterinary research, particularly such of them as are engaged in the manufactures of sera and vaccines.

27. Although the emergency of the war has been responsible for the development or at least the stimulation of industrial research in some of these institutions, the position would appear to be far from satisfactory. From the information available to us it does not appear that the programmes of researches of these various institutes concerned with industrial research are framed by mutual consultation or according to any co-ordinated plan. Such a state of affairs is hardly favourable to the utilisation of the scientific talent and resources of the country to their best advantage.

28. As between the Government research organisations and universities, only during recent years an attempt has been made to establish a contact by such organisations as the Imperial Council of Agricultural Research and the Council of Scientific and Industrial Research. But this has been more in the form of grants made by these organisations for research schemes sponsored by individual members of the teaching staff in the scientific departments of universities. It has not extended to the développement of any practice or convention regarding continuous exchange of views between the research staff of universities with those employed in the official research institutes.

29. Thirdly, the organisation for industrial research represented by the Government and aided institutes is found, on the one hand, to be very inadequate for a vast country like India, and, on the other, rather lop-sided. In some of the evidence tendered before the Committee, it has been emphatically urged that if in respect of mineral deposits, their extent and quality, the resources of India have to be fully explored within a reasonable period, the task should no more be left entirely in the hands of a single department at the centre, viz., the Department of Geological Survey, but shared with some Provincial or State Departments, for the purpose of intensive investigation of particular regions and study of the special characteristics of local deposits. Suggestions have also been made to the Committee that some work on this line can and should be taken up by the universities as well. Similar remark applies to the Forest Research Institute. The Institute at Dehra Dun is situated too far away from many parts of India in the East and the South for giving adequate attention to their local problems with the desirable expedition. The geographical conditions of the country in this respect and the variety of her forest wealth call for the establishment of several research laboratories in different regions of the country to supplement the work of the Dehra Dun Institute. Our attention has also been drawn to certain obvious deficiencies particularly in regard to such subjects as Genetics (in regard to both the plant and animal worlds) and marine biology, the importance of which in an agricultural country with an extensive sea-board can be hardly over-estimated. Universities must play a leading part in these fields.

Lacuna in the present organisation.

30. Lastly, in some of the institutes engaged in industrial research a tendency is discernible for the research staff being actuated too much by the profit motive. The royalties readily offered by businessmen under the prevailing war conditions has accentuated this tendency. Unless held in check, this must steadily exercise a demoralising influence on research, prevent the same from being directed to real creative work in the best interests of the country and eventually undermine the status and utility of the institute.

Evidence of profit motive

Research
organisation
of private
industry.

Industry not
research-
minded.

31. So far as private industry is concerned, there is a manifest lack of research-mindedness among the industrialists with a few exceptions. Some of the larger firms which maintain small laboratories do not assign to this part of their organisation due measure of importance. As pointed out in the survey, only a very few have fully equipped laboratories and maintain a regular research staff, the majority being interested in routine testing only. With rare exceptions there are no specific budget allotments for research. In most cases, the technical staff employed on the operational side are also employed for casual research. They have hardly any contact with either universities or other research organisations in the country and are supposed to keep themselves abreast of the latest technical developments through journals and through membership of scientific associations. Generally speaking the emoluments paid to the staff are not adequate for attracting the best men. The stinted expenditure on research also testifies to the general attitude of apathy of the vast majority of industrialists towards research.

Absence of
Industrial
Research
Association.

32. The same attitude is responsible for the absence of any research organisations set up by specific industries on a corporate basis except in the case of tea and jute. The position in India in this respect affords a striking contrast to that in England where the research associations of British industries now occupy a very prominent place in the research organisation of the country. "These were started at the end of the last war with the help of a million pound fund voted by the Parliament to the Department of Scientific and Industrial Research. There are now twenty-four of them, and they are self-governing bodies, supported voluntarily by firms engaged in the industries for which they cater or in a few cases by a levy on the raw materials of the industry in question. The Department of Scientific and Industrial Research supports the associations financially by means of annual grants of an amount depending on the subscriptions from the Industry". In 1943 the total incomes of the associations were estimated to be over £800,000 including a Government grant of £275,000. "The subscriptions vary with the size of the member firms, being in some cases as low as £10 annually for the smallest unit. Most of the associations possess their own laboratories but some of their work is done in Government or University laboratories or in the laboratories of member firms. The control of the associations is in the hands of the councils elected by the members; the results of the work are confidential to members in the first instance but in fact, much of it is subsequently published and added to the general fund of knowledge." The method of working of the Shirley Institute of Manchester of which a general outline has been given in a previous paragraph fully testifies to the alertness of the research associations in dealing with the problems of their constituents.

33. The research associations in Great Britain today embrace almost all the important industries of the country. In India, this example of self-help has been emulated so far only by the tea and jute industries. It is interesting to note that these are industries in which India's position is definitely much stronger than many of her other manufacturing industries, confronted with foreign competition, in which the urgency of research is more keenly felt. It is, of course, true that the meagre financial resources of the smaller industries do not permit them to organise and maintain any laboratories on a corporate basis, but the same argument cannot possibly justify the inaction of such prosperous industries as coal, cotton, sugar and cement, which are run on a fairly large scale and have well-established associations for dealing with their problems relating to marketing, production, control, etc. It must, however, be admitted, in fairness to Indian industries, that they did not get from the Government of India the initial financial assistance on the lines in which such assistance was given by the British Government to British industries for starting research associations.

34. It is again the general apathy of our industries towards research that has prevented them from making any efforts for utilising the scientific resources of our universities particularly in the Applied Departments. There is a conspicuous absence of industrial fellowships in our universities, endowed by any industrial firms for research on their specific problems. The few cases referred to are of the nature of exceptions which prove the rule. The question whether universities should be encouraged to adopt such a system to any considerable extent is considered later in connection with our specific recommendations. The existing position in this respect is stated just to indicate how even the available resources, inadequate as they are, are not taken advantage of by industry for want of the necessary foresight and enterprise.

Absence of
Industrial
Fellowships.

35. Universities must be the cornerstone of research in the country. Fundamental or pure research in universities must really offer the real foundation for all research activities. Indian universities have rightly devoted themselves to academic research and some of them have a brilliant record in this field. But except in the case of a few universities, there has been no appreciable work in the field of applied research. Since the Industrial Commission recommended in favour of certain lines of technology being taken up by universities, some of them have taken steps to develop their applied departments. The lack of the necessary emphasis on applied research in the Indian universities has, to some extent, created the impression among Indian industrialists that research activities in universities are of no immediate benefit to them. This may account for the failure of industry to take

Research in
Universities.

advantage of research facilities in universities and the consequent failure of universities in making their contribution to the promotion of the country's economy. Indian industry has not realised the value of universities in the industrial organisation of the country. The needs of the war have demonstrated that workers in the field of fundamental research possess a high capacity for applying their knowledge in the solution of the practical problems of industry.

Financial
handicap.

36. The scepticism of the industrialists is no doubt mainly attributable to the lack of friendly contact between the two parties, but it is also admittedly due to the inadequate equipment and lack of research staff in most of the universities. Only a few of them have workshops and necessary resources for undertaking pilot plant experiments. The majority have no such resources and from the discussions we have had with representatives of various universities, we are satisfied that it is the paucity of finance, more than anything else, which is responsible for this unfortunate drawback which has been preventing our universities from taking their legitimate place in the organisation of industrial research in this country.

SECTION IV.

NATIONAL RESEARCH COUNCIL AND RESEARCH BOARD.

37. In this and in subsequent sections, we make our specific recommendations for the setting up of an active research organisation in the country.

Inter-rela-
tion of
researches.

38. The experience of the past as revealed in our comments on the existing organisation of scientific and industrial research in India as also the problems arising from international competition emphasise the need for setting up an adequate research organisation in the country and for taking measures for bringing about a co-ordination of the activities of the various research organisations and universities. The co-ordination and inter-relation does not signify a more inter-departmental co-ordination from an administrative point of view. The inter-relation that we contemplate is more fundamental in its implication arising from the organic relationship between pure and applied researches. For the sake of convenience, the various kinds of investigation embraced by scientific and industrial research are generally classified into two distinct categories (1) Pure or fundamental research and (2) Applied research. Applied research is again divided into (i) basic and (ii) specific. The distinction between pure and applied research is that while pure research aims at the advancement of human knowledge with no immediate and material gains in view, applied research has the definite object of achieving results of practical utility in industrial and other fields by the application of scientific discovery

to the known forces of Nature. Pure research, therefore, has generally no financial appeal to any particular section of the community. Such researches therefore have come to be regarded as the primary concern of the universities. Applied researches, on the other hand, are not inspired by any such spontaneous scientific urge. They include specific researches undertaken for the immediate benefit of an individual manufacturer and also researches of a basic character which are concentrated either on the major technical problems of a group of industries or on problems of a long range nature such as those relating to the investigation of raw materials and the study of their characteristic properties with a view to the removal and control of their deficiencies by scientific treatment for the general benefit of industry. Research laboratories belonging to individual firms are mostly concerned with the type of what has been described as specific research though some of them may also undertake applied research of the basic character. Investigations coming under the category of basic research are generally undertaken by research organisations set up either by the corporate effort of particular industries or by the State for the general benefit of industries. Typical instances of the former type of organisation in India are furnished by the Jute and Tea industries, and of the latter by the Cotton, Sugar and Shellac Institutes. The reason why in the organisation of such basic research the initiative has to be taken either by a group of industrialists or by the State is that such researches aim at comparatively long range results the benefits of which are to spread to the whole industry.

39. Despite these special features of the different categories of research, it should be pointed out that the distinction between these must not be regarded as indicative of any essential difference that would justify their organisation and control on a mutually exclusive basis. A proper appreciation of the intimate relation between pure and applied research constitutes the first postulate on the basis of which any scheme for the organisation of scientific and industrial research in India should be conceived and planned. The inter-relation between pure and applied research is effectively urged in a pamphlet recently published by the Nuffield College over the signature of some distinguished British scientists, industrialists and public men.

“No doubt it is necessary for some purposes to make a distinction between fundamental and applied research especially in the sense that in industry the latter is necessarily guided in the main by practical and economic motives. Too much emphasis, however, is often laid on this distinction: and it is a great mistake to attempt to press it too far or to forget that fundamental research plays a vital part not only in producing new ideas which lead to new

industries and products, but also in the development of existing products and appliances in a great variety of ways such as the analysis of design, the introduction of new materials and the investigation of their properties, the scientific control of materials and production, and the execution of performance tests of new appliances and techniques. It is increasingly recognised as of vital importance for research of a fundamental character, not directed to specific practical objectives, to be undertaken in industry, especially by Research Institutes and Associations as well as by academic bodies."

Central
Co-ordina-
tion.

40. The need for central co-ordination of scientific and industrial research has been keenly felt even in an advanced country like the United Kingdom. The constitution of the Scientific Advisory Committee of the War Cabinet even though it may be a war measure will probably endure in some form or other even after the war. Our surmise is reinforced by the proposals contained in the Report on Scientific and Industrial Research adopted by the London Chamber of Commerce early in 1944. Reviewing the existing organisation of scientific and industrial research in England which it considers to be inadequate and unsatisfactory, the report contains a forceful plea for the initiation of a centralised and planned direction through a Central Research Board as the first of three essentials for galvanising research in that country, the other two being a far greater stream of money flowing into research and a larger, better trained and better paid personnel. The report suggests the constitution of a Central Research Board with the status and functions analogous to the British Broadcasting Corporation. The scheme seeks to bring under the purview of the Central Board not only industrial research associations engaged in basic research but also the laboratories belonging to private industry and interested in specific research through a system of grants to be made to the firms concerned in respect of such discoveries of wider interests as may be surrendered by the latter to the Board. The report contains also specific recommendations even for bringing the universities within the sphere of influence of the proposed Central Board at least in the matter of research either through the Universities Grants Committee or by delegation or by a separate committee of its own.

41. We need hardly stress that if the necessity of central co-ordination of scientific and industrial research is so keenly felt in England, it must be considered even more imperative in India having regard to the obvious differences between the conditions of these two countries in the field of research. In the first place, industrial research in England is already highly developed there being as many as 24 research associations which practically cover all the major industries of the country. Secondly, a certain measure of co-ordination between the activities of these associations is ensured by the Department of Scientific and

Industrial Research through the system of grants which have been steadily increasing. The universities also are assured of a substantial increase in grants for strengthening their laboratory equipments and research personnel. Thirdly, a co-ordination at a higher level is attained by the activities of the Parliamentary Scientific Committee. In India, where a proper beginning has yet to be made, a central organisation is required to build up an adequate network of research organisations in the country, to plan research on a comprehensive scale and to bring about effective co-ordination in the research activities of the country. The research activities of the Indian universities are almost universally found to be seriously handicapped for want of funds. The research activities of private firms are almost negligible: only two industries, viz., jute and tea, have research associations worth the name. The research institutions financed by the Government remain yet to be transformed into integrated parts of a comprehensive research plan.

42. In the United States of America, research has been built up almost entirely by the private enterprise of industrialists and philanthropists and by scientists and universities without any Government help or control. In the United Kingdom, research has made great advance through universities and through research associations which are mainly built and maintained by industries with a substantial amount of Government financial help. In India, as matters stand at present, it is not possible that research associations on any large scale would spring up at the initiative of industries, nor is there much hope of voluntary help coming from private individuals. The universities, as already pointed out, suffer from the handicap of slender financial resources. If, therefore, scientific and industrial research is to make any headway in India in the immediate future, Government must take the initiative in setting up a suitable machinery for the development of research along sound lines by giving an initial push by filling up gaps in the existing research organisation, by strengthening the science departments of universities and the existing research institutions wherever necessary by financial help and by bringing about an effective co-ordination amongst all the institutions. In the early stages, at any rate, the finances both for capital and equipment and for recurring expenditure must come from the Central Government. The Central Government, in our opinion, is the proper authority that must undertake this initial responsibility though the help and co-operation of Provincial and State Governments are essential if effective results are to be achieved.

Initiative
by the State

43. For stimulating and directing scientific and industrial research on a planned and comprehensive basis, we recommend that the Government of India should forthwith set up a central research organisation to be called the National Research Council. This organisation should

National
Research
Council.

consist of representatives of scientists, universities, industry, labour and administration. The Hon'ble member of the Viceroy's Executive Council in charge of the portfolio of Planning and Development should be the ex-officio President of this Council. Though the Council will, for administrative purposes, function under the Department of Planning and Development, it should be an autonomous body and made responsible for scientific and industrial research. The funds allocated to this Council must be under its complete control and there should be no interference in its activities by any department of Government. The Council must be recognised as a corporate body invested with full powers to manage its own affairs. The term of the Council must be for five years.

44. The total membership of this Council should be fixed at 60 made up as follows :

- (a) 20 scientists to be elected by all the universities and recognised scientific associations and academies.
- (b) 15 members to be elected by recognised chambers of commerce and associations of manufacturers.
- (c) 5 members to be elected by recognised trade unions and other labour organisations.
- (d) 20 members nominated by the Government of India of whom not more than 8 may be officials. Of these two should represent the Railway administration. In making the nomination for the remaining 12 seats, the Government of India should fill up any lacuna, regional or otherwise, in the representation of various interests and also for strengthening the Council if necessary by nominating eminent scientists, engineers, educationists, economists, industrialists or labour leaders who may not have been elected by any of the recognised bodies. In the case of universities, chambers of commerce and or manufacturers' associations, allocation of seats will be on the basis of industries and regions.

45. In deciding the composition of the National Research Council we examined a proposal that Provinces and major Indian States should be given representation on this Council on condition of their making a specified minimum contribution. We have rejected this proposal for various reasons. Such a scheme would, in the prevailing conditions, exclude some of the smaller undeveloped Provinces whose meagre researches may not permit their making the minimum contribution even though their needs for research may be more urgent than those of the contributing Provinces. An unconditional representation to all the units would make the National Research Council an unwieldy body. Apart from these considerations, a representation on the basis of financial contribution often creates undesirable complications in the working of the central organisation. The contributing units cannot often resist the temptation to judge the value of their contribution by the amount

of money spent for research within the territorial limits of the area in question. In other words, there would be an undesirable scramble for the allocation of expenditure by the Council in various regions without due regard to the needs of the country as a whole or the orderly progress of research. We hope that in the constitution that we have devised all the important regions of India would secure adequate representation.

46. The functions of the Council will be as follows :—

- (i) To organise and maintain national laboratories.
- (ii) To establish and maintain specialised research institutes.
- (iii) To stimulate pure and applied research in universities by grants-in-aid and by the institution of scholarships and fellowships.
- (iv) To provide for the immediate problem of the dearth of technical and research personnel by the inauguration of scholarships available in India and abroad.
- (v) To stimulate and encourage research activities by industry.
- (vi) To co-ordinate research activities of all the existing research institutes and departments of Government and undertake planning of research programmes on a comprehensive basis.
- (vii) To function as a National Trust for Patents.
- (viii) To set up a Board of Standards and Specifications.
- (ix) To function as a Clearing House, encourage deserving scientific and technical societies and foster the growth of new ones in appropriate lines.

47. The Council should ordinarily meet twice a year. It should set up a number of standing Technical Committees which will advise the Council and the Research Board referred to hereafter. It should also set up a Budget Committee to scrutinise the Budget proposals prepared by the Research Board and a Grants Committee to examine and recommend the allocation of grants to universities and research institutions.

48. Although the Research Council will be made responsible for the direction and control of the research activities of the country in the field of scientific and industrial research, its numbers will make it too unwieldy a body to manage this task by itself. For the actual administration of the work vested in the Council, we recommend the creation of a small executive body to be called the Research Board which will act under the general direction of the Council and will be responsible to the Council. The Board at its inception should consist of three members all full time men of whom two must be scientists and the third an administrator or industrialist of experience. One of the three members will be the Chairman of the Board. The tenure of the members should be five years but the term of individual members may be extended for a further period not exceeding two

Research
Board.

years, if it is considered necessary for facilitating the continuity of work or for other valid reasons. The Board will be assisted by a full-time Secretary with a strong and efficient secretariat. We consider that in the earlier stages it would be sufficient to have three full-time men as members of the Board. In selecting the members of the Board, the greatest care and attention must be devoted. The Board will function as the pivot of the entire research organisation envisaged by us. The value of research cannot often be judged by any immediate results of commercial value or by any criterion of profits and loss. Apart from this consideration the scheme recommended by us contemplates an effective liaison not only with research institutes working under the administrative control of Government departments but also with universities and non-official research organisations. To discharge such enormous functions satisfactorily, the members of the Board should be outstanding men of judgment and experience in order that the Board may carry the necessary prestige, and command the fullest measure of public confidence. We consider that such men are available in India and that it should be possible to persuade them to accept the membership of the Board having regard to the appeal of the national interest involved in the work. As one of the means of creating full confidence in the members, we recommend that the scientist members of the Board should not themselves be engaged personally in research during their membership of the Board. In making this recommendation, we do not lose sight of the fact that the consequence of imposing such a condition may be to deprive the country of the benefits of research by the eminent scientists who may be selected to serve on the Board. In view of the comparatively short tenure of office involved in the membership of the Board, we consider it worthwhile for one or two scientists to make this sacrifice in the wider interest of research so that no suspicion of personal profit or gain will be levelled against any of the decisions of the Board in their planning of research.

49. The exact manner of selecting the members of the Board is a question on which we spent considerable thought and attention. Since the Board is to function under the National Research Council it would logically follow that the members of such a Board should be selected by the Council itself. Theoretically such a course would be the most proper one. But practical considerations made us reject this method. In view of the importance that we attach to the work of the Board, we consider that the elective principle is not the appropriate one to be adopted in selecting persons entrusted with such responsible work. If the choice were left to the Council consisting of 60 members, extraneous considerations other than mere merit would often come into play. Apart from this, suitable men whose services

are required on the Board may not submit themselves to a process of election. For these reasons, we decided that election by the Council will not be a desirable method. The only alternative is nomination by the Central Government. As against this proposal it was urged that if the members of a Board nominated by Government are to command public confidence then that Government must be one responsible to the people of the country in a constitutional manner. The present Government of India is not responsible in that constitutional sense. We do not know what would be the nature of the future Government of India when the scheme contemplated by us comes into operation. In any case, taking all the factors into consideration we have decided that the members of the Board should be nominated by the Government of India. We presume that the Government in exercising this power will be largely guided by the Member of the Government in charge of Planning and Development. Since the Research Board is subordinate to the National Research Council there must be some means by which in extreme cases the Council may exercise its authority over the Board. For this purpose, we recommend that any member of the Board shall be removed from office if the National Research Council by a majority of two-thirds of its total strength recommend the removal of such member from office.

50. In course of time the scientist members of the Board will probably be selected from amongst the Directors of the national laboratories and the specialised research institutes under the control of the National Research Council. The salary attached to the membership of the Board should not by itself be an attraction to these Directors who might be looking forward to a membership of the Board as the goal of their ambition. Directors of these laboratories and institutes must aspire to a place on the Board solely by proved merit and talents. We, therefore, recommend that in fixing the salary of the members of the Board, care should be taken to see that there is not a wide disparity between their salaries and the salaries of the Directors of the national laboratories and institutes.

51. The Research Board will be the executive body entrusted with the task of carrying out all the functions of the National Research Council. We shall enumerate a few of the major functions which will come under the purview of the Board. The Board will be in charge of all the research laboratories and institutions set up by the National Council and the Directors of these institutions will be under the control of the Board. The Board should maintain the closest contact with all those Directors and also the Directors of Laboratories engaged in industrial research under the administration of other departments of the Central Government. With a view to enable the Board

Functions of
the Board.

to act as a clearing house of research information and to co-ordinate all the research activities of the country, it should be empowered to inspect all the institutes and laboratories under the administrative control of the Central Government and to obtain periodical reports from other institutes by mutual arrangement. For purposes of effecting co-ordination we do not think it necessary to bring under the administrative control of the Board such institutes as the Cotton and Jute Technological laboratories or the Institutes of Sugar Technology and Lac. Apart from the practical difficulties that may be involved in bringing about such an administrative measure, we realise that the scope of many of those institutes embraces activities other than purely industrial research. We believe that it should be possible to bring the industrial research activities of these institutes within the purview of the Board through suitable conventions fostered by a close association of the Departments concerned with the National Research Council. The object may be further achieved by the inclusion of the heads of some of these institutes among the nominated official members of the National Research Council. Through suitable conventions on an inter-departmental level, it should be possible to gain the objective of co-ordination that we have in view without effecting any radical change in the present administrative arrangements of these institutes. The Board must take an active part in encouraging the establishment of research associations by industries and must maintain the closest contact with such associations and all public bodies engaged in research in Provinces and Indian States. The Board must from time to time prepare comprehensive plans of research programme. Subject to the approval of the general plan by the National Research Council, the Board will undertake the execution of the plan. It is expected that research problems will as a rule be referred by the Board to the various laboratories and institutes directly under the control of the Board itself. It should also be open to the Board to refer by mutual arrangements such problems to Provincial and State laboratories, universities, research associations and public laboratories and academies. The Board should prepare the annual budget of the Council and when the budget is sanctioned by the National Research Council, the Board will have the control over the expenditure of the funds allocated to various purposes in the budget. With the help of the Grants Committee referred to above, the Board will distribute from time to time grants-in-aid to universities and other research institutions from funds specifically allotted for such purposes by the Council. In course of time, the Research Board must be in a position to offer expert advice and guidance to all the research institutions in India in formulating their respective research programmes and in the general expansion of research activity throughout the country.

52. The Research Board should also actively encourage the development of scientific and technical societies which provide an important forum for the interchange of ideas between the pure research worker and those engaged in applied and industrial research. The part played by such societies in stimulating research can hardly be over-estimated. They help not only in the dissemination of scientific knowledge but also in providing an additional incentive to the researcher who by tradition as well as by a natural urge is accustomed to looking upon the recognition of his original work by an established society as a valuable and cherished reward. In ordinary circumstances one would expect such societies to grow by their own strength, but in the present state of industrialisation in India these would deserve to be given a special impetus having regard to the basic object of research planning. There is already a number of scientific and technical societies functioning in India, and we are of opinion that with suitable measures of State patronage these can play their part in a more effective manner. In appropriate cases the Research Board should even foster the growth of new societies and make suitable financial grants for the purpose, if necessary.

53. In the section relating to finance, we have recommended that the Central Government should give to the National Research Council a block grant of six crores of rupees spread over five years. With this amount the Council must make and carry out a five year plan of research organisation in the country. This plan will consist of:—

Five-year
plan.

- (i) the building and equipment of National Chemical and Physical Laboratories,
- (ii) the building and equipment of certain specialised research institutes,
- (iii) giving grants-in-aid to universities for strengthening their research organisations, and
- (iv) training a sufficient research personnel by the award of scholarships tenable in India and abroad.

54. One of the foremost tasks which the National Research Council must take on hand is the organisation of two laboratories, Chemical and Physical. The research activities of these laboratories will, generally speaking, be of an applied character though pure research will also play its part in these. The services of laboratories of this kind cannot be related to any specified industries and their national importance makes it necessary for a State organisation to assume the responsibility of the establishment and maintenance of such laboratories. Our attention has been drawn to the fact that the establishment of these two laboratories has already been approved by the Government and that schemes for these are being drawn up by special committees constituted by the Council of Scientific and Industrial Research. A

National
Physical and
Chemical
Labora-
tories.

tentative scheme for a National Chemical Laboratory has been supplied to us for information by the Director of Scientific and Industrial Research. We would like to stress one important consideration in the preparation of the plans and estimates of laboratories and special research institutions. The ultimate success of such institutions depends on the quality and character of the work done in the initial and earlier stages. The first Directors of these institutions would naturally give a lead to their activities. They must therefore be chosen with the greatest care. Before actually making the plans for a laboratory or institute, the Director who is proposed to be put in charge of the institution must first be selected and the task of preparing the plans must be entrusted to such Director with the help of appropriate technical experts. We attach great importance to this suggestion.

55. While the details of the schemes relating to these laboratories and institutes must be prepared by expert committees, we would draw attention to some fundamental questions of principle involved in some of these schemes and hope that these will be taken into account in finalising them. The tentative scheme which has been prepared for a National Chemical Laboratory appears to us to have a very large scope as seeking to provide accommodation and facilities for many main branches of chemistry, viz., Inorganic Chemistry (including analytical investigations); Organic Chemistry (including drugs and chemotherapy); Physical Chemistry (including high pressure technique and electro-chemistry); Biochemistry (including biological products); and Chemical Engineering. The laboratory is evidently designed with the expectation of effecting proper co-ordination of the activities of all these sections, to deal with raw materials and problems of a fairly large number of industries such as Heavy Chemicals (acids, alkali, salts, etc.); Minerals (particularly from the analytical standpoint and such industries as non-metal industries); Fertilisers (organic and inorganic chemicals including solvents); Pharmaceuticals and Food; Fermentation and Biological Products; Resins and Plastics; Paints, Pigments, Lacquers and Varnishes; Oils, Fats, Soaps and Lubricants; Essential Oils; Leather and Adhesives; Rubber; Petroleum; High Pressure Research and Electro-Chemical Industries. The Chemical Laboratory is also designed to contain workshop and pilot plant equipment that should enable it "to undertake ordinarily any type of industrial research." Evidently, the National Chemical Laboratory under this plan is intended to be set up as a polyglot institution. We are informed that this particular type of organisation was contemplated not so much for any technical advantage for dealing with all these industries in a single institution as with the object of gaining maximum results from the application of an amount of about 25 lakhs which seems to have been considered.

to be a reasonable sum for such a laboratory. We consider that this approach to the problem is not the correct one. It has been strongly urged upon the Committee by many of the expert witnesses examined by us that the primary concern of the National Chemical Laboratory should be pure and basic applied research and that any considerable deflection of its resources to applied lines of the specific character would gradually push its main objective into the background and ultimately impair the standard of its research activities. It has also been impressed on us that some of the industries sought to be brought within the purview of the proposed scheme are by themselves important enough and would justify the establishment of separate laboratories with full equipment. It would therefore be desirable to establish special institutes for research work connected with some of these industries. The need for locating research institutions as far as practicable in proximity to industry and raw material resources reinforces the case against centralisation of research in one polyglot institution.

56. We are fully alive to the fact that the financial resources available must necessarily impose a limitation on the planning of research laboratories. Financial limitations, in our opinion, should lead rather to the restriction of the number of institutions to be set up than lead to any attempt to circumvent it by undue expansion of the scope of individual institutions. The proper course should be to plan out each laboratory according to its minimum requirements without which it cannot bear any appreciable results and then to determine the expenditure necessary. In making such a plan if it is found that the total expenditure exceeds any pre-determined limits and the excess expenditure is considered indispensable having regard to the research requirements of the country for industrial development, the reasonable course would be to impress the point on the authorities concerned for providing the additional finances.

57. Having regard to the stage of industrial development already reached by the country and the potentialities awaiting development in the near future, we consider that an expenditure of about Rs. 2½ crores would be necessary in the initial stage. In arriving at this estimate we have taken out a number of industries from the scope of the proposed National Chemical Laboratory scheme. We think that the progress made by these industries would justify the establishment of specialised laboratories. It is not our intention that the establishment of these separate laboratories should involve complete detachment of their work from the National Chemical Laboratory. On the contrary, it would be necessary to maintain the most intimate contact between the National Chemical Laboratory and the specialised laboratories engaged in chemical research.

58. While we recommend that the National Chemical Laboratory should be designed so as to concentrate mainly on basic research, we are not overlooking the fact that specialised institutes can be set up at present only for a limited number of industries. There would be many chemical industries not covered by these specialised institutes which would in the mean time be confronted by many research problems. In the absence of specialised institutes to deal with these problems, there must be some organisation to tackle those. We consider that such problems may appropriately be taken up by the National Chemical Laboratory pending the establishment of suitable specialised institutes that may be established in future in accordance with the prevailing progress of industrial development. The National Chemical laboratory therefore, in addition to concentrating on basic research must also deal with the problems of 'residuary' chemical industries, *i.e.*, those not served by any specialised institutes, and the laboratory should accordingly be planned on such a basis. These observations would apply *mutatis mutandis* to the planning of the National Physical Laboratory also. Our proposals for the establishment of specialised institutes will not result in any substantial reduction in the expenditure on the National Chemical and National Physical Laboratories. These must be designed and equipped on modern lines. With the information available at our disposal, we can only give an approximate estimate of what we consider to be an adequate provision of funds for these two laboratories. We think that approximately Rs. 40 lakhs would be necessary for each of these laboratories. If the general lines of our plan are approved, the details regarding the planning and estimates must have to be worked out by small expert committees which would include the Directors who are proposed to be placed in charge of these laboratories.

Specialised
Labora-
tories.

59. We have already mentioned that in the absence of industrial research associations, it is necessary for the State to take the initiative for fulfilling the object of such associations by the establishment of specialised laboratories. The need and importance of such institutes have been impressed on us in the course of our discussions with various witnesses and we have been confronted with proposals for such institutes not only for the benefit of industries already established on a fairly large scale but also for such of them as are at present inadequately developed. We do not consider that the planning of the specialised institutes on such an ambitious scale all at once would be justified, not only because of the very large financial commitments involved but also in consideration of the probability that research institutes for industries not yet developed would not have enough work; the volume of the relevant problems and their inflow to such institutes would depend largely on the experience of actual working

of the industries concerned. We are, accordingly, of opinion that the establishment of the specialised institutes should be correlated to the principle that such an institute must have a distinct bearing on the stage of development of the industry for which it is proposed to be set up. In other words, there would be no use in establishing research institutes to conduct research in these specialised fields in which no industrial development worth mentioning has taken place in the country. This principle stands not only on economic grounds but also on the consideration that in respect of these industries not yet developed, the dearth of suitable technical personnel must also put up serious practical difficulties. We appreciate, however, that although certain industries might not have yet sprung up there might be important natural resources in the country which, if properly exploited, might lead to the establishment of these industries. In such cases also research will be necessary even though the industry itself may not have come to the proper stage of development. We recognise that research in such cases should be duly provided for and we recommend that they may be taken up by the National Chemical and National Physical Laboratories in the initial stage as researches belonging to the category of the 'residuary' type already referred to.

60. Pursuant to the principles stated in the foregoing paragraph, we recommend the establishment of the following specialised institutes in order of priority :—

1. Institute of Food Technology.
2. Metallurgical Institute.
3. Fuel Research Institute.
4. Glass and Silicate Research Institute.
5. Oils and Paints Institute.
6. Buildings and Roads Institute.
7. Leather and Tanning Institute.
8. Industrial Fermentation Institute.
9. Electro-Chemical Institute.

61. This priority is intended to indicate the order of importance in relation to availability of funds. If, however, other factors intervene, for example, availability of personnel in one category and non-availability in another higher up in the list, the order of priority may have to be changed.

62. We have considered in this connection proposals for the establishment of some other specialised institutes such as one for plastics, one for the designing and fabrication of pilot plants and one for synthetic fertilisers. In regard to plastics we recognise the potential importance of the industry but we are of opinion that in the initial stages the research in this particular line may be undertaken by the National Chemical Laboratory pending the development of the industry on a fairly extensive scale when the case for a separate special institute for plastics may be re-examined. In regard to the design

ing of pilot plants, we consider that so far as the requirements of the various new laboratories are concerned, it may be possible to undertake the work in the individual workshops of the laboratories themselves; where pilot plants on a more elaborate scale are involved, the work may be taken up in the laboratories and workshops of the National Chemical and National Physical Laboratories. In cases where the manufacture of pilot plants cannot be undertaken even by the latter, the possibility of getting them manufactured by commercial engineering firms should be explored. We recognise that the designing of pilot plants involves research to some extent; we, therefore, recommend that if it is found that there is no facility in the country from any of the sources referred to above, the question of setting up a specialised institute for the designing and fabrication of pilot plant may have to be taken up for re-examination at a later stage. In regard to synthetic fertilisers we consider that the research involved may be taken up by the National Chemical Laboratories and also by the Fuel Research Institute if the scope of the latter is suitably widened so as to include the utilisation of coal and 'other fuels.'

63. The capital expenditure involved in the National Chemical and National Physical Laboratories and the various specialised institutes as recommended by us are estimated as follows (in round figures);

National Chemical	..	..	Rs. 40 lakhs
National Physical	..	..	.. 40 ..
National Metallurgical	..	..	.. 50 ..
8 other Specialised Institutes referred to in para 50 at an average of Rs. 15 lakhs each			.. 1,20 ..
Total			.. 2,50 .. (approximately)

Nature of work in the Specialised Institutes.

64. These specialised institutes will deal with applied problems of basic and specific character relating to their respective spheres. The Research Board is expected normally to prepare programmes of research from time to time and the work of these institutes will be mainly on the basis of such programmes. The Directors of these institutes would naturally be consulted when such a programme is prepared. In addition to such work, research work may be carried on in these institutes on the initiative of their respective Directors or staff. Provincial and State Research Councils may also send problems for investigation to these institutes with the approval of the Research Board. It should also be open to individual manufacturers to refer specific problems of immediate concern to a manufacturer to such laboratories, including the National Chemical and National Physical Laboratories, on payment of scheduled fees or by the establishment of fellowships on the model

of the Mellon Institute in the United States of America. The Mellon Institute " was set up in order to provide an organisation in which, in agreement with manufacturers, research workers are delegated to studying specific problems. The Institute works primarily through a system of research fellowships endowed by firms or individuals. The manufacturer pays the salaries and running expenses, while the Institute provides the laboratory facilities, technical assistance, and, what is more important, expert direction in the organisation and methods of industrial research. The results of the research become the exclusive property of the donors of the fellowships in question". Invariably, the research fellows are absorbed in the concern which instituted the fellowship after the problem has been worked out. We consider that this kind of specific research through the institution of research fellowships being taken up by the specialised research institutes to be an important part of their activity. The Research Board should do every thing possible to persuade individual manufacturers to avail themselves of the facilities of these laboratories and institute fellowships for working their specific problems. This system will be of special value to the smaller firms that do not have the financial resources for setting up any research laboratories of their own either individually or on a corporate basis. This system will also lead to the establishment of an intimate contact between these institutes and industry. The institution of such fellowships in these institutes must be subject to the sanction and control of the Research Board. The Research Board, however, may by rules and bye-laws delegate powers in this behalf to the respective Directors of these institutes.

65. The location of the two National Laboratories and the specialised institutes is a matter of great importance. The easy availability of land in a particular locality or the salubrious climate of a place should not by themselves be regarded as sufficient justifications for choosing the sites for these laboratories and institutes. Some of the witnesses who appeared before the Committee expressed their anxiety that the proposed institutes may be located in such a manner that many regions may not be in a position to avail themselves of these research facilities. The conditions in a vast country like India are so divergent in character that it may not be possible for a single institute to do full justice to the problems arising in different parts of the country. These institutes must be located with due regard to proximity to Industry, sources of raw material and university centres. In cases where the importance and extent and industry in any particular area would justify the establishment of a separate institute for that particular locality, there should be no objection to additional institutes being established by the Provincial and State Councils. In facts, such a tendency must be encouraged by the Research Board. Such development would no

Location.

doubt involve a certain amount of duplication. This consideration should not deter the establishment of such institutes. It is expected that to some extent duplication of these facilities will create an atmosphere of healthy competition that would have wholesome stimulating effect on the several institutions working on parallel lines. The Research Board should see to it that the institutes proposed to be set up by the National Research Council should scrupulously maintain an all-India outlook irrespective of their location, as otherwise they would be failing in the primary object of helping the industry of the country as a whole and promoting the cause of industrial development in the best interest of the country. We consider it necessary to stress this point because of the alleged interprovincial conflict of interest in certain lines of industries. The supervisory control of the Research Board should enable these institutes to rise above all provincial prejudices and suspicions.

66. The success of research institutions depends not so much on their buildings and equipment but on the character and capacity of the persons who run the institutions. The technical staff of these institutions should therefore be selected with the greatest care. The Directors and the Assistant Directors of these institutions should not automatically get a permanent tenure like the employees in Government service. They should be employed on a contractual basis for a limited term renewable on proof of satisfactory work and promotions also should be determined by the same criterion. We are not in favour of importing experts from abroad except where it is considered indispensable. We recognise that in some cases the right type of men for designing and organising the laboratory may not be available in India and that the service of foreign experts may have to be requisitioned for such purposes. The selection of such foreign experts should be made in a manner that would help the country to secure the services of the best men available abroad without any preference being given to men of any particular nationality. In all such cases, the appointments should be made on a contractual basis for a specified term. While the recruitment of foreign experts may be necessary in particular cases, the staffing of the proposed institutes will have to be arranged mainly with the scientific and technical personnel available within the country. We are satisfied that the scientific talents locally available are of a fairly high order and that they will prove equal to the task by being put through an intensive course of technical training either in India or abroad. We therefore recommend that steps should be taken immediately for the training of the necessary technical personnel by the institution of scholarships as detailed hereafter.

67. Although the proposed research institutes are designed to serve specific industries it should be borne in mind that an efficient

discharge of this function cannot be ensured if the technical staff in charge of these institutes allow themselves to be chained to routine administrative work or entirely to the problems concerning particular industries. The technique of particular industries is intimately connected with development in fundamental and basic research. It is, therefore, essential that the technical staff of these institutes should keep themselves abreast of the latest development in academic research and keep their mental horizon sufficiently wide. This objective can be achieved through the establishment of effective contact between the research staff of these Institutes and universities through such arrangement as refresher courses for the staff in the universities and also by associating, wherever possible, the senior members of the staff with teaching in the post-graduate departments of science in the various universities. In addition to this intimate contact with universities, it would be also necessary for the staff to maintain the closest contact with the industries of the country. For this purpose the Research Board must arrange in suitable cases for the deputation of selected members of the staff for working for specified period in industrial concerns and by permitting selected technical men from industries to undergo a period of training in the institutes. Such arrangements will create an intimate contact between research workers in the institutes, the scientific staff of universities and the technical personnel of industries.

68. As we have already pointed out, the universities constitute the foundation of all research in a very real sense and they are the fountain spring for producing and maintaining a continuous flow of scientific talents of the requisite standard essential for the staffing and sustenance of the activities of all the research organisations in the country. It is the recognition of the place of universities in the field of research that has recently led to the institution of 80 research fellowships in nine universities in Great Britain by the Imperial Chemical Industries, Ltd. In his letter to the university authorities announcing the institution of these fellowships, the Chairman of the company observed :

“ Nearly seven generations of experience of the administration and conduct of research have convinced us that academic and industrial research are interdependent and complementary and that it is useless to expect substantial advance in industry without corresponding advances in academic science.”

The planning of the organisation of scientific and industrial research on a sound basis therefore calls for, as a preliminary, the strengthening of the scientific teaching and research work in Indian universities. We have already referred to the absence of a proper appreciation of the organic relationship between pure and applied research which has led to some unfortunate results characterised by detachment between the two and a growing prejudice on the part of industrialists against

Universities
the foundation of
Research.

universities as being too academic in their outlook. It is essential that the universities should be adequately strengthened in order to be able to bear the weight of the responsibility which must rightly devolve upon them.

Grants-in-aid to Universities.

69. In the course of our discussion with representatives of universities and with distinguished scientists, it has been impressed upon us that the Indian universities have been labouring under serious financial handicaps which have exercised a deleterious effect on the activities of their scientific departments and have made it impossible for them to expand on proper lines for the purpose of research. In many cases, there is no separate research staff as such and research continues to be the concern of the teaching staff who have not much time to spare for it. Not only are they overburdened with teaching duties but those among them who are at the top and hold the position of professors have also in many cases administrative duties imposed upon them in addition to teaching. Some of the universities have instituted research scholarships in post-graduate departments of science but their number is extremely limited and the emoluments offered are much too low to attract the right type of talents and retain them on research work for any length of time. In some of the Indian universities, the value of research scholarship is as low as Rs. 30 per month. This indicates an extremely unsatisfactory state of things which should be remedied as quickly as possible. It would be futile to build our research organisations on such weak foundations. As an essential part of the five year plan which we have recommended for the National research Council, effective measures must be taken for strengthening the scientific departments of universities. These will take the form of financial assistance to the universities both in the form of capital grants for the provision of the necessary equipment and also the establishment of scholarships and fellowships in larger numbers and on more attractive terms. The Grants Committee referred to in para 47 should make an exhaustive survey of the science and research departments of all the Indian universities with a view to decide the manner in which these departments must be strengthened. In this connection it has been brought to our notice by some eminent scientists that enough has not yet been done to explore the plant, mineral and animal resources of the country. Investigations in these lines have so far remained the primary concern of some Government departments and these lines should be undertaken by universities for applied research. Suitable faculties in the universities must be organised for studies in plant genetics and the geological resources of the country. In some of the universities, chairs in these subjects with emoluments adequate for attracting the best men should be created. The scope for investigation in these lines is so vast and the potentialities so great that the

suggestion for this being taken up by at least some of the universities along with the official institutions should call for no special pleading. After making a survey of the universities, the Grants Committee must recommend to the National Research Council a scheme of financial assistance to the universities. In making the scheme the Grants Committee must have in view the desirability of providing for post-graduate teaching and research in all scientific subjects in India. This does not necessarily mean that all the subjects should be tackled in the same university. All the universities put together should be in a position to provide for adequate teaching and research facilities in all branches of science and technology.

70. Out of the block grant of six crores referred to in another part of our report, a sum of about two crores must be set aside for giving grants-in-aid to the universities during the first five year period. It is not our intention that the sum of two crores of rupees should be divided equally amongst all the Indian universities. The amount of grant to be given to each university must be decided in the light of what the Grants Committee may consider to be the special needs and the character of development in individual universities. In order to augment the financial aid, it should generally be made a condition that the university should obtain from the Provincial Government or from some other source an amount equal to the grant offered by the National Research Council. If all the Indian universities are able to fulfil this condition, a total sum of rupees four crores will then be available for this purpose. In special cases, however, where the Grants Committee is convinced that a university is not in a position to raise a corresponding amount, the grant may be given without any such stipulation. Each individual case must be decided on its own merits. Before finally deciding the allocation of grants among the various universities the Grants Committee should consult the Provincial or State Research Councils, wherever they exist, with a view to obtain the maximum advantage from the disbursement of the funds that may be available both from Central and Provincial and State resources.

71. It has also been brought to our notice that there is practically no facility for research in the Indian universities in engineering subjects. There are not even post-graduate courses in engineering in any of the engineering colleges in India. The teachers in these colleges have no contact with the engineering industry. In view of the need for the rapid development of the engineering industries in India, especially the manufacture of capital goods, it is essential to build up and maintain an adequate engineering research section in all the engineering colleges. The teachers in these colleges should be encouraged to establish close contact with the problems of the en-

gineering industry and thereby help these institutions to participate in the building up of the industrial life of the country. In view of the special importance of this subject, the Grants Committee must be strengthened by the addition of some representatives from the Institution of Engineers (India) and instructed by the National Research Council to make a special survey of this field of activity in the universities and colleges.

Conditions
attached to
grants.

72. In making the grants to universities, the Research Board may attach conditions governing the grants. The conditions, however, should not be such as to interfere with the autonomy of the universities. It will be open to the Research Board to specify the field of research for which the grant is made. When such conditions are added to the grant, it will be the obligation of a university to carry out the main purpose of the grant but the university will retain full freedom to recruit the staff, fix their remuneration and take all other steps necessary for the fulfilment of the conditions. The Research Board may call for such periodical reports as it may consider necessary to satisfy itself that the purposes of the grant are being observed. It must generally be understood that the grants should be utilised by the universities in organising and strengthening the research departments directly under their control. It may, however, happen in the case of certain universities that they do not have research departments of their own. In such cases it is conceivable that one or more of the colleges affiliated to such universities may be helped in building up and strengthening their research sections. In such cases it should be permissible for the university to utilise the grant to strengthen the research sections of such affiliated colleges. In these cases it should be made clear that the colleges getting the grant will subject themselves to the control of the university in the expenditure of the funds and that the university will undertake the ultimate responsibility to the Research Board for the proper utilisation of the grants-in-aid. Generally speaking it should be a condition of the grant that universities receiving the grants-in-aid must admit to their post-graduate course students from all parts of India without making any discrimination. Such a condition is necessary in view of the fact that for some time to come at any rate every university cannot afford to maintain teaching and research departments covering all branches of science and technology.

Scope of
specific
research
in uni-
versities.

73. Apart from pure research, the work of the universities in the field of applied research will as a rule be of the basic character relating to raw materials (mineral, vegetable and animal) in general with a view to study their characteristics and to reveal methods of improvements and possible new uses in industry. Although such researches will be of a general character, the influence of the resultant

discoveries on the course of industrial development is bound to be very great. This brings us to the problem as to how far and to what extent and under what conditions universities may undertake research problems of a specific nature on behalf of individual firms or manufacturers. Some of the witnesses examined by us were emphatic in their view that universities should have nothing to do with such researches as the profit motive behind them must eventually contaminate the university atmosphere and undermine the activities of the scientific departments by diverting their interest and attention from pure or fundamental research which is and should be their primary concern. Others have taken the view that the universities should be enabled to play a direct part in the growth of industry and that it is necessary for them to undertake researches of a specific character for individual manufacturers if the objective of maintaining close contact between universities and industry is to be achieved. Notwithstanding the conflicting nature of these views, it is possible to find out a middle path by providing the necessary safeguards under which universities may undertake researches of this kind. Those in charge of the administration of universities must have a proper appreciation of the fundamental ideals of universities. The primary object of the scientific departments of universities must be disinterested research for the advancement of knowledge and the maintenance of teaching at a high standard. It would be against the interests of the universities and industries alike if the applied departments of the universities are denied contact with live problems of industry. The danger apprehended can be effectively checked if the profit motive is removed by imposing a condition that the research workers would have no share in the financial benefits of the resultant discoveries and that any share which the sponsors of such research would offer would accrue to the universities themselves. It should however be open to the university authorities to make *ex gratia* payments to the research workers concerned in deserving cases. The university authorities should, however, maintain a careful watch on the work of the university relating to research in specific problems and see that the volume of such researches does not expand to an extent as would prejudice their main pre-occupation with pure or fundamental research. With the exercise of the necessary discretion and control it should be possible for the university authorities to avoid any dangers and difficulties. In undertaking researches in universities on specific problems, it should be made clear that the results of such researches should not be the exclusive monopoly of any individual manufacturer. In other words, if an individual manufacturer offers to pay to the university a substantial remuneration for working on any specific problems with the condition that the result would be a secret monopoly of the person making such an endowment, the university should refuse to undertake such work on these conditions,

For the solution of such individual problems under such conditions, the manufacturer must go to the laboratories and institutes maintained by the Government or by private individuals. The results of any research undertaken by universities must generally be available to the public at large, except where the university itself may decide to take patents in special cases.

Teaching
and Re-
search

74. In paragraph 69 we have drawn attention to the fact that the staff in the scientific departments of the universities are overburdened with teaching, with the result that they have not sufficient time to spare for research. We hope that the strengthening of the departments by the grants from the National Research Council will enable the universities to give substantial relief to at least the senior members of the staff from their teaching work. We should, however, like to point out in this connection that by relief we do not mean a complete divorce of research from teaching. On the contrary, we consider it necessary that teaching and research must go hand in hand for producing the best results. While teaching has a refreshing effect on the research workers, it becomes more effective when it is backed by some original work upon fundamental problems. We have drawn attention to this matter only to emphasise that the position as it stands at present in most of the universities calls for rectification and we believe that it will be facilitated by the measures of assistance recommended by us.

Autonomy
of Univer-
sities

75. Some of the improvements suggested by us in the foregoing paragraphs really come within the purview of the universities. The proposals made by us in this connection are formulated mainly on the basis of consultations with representatives of universities and distinguished scientists with whom we had opportunities of discussing the problem. It is not intended that the acceptance of these proposals should be made a condition precedent to the making of the proposed grants-in-aid. We recognise the importance of maintaining the autonomy of the universities and we hope that the proposals made by us on the basis of discussions with university representatives will in due course have careful consideration and we expect the Research Board to give only a general direction in this respect while making the grants to the universities. Following such general directions, it will be the concern of the universities to decide how the amounts of the grants are to be assigned to specific projects of improvement or expansion. Although the Research Board may not issue any specific detailed instructions to the universities in such matters, we foresee the development of helpful conventions by which the universities may offer to consult the Research Board and take the advantage of its advice based on a comprehensive grasp of the needs and requirements of the research organisations of the country as a whole. It will be entirely a matter for the universities

themselves to decide on the lines of researches to be taken up in their respective scientific departments. If, however, any specific problems are decided by the Research Board to be taken up by any university, it will generally be in the form of special facilities offered to them for the purpose by the Board. It would be open, however, to the Board to make suggestions to individual universities for taking up some particular lines for which they have special advantages according to the natural environments of equipment available to them.

76. A large band of research workers will be necessary not merely to man the various laboratories proposed to be set up but to keep alive the research work in the country and to meet the growing demands of industry. As a part of the five year programme which we recommend for the National Research Council, about 700 research workers must be trained during that period. For this purpose, the Council must institute research scholarships and fellowships in the Indian universities and also for training in foreign countries. From the evidence placed before us, it appears that training in foreign countries will be needed in all branches of engineering. For the other branches of research, the majority might be trained in the Indian universities. We have been assured that in subjects other than engineering there are ample facilities in India for such training and that the institution of these scholarships will give a further stimulus to research activity in the country and create an atmosphere conducive to research. We accordingly recommend that in the first five year period, 200 research scholars may be trained abroad and 500 in India. The scholarships tenable in foreign countries may be for a period of two years' training. Assuming that 100 of these are sent to the United Kingdom and 100 to the United States of America, the cost will be Rs. 27 lakhs on the basis of a scholarship of Rs. 15,000 for two years for the United States and Rs. 12,000 for two years for the United Kingdom, inclusive of passages. The Indian scholarships should be divided into two categories, senior and junior, of which the former should generally be reserved for post-doctorate work and may preferably be described as fellowships. These will also be for a period of two years but in some cases the scholarships should be tenable for three years to meet the needs of longer training. We recommend that the scholarships and fellowships should be fixed respectively at Rs. 150 and Rs. 250 per mensem and that out of the total number of 500 the proportion and term of scholarships and fellowships should be as follows: 100 scholarships for 3 years, 300 scholarships for 2 years and 100 fellowships for 2 years. On this basis the cost of training 400 scholars (100 for 3 years and 300 for 2 years) will be Rs. 16.20 lakhs (Rs. 5.40 lakhs + 10.80 lakhs) and of 100 fellows Rs. 6 lakhs. The total expenditure involved will be Rs. 27 lakhs for foreign scholarships and Rs. 22.20 lakhs for Indian scholarships and

Scholarships for Research

fellowships, making a total of Rs. 49.20 lakhs or say Rs. 50 lakhs approximately.

77. The Research Board should set up a strong and independent committee on the lines of the Public Service Commission to select men for the award of the scholarships. It is not intended that these scholarships are to pay men merely to take university degrees. The central idea is to train a batch of workers in research, both pure and applied, Ordinarily the applicant should be the holder of an M.Sc. degree or its equivalent who has already shown some special aptitude for research work. It is conceivable that young men who may not have taken any university degree might have done research work of proved merit. Such cases must be very exceptional indeed but if they come to the notice of the body entrusted with the task of selecting the scholars, they should not be precluded from the benefit of getting these scholarships. Among the incumbents of the scholarships tenable abroad it would be highly desirable to include some professors and senior members of the research staff of universities, so that with a short visit abroad they would be in a position to establish valuable contacts with foreign universities and thereby be in a position to reorganise the departments of their own universities on up to date lines. The subjects chosen for the scholarships, the number allocated to each subject and the period of training for each scholar and similar questions should be settled by a small expert committee of scientists which the Research Board, will have to set up.

78. It is not our intention that the programme of instituting research scholarships would be confined only to the first five year period. We have recommended a definite programme to be achieved in a short period. After that, according to the availability of funds this practice should be carried on from year to year so that there might be a steady flow of competent men to carry on research work in the country. The institution of these scholarships in India will be an additional help to the Indian universities. Taking into account the size of the country and the need for workers in the research field, the numbers that we have suggested are too insignificant. We, however, expect that in addition to the number of scholarships referred to in paragraph 76 there would be an ever-increasing flow of such sholarships from the universities, private and public endowments, Provincial Governments and other bodies.

Research
Associations of In-
dustries.

79. Our recommendations contained in this section relate to the setting up of a comprehensive research organisation by the Government directly and through the universities in the country. The organisation of research purely by Government agency cannot achieve its purpose unless the industries in the country undertake their share of responsibility in this field, In the survey of the facilities that now exist in

the country for research, we have drawn attention to the fact that industry in India is, generally speaking, not yet research-minded and that there are no research organisations of industry except in the case of the tea and jute industries. Since the outbreak of the war, there is a change in the attitude of many industrialists to the problem of research. The war has created numerous problems of technical significance concerning the industries of the country and this has driven manufacturers to seek the help of research institutions in solving those problems. It would be well to take advantage of this change which we hope will be sustained in the prevailing conditions during and after the war by the anxiety of manufacturers about post-war developments and their earnestness for expansion in new lines. We are informed by the representatives of the Ahmedabad Mill Owners' Association that if suitable measures of assistance were assured by Government, the members of the Association would undertake the organisation of a research association for the benefit of its constituents. There are other industries in the country like coal, sugar and cement which have reached a stage of development which would warrant their undertaking the organisation of such research associations on a corporate basis. The most effective way in which the Government can offer an inducement for development along these lines is to make all contributions made by manufacturing firms to any approved industrial research association, either for capital or recurring expenditure, come within the category of revenue expenditure. Our detailed recommendations in this respect are contained in Section VI under the heading 'Finance'. The amendment of the income-tax law in this direction would be an inducement to industries for setting up corporate research associations. The expert help and guidance of the Research Board should of course be available to the industries in the setting up of these research associations.

80. In this context the problem relating to the organisation and development of research pertaining to Railways which have now been completely nationalised and represent the largest industrial enterprise of the State deserve special attention. Railway research in India has just made a beginning and it still remains to be organised on a planned basis. Prior to 1941 research undertaken by the Railway administration was of a very casual nature, and 'ad hoc' problems were from time to time referred to special officers for investigation. In 1941 a sort of a research organisation was set up with specialised equipment for testing of locomotives etc. The Railways have not yet established any central laboratory of their own. It appears that the services of the Government Test House and some other laboratories have been utilised occasionally and that in one case a problem relating to the "Fluid flow of Steam" was referred to the N. P. L. in England. We were informed that affiliations with some associations in England and the

Railway
Research.

U. S. A. have also been helpful to the research activities of the Railways, which are considered to be of a specialised nature. The research section is now in charge of the Chief Controller of Standardisation who is concerned with the formulation of problems that are to be taken up for investigation. The average annual expenditure since 1940-41 has been a little over Rs. 1 lakh, the amount estimated for 1944-45 being Rs. 1,32,000. -

81. we are definitely of the opinion that although the Railways may have problems of a very specialised nature, there would still be a large number of problems of the fundamental or basic type which would fall within the scope of one or the other of the various national laboratories recommended by us, and that the Railways would be well-advised to take full advantage of the services of such institutes—each fully equipped for specialised research in its field—instead of expanding their research organisation for the purpose which would involve unnecessary and wasteful duplication. The Railways in England are known to have been following this practice and it is understood that many of the fundamental problems of concern to the Railways are handled in that country in the Cavendish Laboratory. We consider that when the various national laboratories and institutes, as recommended by us, are brought into existence, they will offer the necessary facilities for dealing with many problems of the basic type with which our Railways are concerned. For instance, the problem of devising ways and means for minimising consumption of coal in locomotives or for use of lower grade coal for haulage of engines,—which on grounds of economy as much as for conservation of the limited supply of higher grade coal has been looming so large in this country—can be entrusted by the Railways for investigation to the proposed Fuel Research Institute with necessary co-operation vouchsafed to the latter. In the same way the National Physical Laboratory or the National Metallurgical Laboratory would also offer excellent facilities for dealing with many of the problems of our Railways.

82. We consider that the Railways should also utilise the existing facilities for research in the universities and take an active part in strengthening them as a matter of common interest. There is at present a complete detachment between Railways and the engineering colleges in India although the Railways constitute the single largest establishment for the employment of engineers. As a striking contrast to the situation prevailing in this country our attention has been drawn to the practice of the American Railway Association which actively supports and utilises the services of the Universities of Purdue and Illinois to which railway problems of that country are freely referred. We consider that in India also the Railways should come forward to undertake their responsibility in the matter and actively assist at least

a few selected engineering colleges in organising post-graduate courses in railway engineering and allied research. It should be possible to organise such courses by dovetailing theoretical teaching in the colleges with practical training in the railway workshops.

83. We should like to stress in this connection that in the matter of assisting research the Railways must bear the share which industries in general are expected to do. In a subsequent section (Section VI) we have recommended the imposition of a cess of an anna per hundred rupees on the annual value of industrial output as industry's contribution to the maintenance of the research organisation envisaged by us. We are of opinion that this levy should be applicable also to the Railways which represent the largest national industry and are expected to benefit substantially from the application of the results of research. For any "specific" problems, however, proposed to be taken up for investigation in any of the laboratories, the Railways must, as in the case of other industrial firms, make a supplementary contribution by the institution of the Mellon type of fellowships or similar other devices as may be agreed upon by the Railway and the authority or the laboratories concerned. The Railway administration should also work in collaboration with the Board of Standards described in Section VIII.

SECTION V.

PROVINCIAL AND STATE RESEARCH COUNCILS.

84. In any attempt to decide the type and scope of a research organisation for India, the main difficulty is to reconcile the diverse needs of a vast country with the necessity for effective co-ordination in the field of research. Under the Constitution, Industry is a Provincial subject and any rigid control of scientific and industrial research by a central body under the Government of India will lead to friction. This applies with greater force to the Indian States. The laboratories and institutes that may be set up by the central organisation cannot serve effectively the needs of every part of the country. In recommending the type of a central organisation as described in the previous section, our main object has been to create a nucleus for (1) initiating scientific and industrial research on a fairly large scale, (2) co-ordinating the research activities of the country, (3) acting as a clearing house for research information, (4) offering expert advice and guidance, and (5) setting up the standard of research that must be followed. To obtain the best results from the central organisation, a network of corresponding organisations must be set up in all the Provinces and major States.

Need for a network of research organisations.

Provincial
and State
Research
Councils.

85. We recommend that Research Councils on the model of the National Research Council must be set up in all the Provinces and major Indian States. Some of the Provinces and States have already made a beginning in this direction. Like the National Research Council, these Provincial and State Councils must be composed of representatives of science, industry and administration. While the exact size of these Councils may vary according to the needs of different units, we suggest that a Council on the lines of the National Research Council will meet the needs. The finances at the disposal of these Councils may not be adequate for establishing a full time executive board as the Central Executive Board. In any case, there should be a full time Secretary for managing the affairs of the Council.

Their
functions.

86. These Councils should aim at setting up research laboratories for applied research to meet the conditions and requirements of their respective areas. It may be argued that this may create unnecessary duplication of work in the same field of research. Too much importance should not be given to this criticism. In a vast country like India, more than one institute of the same type may often be found necessary. Apart from this, a certain amount of duplication in research will do no harm. If two men work on the same problem, one of them may achieve results much in advance of the other and an atmosphere of healthy competition may thereby be created. In setting up research laboratories or specialised institutes, the Provincial and State Councils will do well to consult the Central Research Board which would be in a position to give expert advice and guidance. These councils will also furnish the contact between science and industry, the importance of which has been emphasised in other sections of this report. When the National Research Council makes any subventions or grants-in-aid to universities or research organisations, the Provincial and State Councils may be consulted in appropriate cases.

Finance.

87. The Provincial and State Governments must provide the finance for the Councils in their respective areas. It is not possible for us to indicate the sources from which the necessary finances should be obtained by the Local Governments. In view of the importance of research in the national economy of the country, the Provincial Government must undertake a reasonable measure of responsibility for financing research. We believe that the resources of the Provincial Governments are adequate for this purpose. With regard to the major States, most of them are even in a better position than the Provinces in this respect. In fact, some of the major States have already made considerable progress in this direction. If our recommendation regarding the levy of a statutory cess on industry is accepted by the Indian States, they will have these additional funds which should be earmarked for expenditure on research in their respective areas.

SECTION VI.

FINANCE.

88. For the setting up of the research organisation that we have recommended for initiating research on a considerable scale and for carrying on the work continuously from year to year, ample financial provision must be made by way of initial capital and recurring income. Both absolutely and in relation to the population and production, the expenditure on scientific and industrial research in India is almost negligible. Even in an advanced country like Great Britain it has been realised that the expenditure on research as compared with the United States and the Soviet Union is inadequate and a much higher standard of expenditure is being advocated. In India a beginning has yet to be made on an adequate scale.

Grant by
the Central
Govern-
ment.

89. It may be argued that in an industrial system based mainly on private enterprise, the bulk of the expenditure on research must be provided by industry itself. But industry in India has not yet become research-minded and there is not yet a full appreciation amongst industrialists in general of the value of research both academic and applied. Government on its part has not offered any encouragement to industry to organise research, nor has Indian industry been prosperous enough, with few exceptions, to spend large sums on research. To depend, therefore, solely upon industry for providing the necessary finance for research would be to postpone indefinitely any appreciable advance in the field of research. Apart from this, there is a strong case for the effective participation of Government in research. Government must take a direct interest in research connected with industries which may be considered as of national importance even though such industries may be privately owned. Basic research and also research in such sciences as geology and genetics and the maintenance of scientific standards must be the primary concern of the Government, Research in subjects like industrial safety, factory lighting and ventilation and the like which have a social as well as an economic value must also be financed from public funds. Government must also watch carefully the development of scientific knowledge in general which has a bearing on the economic life of the people as a whole.

90. Apart from these general considerations, the part the Government of India is expected to play in the post-war industrial development of the country imposes on them a special obligation to undertake the financial responsibility for organising and promoting scientific and industrial research side by side with industrial planning. We therefore recommend that the Central Government should give to the National Research Council a block grant of six crores of rupees spread over a period of five years. The amount that we recommend may appear as totally inadequate for the needs of the country of the size of India.

In recommending the grant of Rs. 6 crores, we contemplate only the needs of the initial steps to be taken for organising scientific and industrial research. This amount is to be spent by the National Research Council for the building and equipment of various national laboratories, for giving grants-in-aid to universities, for scholarships for training research scholars and for the recurring expenditure in the initial years. The details relating to these items of expenditure have been given in other parts of our report.

Statutory
cess on
Industry.

91. While the grant of six crores of rupees will provide the initial finance required for capital expenditure for the setting up of the research organisation that we contemplate and for the recurring expenditure in the initial stages, provision must also be made for ensuring a steady annual income for the National Research Council for the recurring expenditure and for expanding and carrying on its activities. The provision for this annual income must be made by Government and Industry on an equal basis. With this end in view we recommend that after the first five-year period when we expect all the laboratories that we have recommended would have been established, the Central Government should give an annual grant of one crore of rupees to the National Research Council. In addition to this we also recommend that a statutory cess yielding approximately one crore of rupees annually should be levied on the industries in the country. Since the main object of scientific and industrial research is to help industry, it is only reasonable that a part of the burden of the financing of research must be borne by the industries in the country. It is difficult to get an accurate estimate of the total value of industrial production in India. Calculations made by some economists on a rough and ready basis indicate that the total annual value of industrial production in factories governed by the Indian Factories Act is approximately 1500 crores of rupees on the basis of the volume of production and the level of prices in the year 1942. A levy of 1 crore of rupees which represent only about 1/16 of 1 per cent cannot be considered as an undue burden on industry. A cess at the rate of 1 anna per 100 rupees worth of goods produced will yield approximately the amount that we have in view. In more concrete terms this would mean a cess of Rs. 62/8/ on production of the value of Rs. 1-lakh. Such a small cess cannot be felt as a burden by any industry. The cess on industry should not be levied until all the laboratories recommended by us are established. As the amount of cess collected from industry increases, a corresponding increase should also be made in the amount contributed by the Government so that the 50 : 50 basis may be maintained. The cess should be collected from all factories to which the Indian Factories Act applies and which have to send returns under the Industrial Statistics Act. Exceptions may be made in the case of very small factories. On the analogy of

the cess on industry and for the same reason we recommend that a similar cess should be levied also on the Railway administration of India on the basis of its gross annual revenues. Assuming that in normal times the gross annual revenue of Railways may be in the neighbourhood of Rs. 160 crores the cess on Railways will yield about Rs. 10 lakhs.

92. The cess may be levied either on the basis of the value of the industrial production or as a small surcharge on income-tax. The latter method would no doubt be simple from the point of view of administration and collection of the cess. A surcharge on income-tax may however be criticised on the ground that it would penalise the more efficient units of industries which earn a larger profit by reason of their efficiency. The most equitable basis for the levy of the cess will no doubt be on the basis of production. The administrative complications may appear to be great at first sight. It need not, however, be so. An Industrial Statistics Act has been already passed by the Central Legislature and when this is brought into force it should be easy for the Government to obtain the necessary data from year to year for the purpose of the cess. We, therefore, recommend the cess on production.

Income-tax.

93. Some apprehension exists that if the principle of a statutory cess is once accepted, there would be a tendency to increase the rate of the cess in course of time even though the initial rate may be small. On this ground most of the commercial bodies view with disfavour any proposal for levying a statutory cess. With the prospect of industrial expansion on a large scale in the post-war years, the value of industrial production must also increase enormously. The proceeds of the cess would, therefore, increase automatically as industrial development expands. It should, therefore, be made clear at the very outset that the rate of the cess decided upon in the first instance will not be increased under any circumstances. Such an assurance will go a great way in allaying the suspicions of commercial and industrial bodies. It has also been represented to us that it would be inequitable and unfair if manufacturers who contribute towards the establishment of research associations are again called upon to pay a further contribution in the form of a statutory cess. There is certainly considerable force in this contention. We expect that in course of time research associations will be established by industries. In levying the statutory cess, it must be provided that where a manufacturer makes an annual contribution to a research association of amounts which will not be less than the cess that he would have to pay, such manufacturers should be exempted from the payment of the cess. With this exception, the levy of a statutory cess will operate equitably in the case of all industries. One attractive feature of the proposal for levying a cess is that even though the rate may be unalterable, it will be an expanding source of revenue,

With the progress of industrial expansion, the proceeds of the cess will automatically increase and the National Research Council will thus have at its disposal an expanding source of revenue to meet the growing needs of research.

Indian States.

94. If our recommendation regarding the levy of a statutory cess is accepted, the burden, though small, will fall only on the industries established in British India. The Government of India have no constitutional power to levy such a cess on the industries in Indian States. There is already a disparity in the burdens borne by industries in British India as compared with industries in Indian States. India is an economic unit and there can be no justification for such disparities. Every attempt should be made within the permissible limits of the constitution to remove all such disparities. We would, therefore, recommend that if and when the cess is levied on industries in British India, the Government of India should invite all Indian States to levy a corresponding cess on the industries within their respective jurisdictions. As indicated in another part of our report, we contemplate the establishment of Research Councils both by Provinces and the Indian States. We would suggest that the Indian States may use the proceeds of the levy for financing the working of their own State Research Councils.

Ten year plan.

95. According to our proposal, the National Research Council will have at its disposal during the first five years of its existence the block grant of six crores of rupees paid by the Central Government and later on the proceeds of the cess and the annual contribution of the Central Government. All these grants to the Council must be of a non-lapsable character. No artificial time-limit should be imposed on the Council for spending the money placed at its disposal. After the first five year period, the Council will have at its disposal the annual grant by the Central Government and the proceeds of the cess. With these amounts at its disposal, the Council must be in a position not merely to build up a network of research laboratories and train a large body of personnel but also to accumulate a reserve fund. It is not possible to indicate at present a standard for India in the field of research which may be considered as an indispensable minimum. Without therefore attempting to go into the question of how much India ought, in the long run, to spend on scientific and industrial research, we have attempted to indicate how much should be spent within the next ten years so as to enable industry to obtain the fullest advantage from research. As concrete plans for the building up of industries develop in course of time, the need for further research will emerge. We would recommend that at the end of ten years from the setting up of the organisation that we recommend, the whole financial position must be reviewed.

Taxation and Research.

96. There is one other subject relating to the financing of research. Whatever the Government might do by way of building up of

of research organisations, every encouragement must be given for the establishment of research associations by various industries. In Great Britain, such research associations were started by industries with the financial assistance of the Government. In 1916 the British Government announced its intention to set aside the sum of one million pounds to enable the Department of Scientific and Industrial Research to co-operate with the industries of the country in the formation and maintenance of approved research associations. By 1943, 24 such associations had been established. In view of the direct financial burden that we propose to be undertaken by the Central Government we do not recommend any direct financial assistance for the formation of research associations. We recommend, however, that certain changes should be made in the income-tax law which we hope would give the necessary stimulus for the forming of such research associations.

97. The provisions of the income-tax law as they stand at present are not conducive to giving encouragement to the manufacturer for making contributions for research associations or for establishing research departments in individual manufacturing concerns. Contributions to research associations or for universities for purposes of research are not considered as permissible items of expenditure. In the case of expenditure on research departments in individual manufacturing concerns, the case is somewhat different. Capital expenditure for research plant is treated like ordinary items of capital expenditure in industry. Current expenditure on research is allowed as a permissible item of revenue expenditure as and when incurred. These provisions of the income-tax law must be altered if industry is to be encouraged to spend money on research.

98. Expenditure on research stands on a different footing from the other normal expenditure of a manufacturer. Such expenditure does not necessarily bring in immediate profits and very often the benefits of such expenditure on research accrue to a wider public than individual manufacturers. There is, therefore, a case for modifying in favour of the research expenditure the distinction which income-tax law draws between capital and revenue expenditure and also in the treatment of the capital expenditure as permissible items of expenses. As a proof of the recognition of the importance of research in the industrial organisation of the country and with a view to stimulate research in the widest possible field, the British Government have recently amended the British income-tax law. The amendment in question is contained in the Finance Act of 1944, 7 and 8 George VI, Chapter 23. Sections 27 and 28 of this Act contain the substantive provisions relating to the modifications introduced. The Committee suggest that steps should be taken to amend the Indian income-tax law also on these lines.

99. The substantive matters requiring amendment are as follows :—

- (a) Any research expenditure of a capital character on laboratory, buildings, plant and machinery must be allowed over a period of five years or over the life of the assets whichever is shorter as a deduction from profits for income-tax (including Excess Profits Tax). In addition all current expenses such as wages, cost of materials, repairs and so forth must be allowed as and when incurred by the manufacturer. The allowance referred to relates to re-research expenditure carried out by the manufacturing concern on its own account.
- (b) Any payment whether for a capital purpose or not made by the manufacturer to a research organisation approved by the National Research Council must be allowed as and when made as a deduction in computing the profits of the concern. Contributions to research carried out by a university or college on matters of concern to the manufacturers' business must similarly be allowed.

100. We, therefore, recommend that the Indian income-tax law should be amended in the manner indicated above. Our recommendation regarding the amendment of the income-tax law has already been forwarded as an *interim* recommendation. Pending the establishment of the National Research Council, we have recommended that the Governing Body of the Council of Scientific and Industrial Research may be recognised as the appropriate body for the purpose of approving a research organisation.

SECTION VII.

NATIONAL TRUST FOR PATENTS.

Profit
motive in
research.

101. Earlier in this report we have stressed the general principle that research in either the laboratories under the control of the National Council or in universities should not be actuated by any profit motive. It has been pointed out that the existing position in this respect is unsatisfactory, that during the war in particular the research activities of certain institutes have increasingly come under the influence of considerations relating to their commercial advantage, and that even in some universities the present practice is to allow a share of premia and royalties to go to the research workers. Such a system may have a demoralising influence on pure research, and even on the research activities of applied departments in the universities, by the inducement offered to the workers to concentrate on investigations of immediate commercial value. Evidently, under such a system the research spirit of the workers may be gradually undermined, and, it may have serious repercussions on the prestige and status of the institutions concerned.

Exploita-
tion of
patents.

102. This brings us to the question of evolving a suitable method for the exploitation of patents in respect of inventions made at either

the national laboratories or universities and other research organisations,—that would be conducive to research at a high level and also ensure the development of resultant inventions in the best economic interest of the country. Our attention has in this connection been drawn to the fact that the present state of things in the matter is rather confused and complicated arising from the prevalence of diverse sets of rules of patent rights of which some have been framed for Government servants and the rest laid down by organisations like the Council of Scientific and Industrial Research and universities for researches financed by them, and that these different rules so far remain unrelated by any unifying principle. The conditions applying to Government servants are provided for under F. R. 48-A, which lays down that “ A Government servant whose duties involve the carrying out of scientific or technical research shall not apply for or obtain or cause or permit any other person to apply for or obtain a patent for invention made by such Government servant save with the permission of the local Government and in accordance with such conditions as the local Government may impose.” The provisions of this Rule were made applicable also to Government servants under the control of the Government of India and the latter have issued specific instructions as follows :—

1. Application for permission under Rule 48-A of the Fundamental Rules should be made by the Government servant making an invention to the head of his department or if he is himself the head of the department to the department of the Government of India or to the Chief Commissioner under whom he is serving.
2. The Head of the Department should deal with the application confidentially and with expedition so that the inventor may not be prejudiced by delay in making his application at the Patent Office, and should forward it with his recommendations to the department of the Government of India or the Chief Commissioner under whom he is employed.
3. Permission may be granted by the department of the Government of India or the Chief Commissioner to the applicant without any restriction if the invention has no connection with the Government servant's official duties and has not resulted from facilities provided at Government expense.
4. If the invention is made in the course of the Government servant's official duties or has resulted from facilities provided at government expense, then—
 - (a) if the invention is of such general interest and utility that the public interest will be best served by allowing the public a free use of the invention, the application for taking out a patent should be refused and the invention should be published. An *ex gratia* payment should ordinarily be made to the inventor as a reward in all such cases;

- (b) in other cases, the inventor should be allowed to take out a patent for his own benefit subject to his undertaking to permit Government the use of the invention either without payment or on such terms as they may consider reasonable.
5. When the invention has been assigned to the Secretary of State for India in Council under paragraph 4 (b) above, the department of the Government of India concerned or the local administration may exploit the patent themselves or
- (a) advertise the patent and grant licenses on payment to manufacturers or
- (b) sell the rights under the patent to a firm or to a private person.

(Vide Finance Department Notification No. F.-11 (21)-R.I./33 dated the 1st November, 1933 published in the *Gazette of India* (Part I) dated 4-11-33).

Almost identical provisions have been made for Railway servants under Rule 2037 of the State Railway Establishment Code (Vol. II).

103. The research grants made by the Council of Scientific and Industrial Research are subjected to the condition that the patent right in regard to the results of researches financed by the Council shall, irrespective of the place where the investigations may be carried on by the sponsors of the schemes—whether at university laboratories or at other research institutions, vest in the Government of India; the Council however, allows distribution of one third of royalties received by it to the research workers concerned. So far as inventions made under the auspices of the universities themselves are concerned, there is a manifest lack of uniformity of practice. In some cases patents are taken in the joint names of the university and the researcher while some universities permit patents being taken by the scientist subject to the specified conditions in regard to the share of the premium and royalty that should go to the latter.

104. We consider the circumstances as set out above to be unsatisfactory and even fraught with the possibilities of friction as the Government departments, the Council of Scientific and Industrial Research and universities do not work—and rightly so—on a mutually exclusive basis; as a matter of fact, the research schemes financed by the Council include many which emanate from universities for being worked upon in their respective laboratories, and also some sponsored by Government servants serving in departments or institutions which provide suitable facilities for research. In these circumstances the need for rationalising the whole system on some fundamental principles and with the main object of facilitating exploitation of the patents in the national interest of the country can be hardly over-emphasised.

105. The question whether academic bodies like universities should interest themselves in patents has engaged our attention. It has been considered by expert committees in other countries also and the principle is now widely recognised,—that in respect of researches conducted under the auspices of universities with means and facilities provided by the latter, it is necessary to take out patents for reasons other than the benefit of their respective funds. A patentable invention in universities is often likely to be the result of inter-related researches in a continuous series engaging a team of workers over a period of time. If no patent is taken for such invention, it may not attract business interests to undertake its commercial exploitation. If, on the other hand, a patent has to be taken, it would not be fair to have it in the name of the last worker bringing the series of researches to the stage of culmination, which, in effect, would involve a denial of the contributions made by the collaborators; in fact one actuated by genuine scientific spirit would fight shy of taking up such a line of investigation for fear of criticism that his work was inspired by profit motive. Should this consideration lead the research workers to eschew such lines of investigations, as require to be followed up, both the cause of the advancement of scientific knowledge and the application of the same towards the economic development of the country would suffer. Such a deplorable eventuality can be avoided if only the university steps in and arranges to take out the patent in its own name and accords due recognition to the contributions made by all the workers in the particular series of researches resulting in the patentable invention. On similar technical grounds the taking of patents even for the results of medical researches, which on humanitarian considerations would appear to be particularly fit for being made freely available, is now recognised to be an imperative necessity. Recent developments in chemotherapy which have resulted in the discovery of numerous synthetic drugs have revealed that the cause of medical research in these lines is likely to be stultified, if the workers are prohibited from taking patents for methods of synthesis already evolved and if, as a result, the manufacturing interests are tempted by the opportunity of taking out patents for some derivative inventions which would have the effect of blocking further investigations in the line. In view of the contingencies stated above we consider that there should be no absolute ban imposed upon universities and other academic bodies and research institutions in the matter of taking out patents, but for reasons already stressed by us they should not regard the patents as a source of revenue nor allow the research workers to be corrupted by the desire to share in the royalties or other commercial benefits accruing from such patents. We do not, however, exclude the payment of extra remuneration to research workers

Academic
bodies and
patent
rights.

in cases of meritorious work resulting in financial gains to industry.

Need for
machinery
to exploit
patents.

106. Even so we consider that the universities and similar other academic bodies do not possess any suitable agency or organisation for the exploitation of the patents in a manner that would be conducive to the best economic interest of the country. In all progressive countries exploitation of patents is now being recognised to be a matter of national importance; and if this is to be directed towards the best interest of the country it cannot be left to the uncertainties of private negotiations of particular scientists or individual institutions with parties, when perchance they can attract, on a rather imperfect appraisal of the potentiality of the processes. While the worry and technicalities involved in taking out patents together with the necessity of incurring some preliminary expenses might have a deterrent effect on many individual scientists or make them easy victims for shrewd businessmen (within their limited acquaintance), who, often ill-informed themselves, must try to strike a hard bargain in their anxiety for minimising the risk, the institutions like universities are also very much handicapped by the absence of any suitable and efficient organisation for dealing with this job.

107. The realisation of the ideal exploitation of scientific inventions in the best interest of the country calls for the establishment of a suitable machinery that must be adequately equipped both in respect of expert knowledge and resources for an efficient discharge of this task and work on the basis of a comprehensive plan formulated according to the present problems and future need of the industrial development of the country. Considered from this point of view, the present resources of Government departments as much as of the universities and other non-official research institutions are quite inadequate; in regard to patents to be taken on behalf of Government in terms of Rule 48-A, it is no less urgent, than in any other case, to have expert advice on the commercial possibilities of the processes evolved by any member of the departmental technical staff and also to have expert guidance in the matter of drawing up specifications in order that any technical imperfections in this respect may not eventually render the patents ineffective. The Council of Scientific and Industrial Researches has attached to it a Utilisation Committee which was set up to advise on the lease of processes evolved under its auspices, but, the scope of the functions of this Committee is limited to the research schemes financed by the Council itself.

108. It may be pointed out in this connection that in India the problem has not so far attracted any non-official enterprise on the model of the Research Corporation Inc. of New York to provide at least a partial solution. This Corporation was set up as a private registered body in 1912 with the object of acquiring patents by assignment

on agreed terms and arranging their exploitation. There are no shareholders and the organisation of the body provides for the perpetuation of the Board of Directors. The profits accruing to the body are, according to the terms of its incorporation, applied entirely to the promotion of scientific research. The initial capital was furnished by the first Board of Directors on condition that the return of the capital would be the first charge on the profits. The Corporation has received considerable support from scientists engaged in academic research for being able to fulfil its main objective after repayment of the initial subscribed capital; and some American universities have been taking advantage of its services for the exploitation on assigned patents on agreed terms of sharing proceeds. Such private organisations must have necessarily limited resources which would restrict their scope. In India even the limited advantage of such an organisation is not available; nor is it likely that private enterprise in India will, at least for the near future, be attracted to such a non-profit earning scheme not altogether free from an initial risk.

109. We consider that the object in view can be achieved and the complications in the present system avoided if an organisation is set up that would function as a National Trust for Patents for the purpose of holding and exploiting, in best public interest, all patents that may be dedicated to it not only by individual scientists—whether independent workers or Government servants—but also by institutions supported either from public funds or private endowments. As the assignment of patents to this organisation by the various parties concerned will be made on a voluntary basis, the terms of exploitation will be determined to some extent by agreements, if any, between the Trust and the assignor, subject of course to the general ideal of serving public interest in the best and most effective manner. The constitution of the Trust must be so devised that it may secure the co-operation and support of universities, research institutions organised by private endowments and the Government departments concerned through adequate representation on its membership, which should also include representatives of labour and industry. Precisely these are the interests whose representatives would constitute the proposed National Research Council. We recommend, therefore, that the National Council itself should undertake the functions of the National Trust for Patents and necessary powers should be vested in it. Such a scheme would not only relieve the Government departments and universities of a responsibility which they are ill-equipped to discharge in fulfilment of the objective aimed at, but also facilitate effective collaboration between official and endowed research institutions and research organisations of industry by providing a dependable machinery for adjudicating and assigning the shares of the

A National
Trust for
Patents.

proceeds from the dedicated patent to the interested parties in equitable proportions.

110. In regard to the organisation of this function of the National Research Council and the general principles that should guide its activities in the matter we make the following recommendations :—

- (1) For advising on matters of general policy, particularly the assignment and lease of patents, the Council should set up an advisory committee of not more than 10 members including representatives of Government departments (like Finance, Research and Railways) representatives of commerce and industry and universities, the Controller of Patents and Designs and the Chief Controller of Purchase and the Chairman of the Research Board must be ex-officio members.
- (2) For facility in the administrative work involved, the Secretariat of the Council will have to be suitably strengthened by the appointment of an Administrative Officer, a Patent Expert and an Industrial Economist with necessary complement of technical and clerical staff.
- (3) The patent rights in respect of all processes evolved in any of the laboratories under the control of the National Research Council shall vest in the National Trust. The Council, as National Trustees, will also accept assignment of patents from inventors either by voluntary action on their part or at the direction of Government departments, universities, and other institutions maintained either from public funds or private endowments on agreed terms consistent with the principle that neither the Government and State-aided institutions nor the universities would look upon it as a source of income.
- (4) The principle guiding the lease of patents should be to make the benefits of the inventions available as widely and cheaply as possible. Care should be taken to ensure that the benefits accrue to industries organised by the nationals of the country. As a rule no process will be offered on a monopoly basis but in exceptional circumstances it may have to be conceded in the light of economic considerations, of demand and supply when the latter definitely reveal such a method to be indispensable for inducing commercial exploitation. In certain cases of national importance the State may be called upon to undertake exploitation.
- (5) In regard to the initial finance, the Trust must be given an advance by the Treasury, but if the assignments of patents are, as contemplated, made generally on a non-profit basis, the requirement of advance is not likely to be considerable. The repayment of such advance, if any, should be the first charge on the profits earned on the lease of patents. This will require the maintenance of separate accounts for the assignment and lease of patents and the administrative expenses involved.
- (6) The profits or the share thereof accruing to the Trust from the lease of patents should be exempted from income-tax and utilised by the Trustees for the promotion of

research. It should, however, be open to the Trustees to make an *ex gratia* payment to the inventors in cases of highly meritorious work.

111. We hope the scheme outlined above will receive the support of the various Government departments concerned, as much as of the universities and other non-official research institutions and the existing rules will be amended accordingly. We further expect that individual scientists with limited resources will also be induced to take advantage of it particularly in those cases where they cannot undertake costly experiments on a pilot plant scale and consequently the patents taken by them do not attract businessmen for commercial exploitation. To facilitate matters in this direction we recommend that the National Trust should in deserving cases of assigned patent arrange for large scale trials on pilot plants specially erected for the purpose and charge the incidental expenses to the cost of the patents.

112. It has been brought to our notice that information contained in the patent specification is not available in India in a convenient and useful form. A patent specification is a document of practical utility which contains a description of the art to which the invention relates and the method of carrying out the invention. Since 1912 patents for about 30,000 inventions have been applied for in India. There is no abridgement of these patents in a proper form. We recommend that steps should be taken immediately for publishing and making available to the public an abridgement of patents and that all patents should be properly indexed and grouped on the basis of industries.

Abridge-
ment of
Patents.

113. An abridgement of patents is necessary for various reasons. It will eliminate in many cases the labour and expense involved in solving a problem whose solution is already available and the research worker can get a good idea of the field already covered in a particular industry. It will enable research workers to improve upon the known processes and in solving allied problems. The legal position with regard to rival patents will also be more clear if abridgements are available in the proper form.

SECTION VIII.

STANDARDISATION AND TESTING.

114. Standardisation and testing constitute two important and integral parts of any comprehensive organisation of scientific and industrial research. The former provides the basis for guiding systematic research, while the latter is concerned with the scrutiny and evaluation of its results. In India both of these are now being dealt with, on a limited scale, by a number of institutions and laboratories attached to several Government departments, and, as in the case of research,

Present
arrange-
ments for
Standardi-
sation and
Testing.

there is a manifest lack of co-ordination between them. In regard to standardisation, for instance, particular aspects of it are now a matter of concern to the Survey of India, the Bombay Mint and the Indian Roads Congress according to their respective scope; of late even the Ordnance Laboratories at Cawnpore have initiated the fixation of certain standards for the manufacture of military stores. Under the auspices of the Survey of India a certain amount of standardisation work in connection with the measures of length has been undertaken in the past by the Mathematical Instrument Office, which is authorised to hold Standard Yard for the Government of India and to make and certify copies. It is also authorised by the Government of India to hold in deposit the Standard Flash Point apparatus for determining the flash point of petroleum and issues certificates of accuracy for these instruments as required in accordance with the Petroleum Act. Besides the M.I.O. possesses various standards for its work in the manufacture and calibration of the thermometer and also in connection with specific gravity apparatus. Sets of standard weight as used in precision balances are also held for workshop comparison.

115. The Assay Office at Bombay is the custodian of the Standard of Weight of the Government of India and undertakes the standardisation and verification of all Provincial standards of weights.

116. The Indian Roads Congress has prescribed standard specification for road surface, culverts, bridges, earth-work, circles, elevated platforms, etc. It has a standing technical sub-committee which examines designs and specifications submitted by Government Departments from time to time.

117. The Ordnance Laboratories at Cawnpore were originally concerned with routine testing and reporting on tender samples. Later, as a result of the familiarity with samples handled in increasing volumes, particularly during the war when the laboratories were considerably expanded, the task of scientific specification was taken up along with research to improve and eventually provide the Services with stores which would be more useful to them. This has been stimulated by the object of facilitating local manufacture and purchase of war materials, for a material might be too refined for a particular purpose and a revision of the specification might so adjust the quality as to make purchasing easier and more economical. The preparation of war specifications of a number of chemicals, standardisation of measuring equipment, etc., are some of the recent developments in the activities of the Cawnpore Ordnance Laboratories which deserve special mention.

118. A mention should also be made of the Bureau of Sugar Standards which was established in 1935 at the Institute of Sugar Technology with a grant from the Imperial Council of Agricultural

Research for undertaking the preparation and supply of sugar standards to factories and merchants, maintenance of samples and allied work.

119. In regard to testing, the central organisation of the Government of India is the Test House at Alipore (Calcutta), which is the only institution in the country authorised to issue test certificates bearing the Government seal on materials submitted for examination by all parties, Government and private. Although at its inception about 30 years ago it was intended to assist the Railways controlled by the Railway Board in the matter of facilitating local purchase of their requirements, the services of the Test House were at a very early stage thrown open to all Government departments, semi-Government organisations, private firms and individuals, and a system of levying fees at scheduled rates was introduced. During the last Great war, the Test House was largely engaged in the testing of munitions required by the Army, there being no Army testing organisation in the country at that time. An important development in its functions took place in 1934 when the Government of India created the Industrial Research Bureau. In that connection a Research Section was added to the Test House for the purpose of carrying out researches of industrial importance to India. In 1940 on the formation of the Directorate of Scientific and Industrial Research, the Research Section of the Test House was transferred to the new organisation. Originally, the Directorate was located in the Government Test House and remained there till the beginning of 1942 when it was transferred to Delhi. Apart from minor researches and investigations in connection with the behaviour and failure of materials in service and the drafting of specifications, the work in the laboratories attached to the Test House is devoted to testing materials physically and chemically. The laboratories are, accordingly, divided into two broad sections, Physical and Chemical. Since 1937 the Test House has undertaken the organisation and working of a Road Test Track on behalf of the Department of Communications, now the Department of Posts and Air. This has involved the building up of a separate testing station with necessary equipment for the special technique of tests and research. The range of materials which can be physically and chemically tested is extensive, and it cannot be claimed that the Test House is fully equipped for all kinds of industrial tests. Certain types of materials, such as explosives, food and patent medicines have been deliberately excluded from its scope, and as regards general engineering and chemical stores facilities for tests have been provided as the needs have arisen from time to time.

120. Prior to the outbreak of the War practically 50 % of the total samples tested were on behalf of the Indian Stores Department and these consisted mainly of samples tested against the I. S. D. tenders and those submitted throughout the year by the various inspectorates

of the I. S. D. to ensure that supplies were in accordance with the terms of the contract. The other 50 % of the work used to be received from other Government and semi-Government organisations, including the Defence Department (now the War Department) and from private firms and individuals. For all samples tested, whatever the source, test certificates containing results of tests are issued. Whatever standard tests and specifications exist, samples are tested in accordance with these and full remarks given as to their quality. Even before the war, in 1938-39 the revenue by way of test fees realised by the Test House amounted to Rs. 2,37,241, and this provides an indication of the volume of its activities. As a result of the war conditions the activities of the Test House have increased manifold in connection with work undertaken on behalf of the War and Supply Departments, the Aeronautical Inspection Service, the U. S. A. F., etc. The Test House was attached to the I. S. D. under the Department of Commerce till 1940. In that year the I. S. D. was merged in the Supply Department but the Test House was retained in the Department of Commerce under its direct administrative control. Later, with the creation of the Department of Industries and Civil Supplies in 1943, it was transferred to the control of that Department.

121. The Ordnance Laboratories at Cawnpore have also developed their testing activities during the war on an extensive scale, although the testing done by these laboratories is confined to samples of stores supplied to the Defence Services. In 1943 these laboratories tested, on an average, 21,500 samples per month. Particular mention may be made in this connection of the Physical Section of the Laboratories where specialised physical measurements and investigations are undertaken including thermal insulation tests, determination of air permeability of special fabrics, spectro-chemical analysis of alloys, metallographic examination of metals, special measurements of colours, electrical insulation and dyed samples, detection of cracks in metals and photographic work of various kinds. The necessity for decentralisation of test work made itself keenly felt even in the early years of the war and in 1941 a laboratory organisation was set up in Bombay for testing and reporting on cotton textiles. Later, similar other detached units were established in Calcutta, Bangalore and Lahore. The activities of these outstations are confined mainly to routine testing.

122. The Indian Meteorological Department has been testing for a long time meteorological instruments like barometers, thermometers, rain-gauges, wind instruments, etc. The Department has also undertaken the issue of certificates and calibration charts for such instruments.

123. The Metallurgical Inspectorate at Tatanagar undertakes certain amount of research work for the Indian Stores Department and

the Railway Board but it is engaged largely in testing and consultation work (metallurgical) for the I.S.D. The Central Revenue Control Laboratories at Delhi have likewise a restricted scope, their main concern being the testing of materials for assessment for revenue purposes. Testing work is also done in the Cotton and Jute Technological Laboratories for the determination of the spinning qualities of cotton and jute fibres and of the strength of fabrics made out of them. The chemical laboratories maintained by many of the Provincial Governments are also engaged in testing work of the routine type.

124. The organisation outlined in the foregoing paragraph constitutes the background for an examination of the problems of standardisation and testing in India and the allied problems of research. The patent fact of the present situation is that the work of conducting tests and prescribing standards is not systematic but is carried out in a diffused and often perfunctory manner by several Government departments, both Central and Provincial, primarily with the object of satisfying their own needs in the matter of purchase or manufacture. It has been impressed upon us that the contractual specifications usually laid down by a purchaser for his special requirements may not have any resemblance with established standards, and methods of tests are left mostly to the discretion of the technical head of the institution carrying out the test. It is urged that even where scientific tests are applied, the results of different institutions have often been found to vary due principally to the different methods applied, and sometimes the examination of the same case by different laboratories has resulted in contradictory reports.

Problem of Standardisation in India.

125. The primary cause of this unsatisfactory state of things is the absence of an institution in India of the type of U. S. A. Bureau of Standards or the National Physical Laboratory at Teddington in England to which American Engineering Standards Committee (A.E.S.C.) and the British Standards Institution (B.S.I.) act as complementary organisations in the matter of formulating industrial standard specifications. In India the only recognised organisation for this purpose which enjoys a statutory status is the Institution of Engineers (India), but this body does not lay down any standard itself and its practice is to follow the B.S.I. standards. The Government Departments including the Railways make full use of the B.S.I. standards. It appears, however, from the evidence placed before the Committee that the American A.E.S.C. standards are being increasingly adopted as a war measure as they permit 'tolerances' more in keeping with manufacturing practice.

126. It has been strongly urged upon us that the British and American specifications are in many cases found to be unsuitable for Indian conditions. It stands to reason whether an adherence to these specifications laid down by foreign bodies is necessary or desirable in view

Need for Indian Standard Specifications.

of the obvious differences in the climatic conditions and raw material resources of India, England and America. The difference in climatic conditions alone would call for and justify the formulation of special standards for India in regard to such things as materials and fittings for construction of houses and building of roads. Likewise, in electrical industries India presents her own problems in the matter of evolving suitable standards of quality and performance with reference to the bearing of special temperature and humidity conditions of the country. The difficulty of a strict adherence to foreign standard specifications has been felt in the need for modifications of accepted standards on account of the scarcity of certain materials during the present war. These have demonstrated that in many cases the pre-war specifications could advantageously be changed or even replaced altogether. We are advised that in some cases the use of a smaller percentage of scarce materials or of substitute materials available in the country has yielded even better results. India has a manifest deficiency in respect of certain minerals and metals, which might persist even after the war, while she has a surfeit of many materials which await effective and more profitable utilisation. We, therefore, consider the formulation of Indian standard specifications to be essential preliminary to the maximum use of her resources for the industrial development of the country, and this, as already stressed, must be backed by a suitable organisation for research.

127. We should like, in this connection to refer to the two distinct aspects of standardisation, one relating to "scientific" standardisation, and the other to "Industrial" (or commercial) standardisation which do not present identical problems of research and have varying relative significance for a country like India. Standards are classified as those of Measurement, Constants, Quality, Performance and Practice. Out of these, the last three are of vital concern to industry while the first two, though important to industry, in as much as they regulate weights and measures of the country, belong more to the ambit of "scientific" standardisation. Indeed, the latter relating to fundamental units of length, mass and time and the derived measures of area, volume, weight density, pressure and also units of measurement of heat, light, electricity, radio-activity, etc., are now fixed by statutory enactments, being internationally accepted by legally constituted authorities. In order to make them available for the use of industry in almost all the progressive countries national physical laboratories are charged with the duty of maintaining these standards and supplying certified copies to industries. We consider that this task should be taken over by the National Physical Laboratory recommended by us as and when the same is brought into existence.

128. The object of industrial standardisation, on the other hand, is, to set up standards or standard specifications for engineering and industrial materials. It serves the community of interest between producers and consumers, ensures easy marketability of the products by fixing standard of quality on the concensus of expert opinion representing the various interests concerned. For reasons already stated it is necessary for India to set up her own standard specifications for all engineering and industrial materials, which are either used or produced in India in fairly large quantities.

129. It is not fully realised in this country how large a part mathematical statistics is playing at present in supplying a scientific basis for standardisation and economic control of the quality of manufactured products. With the help of appropriate statistical methods controls can be established to keep the degree of variability within assigned limits and thus eliminate waste of material and labour in large scale production of all kinds. The British Standards Institution published a comprehensive book in 1935 (No. B.S. 600 : 1935) "on the application of statistical methods to industrial standardisation and quality control," and a War Emergency Publication "Guide for Quality control" was published in 1942 (No. B.S. 1008 : 1942); and a series of notes and reports on the same subject are also being issued from time to time by the Statistical Advisory Council set up by the Ministry of Supply in His Majesty's Government. In the U. S. A., in December 1940, the War Department requested the American Standards Association to undertake projects "on the application of statistical methods to the quality control of material and manufactured products" as it was considered that "in the national emergency there was urgent need for the prompt development of standards in this field;" a number of publications have since then been issued in a series of "American Defence Emergency Standards" (Z1-1, Z1-2, Z1-3, etc.).

Statistical
Control.

130. Adequate provision for the use of statistical methods in standardisation and testing in India is therefore essential. A Committee on Statistics (Standardisation and Quality Control) was recently set up by the Council of Scientific and Industrial Research. Our attention has been drawn to the preliminary recommendations made by this Committee in December, 1944. We generally endorse these recommendations. We note that there is acute shortage of trained personnel, and we strongly support the recommendation of the Statistics Committee for the initiation of a special course of intensive training in industrial statistics in the Indian Statistical Institute.

131. In progressive countries, particularly England and U. S. A., the task of formulating standard specifications has been entrusted to specific bodies which have gained international recognition. In England, the British Standards Institution now functions as the national organisa-

British and
American
National
Bodies for
Standardisa-
tion.

tion which issues what are known as British standard specifications. The Institution has a General Council consisting of the Representatives of Industry, the Board of Trade, the Department of Scientific and Industrial Research, the National Physical Laboratory, the Federation of British Industries and the Association of British Chambers of Commerce. It has four Divisions relating to Chemicals Building, Engineering and Textile, each of which (except the last) functions through numerous Technical Committees, the latter being assisted by a still larger number of Sub-Committees and Panels. Indeed, in the case of the Engineering Division there are 11 Industry Committees (Aircraft, Chemical, Engineering, Colliery Requisites, Electrical, Gas, Illuminations, Mechanical, Iron and Steel, Non-ferrous, Petroleum and Public Works) interposed between the Division and its Technical Committees. Each of the first 3 Divisions has a Council of its own, which includes representatives of the D.S.I.R., the N.P.L. and a number of Associations and Institutions interested in the particular branch of industry. The following extracts from a memorandum furnished to the Committee by Dr. K. N. Mathur, Assistant Director, Council of Scientific and Industrial Research, for the National Physical Laboratory scheme, give a fair idea of the *modus operandi* of the fixation of standards by the British Standards Institution :--

“Any proposal for standardization received from some recognised authority such as trade association, a technical institution or a Government Department is submitted to the appropriate ‘Divisional Council’ or ‘Industry Committee’ which, if satisfied, may move that a *conference* of all interests concerned may be convened to consider the matter. Notices of such a conference are given as wide a publicity as possible in the trade and technical press. If the conference, after meeting and discussing, reports favourably to the Council or Industry Committee concerned, the latter appoints a Technical Committee to deal with the matter in detail, or if the matter is urgent and practical unanimity is reached, the conference itself may resolve into a Committee. In certain cases the Technical Committees may appoint sub-committees or panels to go into scientific or technical details or to conduct tests. The recommendation of the Divisional Council or Industry Committee has finally to go before the General Council for confirmation.

It is noteworthy that the Institution has a strict rule that it does not initiate standardization itself, nor consider any request if it comes from an individual firm. Also, the Standardisation is arrived at by general consent and no coercion is exercised.”

132. In the U. S. A. the organisation for standardisation is somewhat different—in fact there are many organisations and associations individually working on standardisation, but the purpose of coordination on a comprehensive basis is served by the American Standards Association which is a federation of 33 national organisations

(including 9 major Engineering Societies) 18 national industrial associations and 6 departments of the Federal Government. The A. S. A. functions primarily as an administrative and policy framing body. The technical work of standardisation devolves on the standardising bodies which on the British model are assisted by representative sectional committees. "As in the case of the British practice, the A. S. A. undertakes standardisation only upon an express desire of Industry, and a formal conference of the representatives of the bodies concerned decides whether or not the work shall be undertaken, and, if so, defines its scope and procedure and decides the body who will sponsor it." Apart from the A. S. A. there is in the U. S. A. a Federal Specifications Board which functions as the official agency for unifying and co-ordinating Government specifications.

133. We consider it necessary that for the purpose of framing Indian standards specifications steps should be taken, as early as possible, for the establishment of a Board of Standards in this country. Unlike England and U. S. A. and other advanced countries, the initiative in the matter in India has to be taken by the Government as many of the industries in this country have no proper organisations. The specifications are to be drawn up on the basis of effective co-ordination of principal users, producers and technical experts, and the constitution of the Board is to be so devised that it may command the confidence of all the interests concerned. It is to be an All-India organisation as the formulation of uniform standards for the country as a whole is aimed at, with due regard to quality control, manufacturing efficiency and maximum utilisation of national resources.

134. As the activities of such a Board of Standards will have to be supported by investigations in the various national laboratories to be set up under the auspices of the National Research Council and as the Council itself will be constituted on a representative basis, we recommend that instead of having a separate organisation for the purpose it would be advisable to entrust the National Council with the task of organising a Board of standards on the lines indicated above. In such case the Board may be set up as an affiliated subsidiary organisation of the Council consisting of the representatives of recognised industrial and scientific organisations, trade associations and representatives of the Government departments concerned. Such a scheme would ensure an effective representation of all the interests concerned. The Board is to function as a permanent body. Although the specifications will issue under its authority, the Board will be concerned mainly with the framing of policy and entrust the technical work involved to a number of sectional committees. The number of such sectional committees must of course be related to the present condition of the development of industries in India. It has been suggested to us, that to start with, a limited number of such committees may be set up for such industries

Case for a Board of Standards in India.

Constitution of the Board of Standards and Procedure of Work.

as Building and Housing ; Chemicals and Chemical Engineering ; Civil Engineering and Roads ; Colliery requisites ; Electrical industries ; Illumination, Mechanical ; Iron and Steel ; Non-ferrous Metals and Alloys ; Glass and Ceramics ; Textiles ; Petroleum Products ; Agricultural Implements and Requisites. This is, however, only an illustrative list and will have to be added to in the light of a detailed scrutiny. Under these sectional committees it would be necessary to set up sub-committees and panels in some cases, according to the variety of specialised lines embraced in their respective scope, and in constituting all such sectional committees and sub-committees the Board will have to take particular care to ensure their representative character by inviting representatives from appropriate Government departments, scientific and industrial organisations, and trade associations and also individual experts, in order that the proposal for any standard specification emanating from them may have the authoritative support of the various interests concerned. In order to enlist the services of the best experts for each major class of materials, as members of either the technical committee or any sub-committees thereof, the Board will require to maintain a panel of bodies and persons who have expert and specialised knowledge of each of the subjects.

135. The task of formulating standard specifications by the various technical committees will, however, require to be backed by proper and adequate facilities of research for the clarification of numerous technical points likely to be raised in this connection. Here the Board will be called upon to prepare and maintain a list of institutions and laboratories where particular investigations should be undertaken on behalf of the Board. In this respect the fact of the Board itself being set up under the auspices of the National Research Council will no doubt offer a special advantage as it would ensure the effective co-operation of all the major laboratories and specialised research institutes established by the Council, but the Board would still require the co-operation of several other institutions that would not come under the direct control of the National Council. Besides the Board will require to maintain a standard laboratory of its own.

Alipore Test House as standard Laboratory.

136. As the Government Test House at Alipore has already acquired considerable experience in testing and standardisation we consider it desirable to expand it in the manner required and transfer it to the control of the National Research Council to form an integral part of the comprehensive scheme of standardisation. The establishment of a duplicate central testing laboratory would be unnecessary and wasteful.

Arrangement for allied research in various laboratories.

137. Apart from the national laboratories and specialised research institutes under the direct control of the National Research Council it will be necessary for the proposed Board of Standards to obtain the co-operation of other laboratories and institutions in the country. As

the problem of standardisation is one of common interest we hope that the necessary co-operation of the institutes and laboratories mentioned above will be readily forthcoming. Even so, to strengthen the basis of such co-operation we hope that the desirability of making suitable provision for the representation of these various laboratories and institutes on the appropriate technical committees will be kept in view by the Board of Standards as and when the selection of the personnel of such committees is taken in hand by the latter.

138. In regard to the constitution of the Board we refrain from making any detailed recommendations beyond emphasising the principle that it must provide for adequate representation of the various Government departments concerned and also of recognised scientific, industrial, engineering and trade organisations.

139. Under the guidance of the Board of Standards, the responsibility for executive functions involved in the scheme will devolve upon the Research Board of the National Council. The Board will require for this purpose the assistance of an administrative officer possessing necessary qualifications for this type of work and a few assistants and necessary office staff. It is estimated that the scheme at its initial stages will entail an expenditure of about Rs. 50,000 but it will be a productive expenditure as bringing in a revenue from the sale of specifications, which with the growing popularity of the scheme will more than cover the administrative cost, even making allowance for an increase consequential to a rise in the volume of work and necessary expansion of staff.

140. In the course of evidence placed before us in the matter it has been pointed out by several witnesses that the arrangements for testing in India are at present too much centralised and that in a vast country like India it is necessary to have testing laboratories set up in different zones for meeting local requirements with necessary expedition. It has been urged that if the services of such testing laboratories are made available on a wider scale it would be particularly helpful in stimulating exports of the country on the basis of quality certificates issued by such testing laboratories. We have been impressed with the reasonableness and importance of this proposal. We recommend, therefore, that while Test House at Alipore is taken over by the National Research Council,—and even before that, if possible—the latter should review the position in this respect and consider the desirability of establishing testing laboratories in suitable zones under its own auspices and also examine how far the purpose can be served in particular places by according recognition—in the matter of issuing authoritative certificate of quality—to approved private laboratories having necessary equipment for undertaking testing work.

Need for regional testing laboratories.

SECTION IX.

MISCELLANEOUS MATTERS.

141. As we have mentioned in another part of the report, scientific and industrial research must lead to the practical growth and development of industries in the country. Advance in research and expansion of industry must proceed side by side and each must stimulate the other. One of the essential needs for the development of industry is the availability of higher technical personnel in adequate numbers. Technological colleges and institutes all over the country must be established for training such personnel. The Government of India must establish at a central place a first class technological institute on the lines of the Massachusetts Institute of Technology. The Provincial Governments and major Indian States must each have at least one technological college or institute in their respective areas. In establishing such institutes, the Local Governments would be well-advised in giving the necessary financial and other aid to the universities within their jurisdiction for the starting of such technological institutes or departments of technology. Special technological training institutes can with advantage be located near the industries concerned and national laboratories. Such a combination will result in maximum advantage.

142. Until Indian industry becomes research-minded and shows an inclination to establish research organisations on a voluntary basis, the Government should, when suitable opportunities arise, ensure the setting up of research organisations by industry. When tariff protection is given to any industry, the question of the research facilities for that industry must be specially examined by the Tariff Board. It should be open to the Tariff Board to recommend that an industry enjoying protection should be under an obligation to spend a reasonable amount of money on research pertaining to that industry.

143. Public laboratories and university laboratories must be exempted from the payment of the excise duty on their requirements of alcohol.

144. It is likely that at the end of the war, there might be a surplus stock of laboratory and allied equipment for disposal. In the disposal of such material, preference must be given to universities and public laboratories. If import control continues after the war, priority must also be given to such institutions for the import of laboratory and allied equipment.

145. A comprehensive register of all persons 'qualified' to conduct scientific and industrial research should be prepared and maintained. This task should be delegated to an unofficial agency like the National Institute of Sciences in India. For the purpose of the preparation of this register, the minimum qualification must be the B. Sc., B. E. or an equivalent degree in science or technology. A National Register of persons 'actually' engaged in scientific research should also be pre-

pared and maintained by the same body. This register should contain the names of persons who after taking the university degree in science or its equivalent, are engaged in research work in universities, research institutions, private laboratories and industry. The Committee has already sent an interim recommendation on this matter.

146. The terms of reference to the Committee restricted our enquiry to scientific and industrial research. We have proceeded on the assumption that this was necessary to keep the enquiry within the purview of the C. S. I. R. by which the Committee was appointed and that it was beyond our scope to deal with agricultural and medical research. While we have pursued the enquiry within the limits of our scope and have devoted ourselves to the formulation of a self-contained and complete scheme for the organisation of scientific and industrial research with necessary co-ordination with institutions engaged in both industrial and other kinds of research, we should nevertheless like to make it clear that the usual demarcation between agricultural, medical and industrial research is more or less an arbitrary one, although such a division may have in the past answered the needs of administrative expediency. It is indeed difficult to draw a line between different categories of research in many cases. There are many agricultural raw materials in respect of which the investigations might come under both agricultural and industrial research; presumably for this reason the Imperial Agricultural Institute at Pusa has at a certain stage of its development come to interest itself in particular investigations relating to the utilisation of agricultural waste products which would *prima facie* appear to belong to the domain of industrial research. Again, in the matter of investigations relating to drugs it would be difficult to say if these should come under medical or industrial research. Even if it were possible to assign the various researches to clearly defined compartments, it should by no means be assumed that they can and should be dealt with in isolation from one another. On the contrary, having regard to the ultimate object of various researches as one for the advancement of national welfare, their inter-relationship becomes at once manifest. Often the result is the converging point for allied researches in the agricultural, medical and industrial fields. Accordingly, it is necessary to marshal the different kinds of research according to a comprehensive plan. This relationship is most forcibly brought to the fore by the problem of developing these industries, which from the very nature of the case require to be considered vertically from the stage of producing the raw materials to the manufacture of the finished product. Problems relating to the development of the sugar industry in India, for instance, relate as much to the cheapening of sugarcane through necessary improvement of the variety and yield of cane per acre as to the improvement of manufacturing efficiency and utilisation of the by-products of the industry. Similarly, cotton, jute

and numerous other industries call for the planning of research on comprehensive basis, embracing both their agricultural and industrial aspects. The food industries, again, present in many cases problems for agricultural cum medical cum industrial investigations.

147. Even in England where by tradition research has been developed under the auspices of three distinct organisations viz. the Agricultural Research Council, the Medical Research Council and the Department of Scientific and Industrial Research, the impact of the present Great War has revealed the undesirability of exclusive compartmental treatment as it is not conducive to, and may indeed act as a drag on, the attainment of specific results on problems of common interest. It was to surmount the obstacle on this score that the Scientific Advisory Committee of the War Cabinet was brought into existence with a view to effecting co-ordination between all the three branches of research at a high inter-departmental level. We consider that the inauguration of the Council for scientific and industrial research exercising functions as recommended by us will mark an important step forward in the development and organisation of industrial research on a fairly comprehensive basis. There are two other organisations already in existence concerned with medical and agricultural research, viz., the Indian Research Fund Association and the Imperial Council of Agricultural Research. Steps should be taken to ensure an effective and planned co-ordination between all the branches of research. In Great Britain the Scientific Advisory Committee of the British War Cabinet which consists of the Secretaries of the Agricultural Research Council, the Medical Research Council and the Department of Scientific and Industrial Research and three non-official scientists drafted from the Royal Society has brought about an effective co-ordination. The Co-ordinating Committee is under the chairmanship of the Lord President of the Council. This example suggests the desirability of bringing about such co-ordination in India as well. Our attention has in this connection been drawn to the decision recently taken by the Government of India for setting up a Scientific Consultative Committee with the Hon'ble Member in charge of the Planning and development Department as the Chairman and consisting of both official members and non-official scientists of whom the former include the Master-General of Ordnance; Vice-Chairman, Imperial Council of Agricultural Research or the Agricultural Commissioner to the Government of India; Director-General I.M.S.; Director, Geological Survey and the Director of Scientific and Industrial Research. We consider this to be a welcome move not only for the purpose of achieving the desired co-ordination of policies in regard to the various fields of research but also as one that should facilitate the activities of the National Research Council as and when the same is brought into existence. We envisage an effective liaison between the National Research Council and institutions now engaged

in industrial and allied research under the auspices of different Government departments. We need hardly stress that when the National Research Council is established steps will have to be taken for its direct and effective representation on the Consultative Committee or any other organisation that may be set up in its place for identical purposes. In this connection the possibility of bringing all research activities under departmental control of the Member for Planning and Development deserves examination.

SUMMARY OF FINDINGS AND RECOMMENDATIONS

(1) The prospects of keen international competition in the post-war period underline the importance of research as an essential aid to industries both for consolidation and expansion.

(2) The first and most important desideratum is the establishment of an effective liaison between university, industry and research institutions.

(3) Research by itself cannot foster industrial development: it can yield the best results only when backed by a comprehensive industrial plan. It is necessary, therefore, that the central research planning organisation should work in close co-operation with the organisation set up for industrial planning.

(4) There is no effective liaison between different Government laboratories which are engaged in industrial research, nor between those laboratories and industries. The contact provided for by representation of industrial interests on their governing bodies or advisory committees has not fostered any general practices of reference on industrial problems to such laboratories for advice and solution.

(5) There is manifest lack of co-ordination in the research activities of the various organisations in the country *inter se*.

(6) Although the emergency of the War has been responsible for the stimulation of industrial research in some of the institutions, the programmes of researches conducted therein do not yet appear to be formed by mutual consultation or according to any co-ordinated plan.

(7) In some of the institutions engaged in industrial research tendency is discernible for the research staff being actuated too much by the profit motive.

(8) With a few notable exceptions Industry in India is not research-minded. Even among larger firms which maintain laboratories of their own, only a very few have fully equipped laboratories and maintain a regular research staff, the majority being interested in routine testing only.

(9) As compared with the United Kingdom there is manifest lack of industrial research associations in India, except in the cases of tea and jute industries.

(10) Industry in India has no contact with research departments in universities, and as a result the latter have been handicapped for making their contribution to the promotion of the country's economy.

(11) Many of the universities are seriously handicapped by their inadequate resources. Only a few of them have workshops and necessary resources for undertaking pilot plant experiments.

(12) It is necessary to set up an adequate research organisation in the country and for taking measures for bringing about a co-ordination of the activities of the various research organisations and universities.

(13) The distinction between different categories of research must not be regarded as indicative of any essential difference that would justify their organisation and control on a mutually exclusive basis.

(14) In India, as matters stand at present, it is not likely that research associations on any large scale would spring up at the initiative of industries, nor is there much hope of voluntary help coming from private individuals. The universities suffer from the handicap of slender financial resources. If, therefore, scientific and industrial research is to make any headway in the immediate future, Government must take the initiative in setting up a suitable machinery for the development of research along sound lines.

(15) The establishment by the Government of India of a central research organisation to be called the National Research Council consisting of the representatives of science, industry, labour and administration with the Hon'ble Member of the Viceroy's Executive Council in charge of the portfolio of Planning and Development as 'ex-officio' President is recommended.

(16) Functions of the Council recommended as follows :

- (i) To organise and maintain national laboratories.
- (ii) To establish and maintain specialised research institutes.
- (iii) To stimulate pure and applied research in universities by grants-in-aid and by the institution of scholarships and fellowships.
- (iv) To provide for the immediate problem of the dearth of technical and research personnel by the inauguration of scholarships available in India and abroad.
- (v) To stimulate and encourage research activities by industry.
- (vi) To co-ordinate the research activities of all the existing research institutes and departments of Government and and undertake planning of research programmes on a comprehensive basis.
- (vii) To function as a National Trust for Patents.
- (viii) To set up a Board of Standards and Specifications.
- (ix) To function as a Clearing House, encourage deserving scientific and technical societies and foster the growth of new ones in appropriate lines.

(17) Constitution of Standing Technical Committees, a Budget Committee and a Grants Committee is recommended, the last for advising on allocation of grants to universities and research institutions.

(18) While the National Research Council will be responsible for direction and control of scientific and industrial research, it is recommended that for actual administration of the work vested in the Council, a small executive body to be called the Research Board consisting of three members, all full-time men, should be set up to act under the general direction of the Council in matters of policy. The Board will be responsible to the Council.

(19) The Research Board will be the executive body of the Council and will be in charge of the research laboratories and institutes set up by the latter. The Board will from time to time prepare comprehensive plans of research programme and, subject to the approval of the National Council, undertake the execution of the plan. It will *inter alia* take an active part in the establishment of research associations by industries and distribute grants-in-aid to universities and other approved institutions and bodies with the help of the Grants Committee from funds specially allotted for the purpose.

(20) It is recommended that the Council should make and carry out a five-year plan of research organisation and that the plan should consist of (i) the building and equipping of a National Chemical and a National Physical laboratory; (ii) the building and equipping of certain specialised research institutes; (iii) giving grants-in-aid to universities, and (iv) training a sufficient research personnel by the award of scholarships tenable in India and abroad.

(21) The establishment of a National Chemical Laboratory and a National Physical Laboratory is recommended at an estimated cost of Rs. 40 lakhs each (approximate). The details regarding plans and estimates are to be worked out by small expert committees.

(22) In the absence of industrial research associations in India (except for jute and tea) it is necessary for the State to take the initiative for the establishment of a number of specialised laboratories for fulfilling the object. Such institutes should in the first instance be set up for those fields in which industrial development has taken place on an appreciable scale. Pending such development, research in respect of promising new industries of admitted potentiality should be undertaken in the National Chemical and the National Physical Laboratories as investigations of the "residuary" type.

(23) Nine new specialised institutes are recommended, with an indication of the order of priority thereof and the estimate of expenditure involved in the various new laboratories proposed. (Total Rs. 2½ crores approximately inclusive of the National Chemical and the National Physical Laboratories).

(24) It is recommended that the specialised research institutes should deal with problems of basic and specific research relating to their respective spheres. Researches on such problems are to be undertaken according to programmes in consultation with the Directors of the institutes, and also on the initiative of their respective Directors or staff. In addition, Provincial and State Research Councils may also send problems for investigation to these institutes with the approval of the Research Board. It should also be open to individual manufacturers to refer specific problems of immediate concern to industry to such laboratories on payment of scheduled fees or by the establishment of fellowships on the model of the Mellon Institute in the U. S. A.

(25) As a rule the specialised institutes should be located with due regard to proximity to university centres, industries and sources of raw material, and not concentrated in particular regions.

(26) The superior technical staff of the various laboratories and institutes should be selected with the greatest care. The Directors and the Assistant Directors of these institutes should not automatically get a permanent tenure like the employees in Government service. They should be employed on a contractual basis for a limited term renewable on proof of satisfactory work, and promotions also should be determined by the same criterion.

If it is necessary to import experts from abroad, care should be taken to obtain the services of the best men available without preference to any particular nationality, and in all such cases the appointment should be made on a contractual basis for a specified term.

(27) The technical staff in charge of the specialised institutes should not allow themselves to be chained to routine administrative work or entirely to the problems concerning particular industries. As the technique of specific industries is intimately connected with development in fundamental and basic research, the superior technical staff of these institutes should keep themselves abreast of the latest development in academic research and for this purpose have necessary liaison with universities. In suitable cases selected members of the staff may also be deputed for working for specified period in universities and industrial concerns and facilities may also be provided for promoting selected technical men from industries to undergo a period of training in the institutes.

(28) The universities constitute the foundation of all research. The planning of the organisation of scientific and industrial research on a sound basis, therefore, calls for the strengthening of the scientific teaching and research work in Indian universities. As an essential part of the five-year plan it is recommended that the National Research Council should make substantial grants for strengthening the scientific departments of universities. For this purpose the Grants Committee should make a survey of science and research departments

of all the Indian universities and recommend to the National Council a scheme of financial assistance to the latter. It is recommended that out of the block grant of Rs. 6 crores a sum of about Rs. 2 crores should be set aside for giving grants-in-aid to the universities during the first five-year period and that it should generally be made a condition that the university should obtain from the Provincial Government or from some other source an amount equal to the grant offered by the National Research Council. Provision should of course be made for meeting exceptional cases.

(29) It is essential to build up and maintain adequate engineering research sections in all the engineering colleges. Teachers in such colleges should have contact with the engineering industries.

(30) The conditions attached to grants to universities should not infringe their autonomy subject to the right of the Research Board to visit the universities and call for such periodical reports as it may consider necessary to satisfy itself that the purposes of the grants are being observed.

(31) With proper safeguards against possible contamination of the research atmosphere in universities, which are primarily concerned with disinterested research for the advancement of knowledge and maintenance of teaching at a high standard, universities may undertake "specific" researches for individual manufacturers provided that the results will not be claimed as a monopoly by the manufacturer and the research workers in such cases should have no share in the financial benefits of the resultant discoveries and that any share which the sponsors of such research would offer would accrue to the universities themselves. It should however be open to the university authorities to make *ex-gratia* payments to the research workers in deserving cases.

(32) While the staff of the scientific departments of universities should be relieved to some extent of teaching work, in cases where they are overburdened with such duties, it is not desirable that there should be any complete divorce between teaching and research. The status and salary of the research staff in the universities should be made more satisfactory than at present.

(33) A large band of research workers will be necessary not merely to man the various laboratories proposed to be set up but to keep alive the research work in the country and to meet the growing demands of industry. It is recommended that as a part of the five-year programme 700 research workers should be trained during that period involving an estimated total expenditure of about Rs. 50 lakhs, 27 lakhs for foreign scholarships and 23 lakhs for Indian scholarships. The scheme should also include a provision for sending abroad selected members of the existing research staff of universities for short periods.

(34) Industries should be encouraged to set up their own research associations on corporate basis by exemption of research expenditure of firms from income-tax assessment in respect of which detailed recommendations are made under " Finance " (Section V).

(35) Pending the establishment of research associations of industries the manufacturers in India should be induced to avail themselves of the opportunities created by the establishment of the various national laboratories by instituting the Mellon type of industrial fellowships.

(36) A net-work of corresponding research organisations should be set up in all the Provinces and major States. It is recommended that Research Councils on the model of the National Research Council, composed of the representatives of science, industry and administration, should be set up in all the Provinces and major States.

(37) The Provincial and State Councils should aim at setting up research laboratories for applied research to meet the conditions and requirements of their respective areas.

(38) The Provincial and State Governments should provide the finance for the Councils in their respective spheres.

(39) Although the industrial system in India is based mainly on private enterprise, State initiative and effective participation of Government in research is necessary as any reliance entirely on industry for the provision of the necessary finance on a voluntary basis would postpone indefinitely any appreciable advance. Besides, there are certain lines of fundamental research and those of national importance which must from the nature of the case be the concern of the State.

(40) The part the Government of India is expected to take in post-war industrial development imposes on them a special obligation for undertaking financial responsibility for organising and promoting scientific and industrial research side by side with industrial planning. It is recommended that the Central Government should for this purpose make a block grant of six crores of rupees to the National Research Council spread over a period of five years.

(41) With a view to ensuring the continuity of the activities of the National Council on a progressive scale it is further recommended that after the initial five year period Government should give an annual grant of Rs. 1 crore to the National Council and that, in addition, industry should also be asked to bear an equal burden. The contribution of industry should also be about one crore of rupees per annum which must be raised by a statutory cess of $1/16$ th of one per cent. on the value of industrial production.

(42) The cess may be levied either on the basis of industrial production or as a small surcharge on income-tax, of which the latter would be simpler from the point of view of administration and collection. The former method is, however, recommended as more

equitable. The cess should be levied only after the organisation and laboratories recommended have been established.

(43) The rate of the cess decided upon in the first instance should not be increased. A fixed rate would ensure increasing revenue with progressive expansion of industries. For avoiding a double burden, manufacturers making a contribution to any approved research association equal to the amount of the cess should be allowed exemption.

(44) To avoid undesirable disparities in burdens on industries, it is recommended that if and when the cess is levied on industries in British India, the Government of India should invite all Indian States to levy a corresponding cess on industries within their respective jurisdictions for use on research in their respective spheres.

(45) The Railways representing the largest industrial and commercial organisation in the country should come in the proposed research organisation and utilise the facilities available in the proposed institutes and laboratories and universities. The Railways should also pay the proposed cess of one-sixteenth of one per cent on their gross earnings.

(46) The grants to the National Council should be of a non-lapsable character. It is recommended that at the end of ten years from the setting up of the organisation, the whole financial position should be reviewed.

(47) With a view to encourage the establishment of research associations by industries, changes in the Indian income-tax should be made on the lines of the latest amendment of the British Income-tax Act for giving relief both in respect of certain kinds of capital and recurring expenditure not permissible at present. Details of specific amendments are suggested.

(48) A suitable method should be evolved for the exploitation of patents in respect of invention made at either the national laboratories or universities and other research organisations that would be conducive to research at a high level and also ensure the development of resultant inventions in the best economic interests of the country. The present state of things in the matter is rather confused and complicated arising from the prevalence of diverse sets of rules of patent rights.

(49) There should be no absolute ban imposed upon universities and other academic bodies in the matter of taking out patents, but they should not regard patents as a source of revenue, nor allow research workers to be inspired by profit motive. Payment of extra remuneration may, however, be allowed in cases of meritorious work.

(50) The universities and even Government departments do not have the necessary organisation for dealing efficiently with the task of taking out patents and leasing out the same for commercial exploitation in the best economic interests of the country; nor is there any private

organisation in India on the model of Research Corporation Inc. of New York.

(51) It is recommended that a National Trust for Patents should be set up for the purpose of holding and exploiting all patents resulting from research financed by Government and those dedicated by individual scientists and by institutions supported either from public funds or private endowments. Having regard to the various parties and interests concerned, it is further recommended that the National Research Council which would be a representative body should undertake the functions of the National Trust and necessary powers should be vested in it.

(52) Steps should be taken for the compilation of an Abridgement of Patents in India for the guidance of research workers and also for facilitating the taking of patents.

(53) The prevailing practice of adopting British and American standards in toto is both unnecessary and undesirable in view of the difference in the climatic conditions and raw material resources of India, England and America. The setting up of Indian standard specifications is essential for the maximum use of the industrial resources of the country. Distinction between "Scientific" and "Industrial" standards explained.

(54) Characteristic features of the constitution and functions of the British and American National Bodies for Standardisation considered.

(55) In view of the advantages of unified control which the National Council would exercise over a number of laboratories including the National Physical Laboratory and also because the constitution of the National Council would ensure a fair representation of both consuming and producing interests, it is recommended that the National Research Council should undertake the task of organising a Board of Standards for drawing up Indian standard specifications and make necessary arrangements for allied research. The Board should include representatives of scientific organisations, industrial and trade associations and Government departments concerned and also individual technical experts. It should act as the policy framing body and the technical work involved should be entrusted to a number of technical committees and panels to be similarly constituted on a representative basis.

(56) The Government Test House at Alipore should be transferred to the Control of the National Research Council.

(57) Under the guidance of the Board of Standards the responsibility of administrative work is to devolve upon the Research Board and the staff will have to be strengthened for the purpose. The scheme is considered to be one that will ultimately pay itself from the sale of specifications.

(58) It is recommended that the National Council should as early as possible survey the needs of different regions for testing arrange-

ments as an aid to industry and export trade and examine how far such needs can be met by the establishment of testing laboratories on a zonal basis and by according recognition to approved private laboratories having the necessary equipment.

(59) As an essential aid to the development of industries it is recommended that the Government of India should establish at a central place a first class technological institute on the lines of Massachusetts Institute of Technology. Provincial Governments and major Indian States should also have at least one technological college or institute in their respective areas.

(60) It is recommended that when tariff protection is given to any industry the question of research facilities for that industry should be specially examined by the Tariff Board and the latter may enjoin, if necessary, the expenditure of a reasonable amount on research as a condition of the grant of protection.

(61) Public laboratories and university laboratories should be exempted from the payment of excise duty on their requirements of alcohol.

(62) Universities and public laboratories should be given preference in the matter of obtaining their requirements out of the surplus stock of laboratory and allied equipment available for disposal after the war and also in the matter of importing such requirements.

(63) A comprehensive register of persons qualified to conduct scientific and industrial research should be prepared and maintained and the task may be delegated to an agency like the National Institute of Sciences in India.

(64) It is difficult to draw a line between the different categories of research, viz., agricultural, medical and industrial, and it is necessary to marshal the different kinds of researches according to a comprehensive plan for the ultimate object of the furtherance of national welfare. The constitution of a Scientific Consultative Committee recently announced, in the Department of Development and Planning, with the Hon'ble Member as Chairman, is a move in the right direction. The possibility of bringing all the research activities of the various Government departments under the administrative control of the Member for Planning and Development should be examined.

(Sd.) SHANMUKHAM CHETTY (Chairman),
,, KASTURBHAI LALBHAI,
,, M. QURESHI,
,, S. S. SOKHEY,
,, J. J. GHANDY,
,, K. A. HAMIED.

(Sd.) J. N. SEN GUPTA (Secretary),
"Bombay House",

Bombay, 24th January, 1945.

I. A NOTE ON THE REPORT OF THE SCIENTIFIC AND INDUSTRIAL RESEARCH PLANNING COMMITTEE BY LT. COL., S. S. SOKHEY, I.M.S.

Gaps in the report.

The Committee specifically recommends (i) the building and equipment of National Chemical and Physical Laboratories; (ii) of certain specialised research institutes; (iii) giving grants-in-aid to universities; and (iv) training of a sufficient research personnel by the award of scholarships tenable in India and abroad. This enumeration might give the impression that the four activities are arranged in order of their importance. But that is not the case. This arrangement is purely fortuitous. The committee did not have time to consider the importance of these four activities in relation to each other and did not assign any priorities, nor did it indicate the stages by which the plan was to be fulfilled year by year over the indicated period of 5 years. If such an attempt had been made the committee might conceivably have come to the conclusion that the building of National Chemical and Physical Laboratories was to be undertaken in the fifth years when other things have been completed in the previous four years which would permit of National Laboratories being founded. A precise plan of that nature could have emerged only if the committee had been working to bring about an organisation which would achieve certain specified measurable objective ends, for example the production of given products in given quantities. The committee worked all the time in an atmosphere of unreality. It is possible to plan industry and industrial research together, but not separately. Research Institutions can be organised by themselves regardless of other things, but that would not be planning in any sense of the term. That Great Britain and U.S.A. are discussing the development of Industrial research as such is no argument. They are both highly developed industrial countries. India has scarcely any industries commensurate with her size and needs. India has still to make a start and that at this stage of world development when most countries have stolen a march over her of a century or so. To meet the situation we have to plan differently. However that was not what the committee was appointed to deal with, hence the vagueness about its recommendations.

Main Problem-producing scientific workers.

Even considering scientific and industrial research as such in an artificial and narrow sense, it is obvious that the main problem is that we must produce "highly trained personnel with first class scientific ability." Buildings and equipment are merely ancillary to this vital factor. We have plenty of talent in the country, but it is not trained. Trained men with real scientific ability are very few, and in any case totally inadequate for our needs. This lack cannot be made good by importing trained personnel from abroad. The numbers required would grow progressively large and no other country could afford to send first class workers in large numbers to India. Nor can it be met by hurriedly

sending abroad raw workers for periods of a year or two ; sojourn abroad is of value only to very mature workers. It cannot be denied that our universities are far too poorly provided at present to undertake worthwhile scientific training. But fortunately immediate and extensive improvement is possible. That in spite of these dreadful handicaps some departments of science are productive and that some men do become good scientific workers is a testimony to the innate talent of the people. But if we are to plan to put scientific research on a proper basis we must begin without delay with our universities, which "Constitute the foundation of all research," and set them on the way to produce able scientific men in steadily growing volume.

The corner stone then of our efforts to put scientific research in the country on a suitable basis is to make arrangements to produce able scientific workers in progressively growing numbers and the universities are the only organisation that can undertake this task. To turn out a worthwhile scientist, his training from the beginning should be good. You cannot bring up a child badly and then expect to make a gentleman of him by putting him in fine clothes and giving him a big house with lots of servants. So we must immediately attend to the development of the scientific departments of our universities and the first priority must go to this task. We should arrange in a period of 3 years to have represented in the Indian universities, taken together, all the various departments of scientific studies at a high level of excellence. It is not necessary for all universities to have all the departments but all the departments should be available somewhere or other in India, so that a student can undertake any scientific study somewhere in the country. The way to achieve this would be to carefully look into the existing scientific departments of the universities and pick out those that are excellent and can easily be developed further. Such departments should be made the first object of our attention. In addition to this, we would require to organise in the universities new departments of scientific studies which are lacking at present, such as, Genetics, Agriculture, Geology, Engineering, etc. To achieve this it will be necessary to call upon the heads of the selected university departments to submit plans for putting their departments on a high level of efficiency. To enable them to do this they should be asked to go abroad for a period of two to four months to see the corresponding departments in other parts of the world. In addition selected members of the staff of these departments should be sent abroad for periods varying from a year to 2 years to acquaint themselves with the research activities in other parts of the world. These men should be sent out in a manner so as not to unduly deplete the teaching resources of the departments concerned. Foreign awards in the form of scholarship will thus first go to the teaching members of the selected departments of the universities. This reorganisation of the University departments should be pushed through rapidly to bring

them to a high level of efficiency in as short a period as 3 years. The main report has already very carefully detailed the present handicaps from which the universities suffer and have indicated the manner in which the universities should be handled, so that their academic freedom is not interfered with. The only point to be stressed is that "efficient and progressive training is procurable only where original scientific activity is in progress." We must make all teaching scientific departments beehives of original scientific research activity.

National &
Specialised
Labora-
tories.

The problem of national laboratories and specialised research institutes requires to be carefully reconsidered in the light of the fact that it is the scientific workers who make the laboratory and not the buildings. It has also got to be borne in mind that India is a very large country, almost a continent and because of the large distances involved, single centralised laboratories may not suit the needs of the country. The tendency to slavishly imitate the English practice in these matters requires to be curbed. The problems of the two countries are totally different. In spite of these obvious factors which demand careful consideration before action is taken, I regret to have to state that even while this committee was gathering information and opinion of the leading men of the country and before it could make any recommendations plans were being made to build brand new buildings for all sorts of laboratories. Such unconsidered activity is certain to be the future of scientific development of the country a great deal of harm and I urge that some realistic appreciation of the problem and what can be done must be made before action is taken. Such consideration does not require to be unnecessarily delayed. In any case, the men required to man the laboratories must be found first, and they should have the greatest possible say in the matter of planning buildings and selecting equipment. Part-time odd men cannot plan to any purpose laboratories for others to work in. The task must be left to selected directors.

Our action must be guided by the inescapable fact that we haven't got sufficient number of able scientists. This limitation imposes a very definite line of approach to achieve results. We must decide what type of work we want to have carried out in the country and look for the likely persons who can do that work. Having found them, the next thing to do is to enlarge their present departments both with personnel and equipment, to enable them to take up the type of work we want to have carried out and go on enlarging their departments so long as they would bear enlargement. A stage will be reached in time when it would become necessary to build new buildings specially designed to house the now fully developed activities and the men who have done the work and gained a great deal of experience would be the men to design the new buildings. This line of approach brings to the forefront another aspect of the problems of national and specialised laboratories

i.e. their ultimate location. We must again remember that India is a very vast country and highly centralised laboratories would not meet the needs of the country. Prof. Bernal made a very good suggestion as to how best to meet the specific Indian problems in this respect. He suggested that each national laboratory should be split up into sections and each section should be built in different parts of the country in contiguity with other institutions of scientific activity of the locality. This is a very attractive idea and requires to be carefully considered. Similarly specialised research institutes should, in the beginning, be made part of and housed in the existing laboratories. These may, of course, require slight enlargement and modifications. But the need is to start the work and build new buildings only when the work is being carried on for a number of years, a great deal of experience has been obtained and the requirements of laboratory work fully worked out by actual experience.

As regards the use of scholarships to increase the scientific personnel in the country the committee had the opportunity of discussing this topic with the heads of universities and heads of scientific departments, of the various universities and have made very carefully considered recommendations on the subject. All the scientific workers consulted were unanimous that maximum benefit from the activity can be gained by endowing research scholarships mainly in India and that the number of scholarships so awarded year by year should progressively increase as the capacity of the university departments to train research scholars increases. The first year awards would be few, as the capacity of the various university departments is very small. But all felt that at least 500 scholarships should be awarded by the end of the 5th year. Taken in this light, the scholarships tenable abroad would have to be treated as a very special case. I have already indicated that the first awards should go to professors and other members of the staffs of selected scientific teaching departments of universities which are selected for immediate extensive development. In this category will be included other workers who may be called upon to start new departments of scientific studies which do not at present exist in India. Special consideration shall require to be given to engineering studies as no research institutes of engineering exist in India at all. In addition to the members of the teaching staff, we shall require to send men abroad for specific purposes and the way to do that would be to first make up our minds what particular scientific activity we want to have established and then find the likely men in the country who can undertake it, and form them into teams and determine exactly what duties will be assigned to each worker. On this basis, it is possible to find out in what particular manner his studies require to be oriented. Thus scholars would be sent abroad as teams for varying periods of time to fill in the gaps in their training. We would select the various universities the world over where that particular activity is being carried out at its best

Award of
Scholarships

and have our selected members of the terms admitted to them for specialised studies.

(Sd.) S. S. SOKHEY.

Foot note.—All through the world universities is meant to include all research institutes under public control.

2. NOTE OF PROF. SIR S.S. BHATNAGAR, O.B.E., D.Sc., F.R.S.,
DIRECTOR, SCIENTIFIC AND INDUSTRIAL RESEARCH.

I am in general agreement with Shanmukham Chetty Committee's Report. Much of the matter that is included in the report had been discussed and conclusions arrived at when we were in India but some of the recommendations were drawn up during our absence. Some of these I do not approve of at the present stage of our development ; for example, instead of having the executive work of the various boards, which will be set up, under three men ; I should like a separate executive officer for each of the Boards according to the plan suggested by Professor A. V. Hill. It is obvious that Departments do not generally like to part with power and if the Principal Executive Officers of all the various sections indicated in the Chetty Committee's Report are separately retained, it will be easier to give effect to the proposed centralisation of Scientific and industrial research in the country than if power is taken away from the heads of scientific departments and centralised in the hands of three individuals.

2. I favour the raising of funds in the matter suggested in the Chetty Committee's Report. This idea was approved of by all the scientific members of the Committee before they left for U.K. and U.S.A.

3. It will be desirable to co-ordinate the activities of the States and Provinces with the central organisation. But perhaps it is wiser for the time being to keep the States out. Some of the States, however, have already set up their Boards of Scientific and Industrial Research and are co-operating with us and an attempt should be made to maintain this liaison.

4. There are several remarks about pure and applied research and the state of development of various sciences ; for examples application of physics ; with which I do not quite agree. These remarks may be deleted from such a valuable document as they are likely to be controversial and difficult to substantiate. For example much of the work done by me is as much Physics as Chemistry and most processes are physico-chemical in nature. I should not like Physics to be excluded from credit for work of this type.

(Sd.) S. S. BHATNAGAR,

23rd May 1945.

3. NOTE OF DR. SIR J. C. GHOSE D. Sc., F. N. I.

I agree with the recommendations of the Industrial Research Planning Committee subject to the following note :—

1. The Committee have recommended the setting up of a National Research Council representing scientific, administrative and business interests for the control of scientific and Industrial Research and an executive body of three fulltime officers for the administration of the work vested in the Council. The idea of a National Research Council was first mooted in India in a Symposium held in Calcutta by the National Institute of Sciences in september 1943, and was further elaborated at a second symposium held in Delhi at the end of December 1943. This is an ideal arrangement which should be given effect to in near future. For the present, however, it appears more practicable to accept the recommendations of Prof. A. V. Hill (Scientific Research in India) and set up the following boards :—

1. The Medical Research Board,
2. The Agricultural Research Board,
3. The Industrial Research Board,
4. The Board of Surveys and Natural Resources,
5. The Engineering Research Board,
6. The War Research Board,

and coordinate their activities through the agency of a Scientific Consultative Committee.

2. I agree with the view that in the Research laboratories of the universities, considerations of profit accruing to a successful researcher should not be the incentive for work. The researcher there should concern himself mostly with fundamental problems, and any application of his results to industry should be to him of secondary consideration. His reward should principally be the eminence which his work secures for him in the scientific world. But a research worker in a laboratory intended primarily for the prosecution of industrial research cannot hope for such reward as only few publications are likely to result from such work. For the success of such laboratories, "the active prosecution of applied research should be willingly undertaken with the certain knowledge that the more energetically this duty is fulfilled, the less scientific prominence becomes attached to the workers themselves." Where the structure of society is such that profit motive does not enter into any human activity, the researcher may feel happy at the thought that the exploitation of his invention has benefited society as a whole, and that work is its own reward. But in a capitalistic society, nothing will be more disastrous for an applied research laboratory, than the feeling, that capitalists are picking the brains of research workers and are making their pile by exploiting their inventions, while they must remain content with their regular salary which is perhaps not even a

thousandth part of the market value of their inventions. The following extract from *Industrial Research* by F. Russell Bichowsky (Chem. Publishing Co. Brooklyn, N. Y. 1942) epitomises American expert opinion on this problem :

“ * * * “In the long run a satisfactory programme of handling personnel problems will make or break a research laboratory.

The first thing to see to is that the salary scale of the laboratory is not restricted by the general salary policies of the company. A chemist doing research is quite different than a chemist in the routine laboratory and it must be the policy of the company to allow pay scales based on the circumstances of the case, rather than in accord with so-called company general classifications. The easiest way to do this, as has been said, is to classify all research men, as research chemist, etc. But, it is promotions and special awards which wreck laboratories. A man who has made a valuable contribution to the wealth of the company, often in value many times the whole lifetime salary of the man, should be rewarded right than proportionately to the value of the invention, as soon as the value can be determined.

The usual system for doing this, payment of cash or company stock for every invention made, is hopelessly inadequate and unfair. Inventions differ in value. It is unfair to reward the nominal inventor disproportionately to the work of his associates. To do so puts too much emphasis on the first phase of invention and tends strongly to prevent team work, without which a laboratory cannot long prosper.

The best procedure of which I know is akin to the evaluation of patents, previously mentioned. This involves paying to the laboratory, for distribution among the personnel, a lump sum as a bonus in proportion to the wealth created. This is distributed so that all in the laboratory, even secretaries and janitors profit—those most responsible profiting proportionately. One procedure is to give to the group involved in the actual work one-third, one-third to the laboratory and one-third to administration to be distributed as it sees fit. Whether the actual payments are made in a lump sum or distributed over years is a detail.

All this is in addition to normal salary rises, promotions and general company bonuses. This procedure is more or less ideal, but based on the realities of the situation. Inventive work should be properly rewarded in a way proportionate to what one would have to pay for the invention if bought from outside companies.

The advantage of this is that it keeps before the laboratory personnel the incentive to invention, the danger being that the money so created by the laboratory be not fairly distributed. But this danger is present in every method of award, and there is no formula known to me by which one can tell just how, in a given case, to distribute salary or bonus.

There is however, the good old fashioned principle of award in proportion to merit. Distribute the bonus so that no one is omitted—even if he is not actually involved in the invention—that may not be his fault—it usually isn't. Distribute the major portion to those most actively contributing to the invention made and that may not include him whose name is on the patent. Pay due regard to the fact that departments of service, the analyst and test men are to be rewarded. They too contributed. But never forget that those few who really contributed the ideas, the force and the skill back of the successful product have earned a special proportion of the award.

It is the job of director, financial man and section chief to work this out in real fairness, so that the laboratory will work as a team, yet have the incentive to brilliant personal effort. If your director cannot do this fairly, fire him quickly before he breaks the spirit of the laboratory."

I would therefore plead that recommendation 6 in page 77 of the report should be so modified as to make it incumbent on the trustees to make *ex-gratia* payment to inventors, commensurate, with the value of work done. Such payment may be made optional only when by taxation, the income of a capitalist in India has been brought down to the same level as that of an able research worker.

(Sd.) J. C. GHOSH,
Member,

Industrial Research Planning Committee.

4. NOTE OF PROF. S. K. MITRA, D. Sc.

I generally agree with the recommendations made in the Report. I would, however, like to make the following remarks in connection with recommendation of the establishment of Research Institutes.

The principle on which the establishment of specialised research institutes is recommended has been set forth in para 39 of the Report. The principle briefly is that research institutes will be established for those industries only which are already developed in the country. Suggestions for provision of research for industries which though not yet developed, but for which there are natural resources in the country have also been made. The principle is evidently based on the idea of helping, by providing research facilities, only those industries which will be developing, as in the past, through private enterprise because they are of immediate profit. There are, however, industries for which, for various reasons sufficient private enterprise has not been forthcoming till now, but which are nevertheless of vital importance to any scheme of national planning for the general economic advancement of the country and for its defence.* Establishment of these industries and provision for

their research facilities are bound to be the concern of the Government of India engaged at present in post-war planning and development.

Amongst the industries in this category, the radio industry is of special importance and its development will be a major concern of the State. Its uses in fighting mass illiteracy through broadcasting, in the dissemination of information to the people, in the development of communication and the air transport system of the country and in the defence services are too well known to be emphasised. Government of countries with small population like Canada and Australia have already established radio industry and radio research institutes.

I am therefore of opinion that the Committee, in consideration of the above, should recommend the establishment of a research institute for radio. It should be remembered that the planning and establishment of an institute of this nature always take time. And for the case of the radio industry, the development of which in the immediate future through private and or state effort is certain, there ought not to be, for lack of foresight, any lag between the establishment of the industry and the establishment of the Research Institute.

I may mention in this connection that the Radio Research Committee with the approval of the Council of Scientific & Industrial Research is already engaged in drawing up a plan for a Central Radio Research Laboratory. It is estimated that the capital cost of the Institute will be about Rs. 5 lacs.

(Sd.) S. K. MITRA,

Member,

Industrial Research Planning Committee.

*In regard to the development of defence industries I may quote the following remarks by Lt. General Sir Henry Bredsford, (Head of the Expert Committee appointed by the Commander-in-Chief to make preliminary investigations on India's defence requirements after the war): "The development of war industries in future in India should go hand in hand with the growth and expansion of industries in general" (Press Statement, Calcutta, March 2, 1945).

ANNEXURE I.

QUESTIONNAIRE ISSUED BY THE COMMITTEE

A. *Questionnaire for Universities and Research Institutions :*

N. B.—All inquiries in this Questionnaire relate to Scientific and Industrial Research only.

1. Name of the University or Research Institute.
2. Address.....
Year of Establishment.....
Laboratories at.
3. State the field and character of your scientific and Industrial research activities—
 - (a) Fundamental or Basic Research.
 - (b) Applied Research.
 - (c) Testing and Consultation work.
 - (d) Additional activities.
4. What are the problems you are now working on? (Give brief information only).
5. What facilities (other than those employed for general teaching work) have you for research?
6. With reference to the research workers that you have in your university or institute (including members of the staff, research scholars, post-graduate students) will you give the following details?
 - (i) Name.
 - (ii) Age.
 - (iii) University qualification.
 - (iv) Years in which the degrees were taken.
 - (v) Details of publications, if any.
 - (vi) What are the various institutes in which the researcher has worked and the problems on which he has worked?
 - (vii) Details of practical experience in industry, if any.
7. Are you receiving any financial or material support for research work from :—
 - (a) Industries.
 - (b) Government.
 - (c) Other sources.If so, give particulars.
8. Do you collaborate with any industries for investigating their problems? If so, give details.
9. In what particular industries are you interested? Are you prepared to depute your staff for practical training in industries and also take industrial workers for "refresher" courses in your institution?
10. Have you any advisory bodies having representatives of the industries or of technical or professional associations to advise you on the training given at your schools or colleges?
11. What in your opinion should be the reasonable remuneration to be paid to research workers employed in universities and research

institutions? Give also your views on the question of raising the status of these research workers.

12. Are you prepared to carry out research work under a central authority who could plan and advise you on the type of work to be undertaken?

13. Are you prepared to conduct research on behalf of Research Associations, C. S. I. R. and/or take up Fellowship endowments.

14. Have you any suggestions for post-war scientific research (pure and applied) and the expansion of your activities?

What is the material and financial assistance you may require for this purpose?

If a grant is made, what contribution will your University or Institute make towards—

- (a) Equipment.
- (b) Personnel.
- (c) Recurring Expenditure.

15. Have you any pilot plant already in existence? If so, give full description of the plant.

16. What more pilot plants could be usefully located in your institute or region.

17. Please give information regarding the library facilities that you have in your university or institute. In particular please give—

(a) a list of all the scientific and technical journals which your university or institute is receiving.

(b) the list of back numbers with dates.

(c) the number of scientific and technical books on a subject basis, and

(d) a list of any special reference books that you may have.

B. Questionnaire for Industries.

N. B.—All inquiries in this Questionnaire relate to Scientific and Industrial Research only.

1. Name of the Company.
2. Address.
3. Nature of business (manufacturing, service, utility, consulting, etc.)

4. Laboratory and other facilities available for research.

5. (i) Name, designation and experience of Scientific and Technical executives engaged in research work:

- (a) Chemists.
- (b) Physicists.
- (c) Biologists and Bacteriologists.
- (d) Engineers of all categories, aeronautical, Electrical, Chemical, Civil, Mechanical, Mining, Radio, etc.
- (e) Metallurgists.
- (f) Geologists.

- (g) Agricultural Scientists.
 - (b) Medical Scientists (fully qualified).
 - (i) Veterinary Scientists.
 - (ii) Other technical staff engaged in research work not included above.
 - (iii) Administrative personnel, etc. in the research section.
6. What is the salary and status of the research staff in your Industry ?
7. Field of research activities (major or minor activities by subjects).
8. Character of research activities :
- (a) Fundamental or Basic.
 - (b) Applied.
 - (c) Testing and Control.
 - (d) Additional activities.
9. What is your annual budget for
- (a) Scientific Research Staff.
 - (b) Research Work.
10. Are you a member of any Research Association ? If so, give details and your contributions.
11. Are you prepared to offer facilities for university professors, research workers and students to work for stated periods in your industry and to send your staff for 'refresher' courses at universities or Research institutions ?
12. How do you select your superior staff and are you in touch with the universities where they are trained ?
13. Have you found any difficulty in finding qualified technologists ; if so, please specify instances with details.
14. Are you satisfied with the type of technical and scientific men you are getting from the universities, or other institutions ; If not, can you suggest any definite lines of improvements in their training ?
15. Have you any definite suggestions to make for collective research in your industry and for collaboration among inter-dependent industries ?
16. How do you keep abreast of the latest developments in your particular industry ?
- Are you in favour of the establishment of a Central Scientific Information Bureau for the collection and distribution of information on the latest researches pertaining to the various industries.
17. Have you any post-war research plans for the development of your industry ? If so, give the general outline.
18. Are you in favour of levying a cess on industry in order to meet the expenses of Industrial Research as it is done for the lac industry and jute industry ? If so, state whether in your opinion the cess should be on a voluntary or statutory basis ?

19. What is the assistance you are getting from Research Departments and from Government Services and have you met with any difficulties in this respect?

20. Have you any Pilot Plant? If so, give full description of the plant.

ANNEXURE II.

A. LIST OF UNIVERSITIES AND RESEARCH INSTITUTIONS TO WHOM THE QUESTIONNAIRE (A) WAS ISSUED

(1) UNIVERSITIES.

1. Allahabad.
2. Andhra.
3. Aligarh.
4. Agra.
5. Annamalai.
6. Benares.
7. Dacca.
8. Nagpur.
9. Osmania.
10. Patna.
11. Bombay.
12. Calcutta.
13. Delhi.
14. Lucknow.
15. Madras.
16. Mysore.
17. Punjab.
18. Travancore.
19. Utkal

(2) RESEARCH INSTITUTIONS, DEPARTMENTS OF GOVERNMENT, COLLEGES, ETC.

20. Forest Research Institute, Dehra Dun.
21. Director, Technological Laboratories, Indian Central Cotton Committee, Bombay.
22. Director, Technological Laboratories, Indian Central Jute Committee, Calcutta.
23. Director, Indian Lac Research Institute, Namkum, Ranchi.
24. Director, Harcourt Butler Technological Institute, Cawnpore.
25. Director, Imperial Institute of Sugar Technology, Cawnpore.
26. Director, Central Research Institute, Kasauli.
27. The Sericulturist, Sericultural Research Station, Kollegal.
28. The Principal, Indian School of Mines, Dhanbad.
29. The Superintendent, Kerala Soap Institute, Calicut.
30. The Superintendent, Government Central Weaving Institute, Benares.
31. The Superintendent, Govt. Central Textiles Inst. Cawnpore.
32. The Supdt., Govt. Silk Institute, Nathnagar, Bhagalpur.
33. The Leather Research Chemist, Leather Trades Institute, Madras.
34. The Metallurgical Inspector, Metallurgical Inspectorate, Tatanagar.

35. The Chief Engineer, All-India Radio, Research Section, Delhi.
36. The Principal, Bengal Tanning Institute, Calcutta.
37. The Director, Malaria Institute of India, Delhi.
38. The Director, Pasteur Institute, Shillong.
39. The Director, Pasteur Institute, Coonoor.
40. The Director, Biochemical Standardisation Laboratory, Calcutta.
41. The Director, Kings Institute, Guindy, Madras.
42. The Director, Nutrition Research Institute, Coonoor.
43. The Director, All-India Institute of Hygiene & Public Health, Calcutta.
44. The Director, School of Tropical Medicine, Calcutta,
45. The Director, Haffkine Institute, Bombay.
46. The Director, I. C. A. Research Institute, New Delhi.
47. The Director, Imperial Dairy Research Institute, Bangalore.
48. The Director, Imperial Veterinary Research Institute Izatnagar, Mukteswar.
49. The Director, Government Test House, Alipore, Calcutta.
50. The Director, Ordnance Laboratories, Cawnpore.
51. Industrial Chemist, Industrial Research Laboratories, Shahdara, Lahore.
52. Industrial Research Chemist, Government Industrial Research Laboratory, Hyderabad-Deccan.
53. The Director, Drug Research Laboratory, Jammu (Tawi).
54. Assistant Director & Officer-in-charge, Government Industrial and Testing Laboratory, Bangalore.
55. The Director, Deptt. of Geology & Mines in Mysore, Bangalore.
56. The General Manager, Government Porcelain Factory, Bangalore.
57. The Director of Public Health, Public Health Laboratory, Bangalore.
58. Industrial Chemist, Industrial Research Laboratory, Madras.
59. Industrial Chemist, Industrial Research Laboratory, Bombay.
60. Officer-in-Charge, Forest Research Laboratory, Malleswaram, Bangalore.
61. Industrial Chemist, Industrial Research Laboratory, Calcutta.
62. The Director of Agriculture, Laboratories of the Department of Agriculture Bangalore.
63. The Director, Survey of India, Mathematical Instruments Office.
64. The Director-General of Observatories, New Delhi.
65. The Director, Botanical Survey of India.
66. The Director, Zoological Survey of India.
67. The Director, Geological Survey of India.
68. The Secretary, War Transport Department, Government of India.
69. The Secretary, Posts & Air Department, Government of India.
70. The Secretary, Supply Department, Government of India.
71. The Principal, Victoria Jubilee Tech. Institute, Matunga, Bombay.
72. The Director, Research Institute, Ayurvedic & Unani Tibbi College, Delhi.
73. Dean of the Faculty of Science, University of Dacca.
74. Dean of the Faculty of Science, Muslim University, Aligarh.

75. Dean of the Faculty of Science, Lucknow University.
76. Head of the University Laboratories, Madras.
77. The Principal, College of Science & Technology, Travancore.
78. Head of the Deptt. of Mining & Metallurgy, Benares Hindu University.
79. The Principal, Engineering College, Benares.
80. The Principal, College of Technology, Benares.
81. The Principal, Science College, Madras.
82. The Principal, College of Science & Technology, Guntur.
83. The Principal, Medical College, Mysore.
84. The Principal, Engineering College, Bangalore.
85. The Principal, Central College, Bangalore.
86. The Principal, Presidency College, Madras.
87. The Principal, College of Engineering, Madras.
88. The Principal, Science College, Patna.
89. The Principal, Osmania Medical College, Hyderabad-Deccan.
90. The Director, Laxminarain Institute of Technology, Nagpur.
91. The Principal, Government College, Lahore.
92. The Principal, Punjab College of Engineering and Technology Lahore.
93. The Principal, Forman Christian College, Lahore.
94. The Director, Punjab University Institute of Chemistry, Lahore.
95. The Principal, Presidency College, Calcutta.
96. The Principal, Carmichael Medical, College, Calcutta.
97. The Principal, Medical College, Calcutta.
98. The Principal, Royal Institute of Science, Bombay.
99. Head of the Dept. of Chemical Technology, Bombay University.
100. The Principal, Engineering College, Osmania University.
101. The Principal, Medical College, Madras.
102. The Principal, Medical College, Vizagapatam.
103. The Principal, Lawley Institute, Coimbatore.
104. The Director, Indian Institute of Science, Bangalore.
105. The Director, Bose Institute, Calcutta.
106. The Secretary, Indian Association for the Cultivation of Science, Calcutta.
107. Principal, College of Engineering and Technology, Jadavpur, Calcutta.

B. LIST OF CHAMBERS OF COMMERCE & INDUSTRIAL ASSOCIATIONS, ETC. TO WHOM THE QUESTIONNAIRE (B) WAS ISSUED.

(1) COMMERCIAL & INDUSTRIAL BODIES.

1. Mysore Chamber of Commerce, Bangalore.
2. Punjab Chamber of Commerce, Delhi.
3. Federation of Indian Chambers of Commerce & Industry, New Delhi.
4. Gwalior Chamber of Commerce, Gwalior.
5. Madura-Ramnad Chamber of Commerce, Madura.
6. Buyers and Shippers Chamber, Karachi.
7. Marahatta Chamber of Commerce & Industries, Poona.
8. Hyderabad Chamber of Commerce & Industries, Secundrabad.
9. Karnatak Chamber of Commerce, Bagalkot.
10. Malabar Chamber of Commerce, Calicut.
11. Madras Chamber of Commerce, Madras.
12. Southern India Chamber of Commerce, Madras.
13. Andhra Chamber of Commerce, Madras.
14. Muslim Chamber of Commerce, Madras.

15. Coimbatore Chamber of Commerce, Coimbatore.
16. Indian Chamber of Commerce, Tuticorin.
17. Calicut Chamber of Commerce, Calicut.
18. Tuticorin Chamber of Commerce, Tuticorin.
19. Bombay Chamber of Commerce, Bombay.
20. Indian Merchants' Chamber, Bombay.
21. Maharashtra Chamber of Commerce, Bombay.
22. Marwadi Chamber of Commerce, Bombay.
23. Karachi Chamber of Commerce, Karachi.
24. Bengal Chamber of Commerce, Calcutta.
25. Bengal National Chamber of Commerce, Calcutta.
26. Indian Chamber of Commerce, Calcutta.
27. Marwari Chamber of Commerce, Calcutta.
28. Muslim Chamber of Commerce, Calcutta.
29. Associated Chamber of Commerce of India, Calcutta.
30. Upper India Chamber of Commerce, Cawnpore.
31. Merchants Chamber of United Provinces, Cawnpore.
32. United Provinces Chamber of Commerce, Cawnpore.
33. Indian Chamber of Commerce, Lahore.
34. Bihar and Orissa Chamber of Commerce, Patna.
35. Bihar and Orissa Muslim Chamber of Commerce, Patna.
36. Nagpur Chamber of Commerce, Nagpur.
37. Punjab Federation of Industries, Amritsar.
38. Bengal Industries Association, Stephen House, Calcutta.
39. All-India Soap Makers' Association, Calcutta.
40. Delhi Factory Owners Federation, New Delhi.
41. Bombay Millowners' Association, Bombay.
42. Ahmedabad Millowners' Association, Ahmedabad.
43. The Association of Indian Industries, Bombay.
44. The Pharmaceutical and Allied Manufacturers & Distributors Association, Bombay.
45. Karachi Indian Merchants' Association, Karachi.
46. Bengal Millowners' Association, Calcutta.
47. Indian Manufacturers' Association, Calcutta.
48. All-India Chemical Manufacturers' Association, Calcutta.
49. Associated Cements, Bombay.

N. B.—Six copies of the Questionnaire were sent to each of the Chambers and Associations with a request to forward these to such of their members as were actually engaged in research work or contemplated arranging facilities for scientific and industrial research.

(2) INDIVIDUAL FIRMS

1. Tata Chemicals Co., Ltd., Mithapur.
2. Tata Iron & Steel Co., Ltd., Jamshedpur.
3. Mysore Iron & Steel Works, Bhadravati.
4. Bengal Chemical & Pharmaceutical Works Ltd., Calcutta.
5. B. K. Paul & Co., Ltd., Calcutta.
6. Bengal Immunity Co. Laboratory, Calcutta.
7. Bengal Drug and Pharmaceutical Works, Ltd., Calcutta.
8. Smith Stanistreet & Co., Ltd., Calcutta.
9. Messrs. Bathgate & Co., Calcutta.
10. Cipla Laboratories, Bombay.
11. Standard Pharmaceutical Works, Ltd., Calcutta.
12. Alembic Chemical Works, Baroda.
13. Bird & Co., Ltd., Calcutta.
14. Birla Brothers Ltd., Calcutta.

15. Burma Shell Oil Storage & Distribution Co. of India, Karachi.
16. Lever Brothers (India) Ltd., Bombay.
17. Delhi Cloth Mills Chemical Works, Delhi.
18. The Calcutta Chemical Co., Ltd., Calcutta.
19. Mysore Chemical & Fertilisers (India) Ltd., Mysore.
20. Imperial Chemical Industries (India) Ltd., Calcutta.
21. Tata Oil Mills Co., Ltd., Bombay.
22. Associated Research Laboratories, Bombay.
23. D. Waldie & Co., Ltd., Calcutta.
24. Government Paints and Lacquers, Mysore.
25. Government Sandal Oil Factory, Mysore.
26. Parry & Co., Ltd., Madras.
27. Spencer & Co., Ltd., Madras.
28. Mysore Paper Mills Ltd., Bhadravati.
29. Swastik Oil Mills Ltd., Bombay.
30. Andhra Scientific Co., Masulipatam.
31. Messrs. P. Orr & Sons, Madras.
32. Messrs. Adair Dutt & Co., Calcutta.
33. Messrs. Hargolal & Sons, Ambala Cantt.
34. Model Industries, Dayalbagh.
35. Messrs. Scientific Instrument Co., Allahabad.
36. Messrs. Raj Der Karr & Co., Bombay.
37. Government Electric Factory, Bangalore.
38. Scientific and Industrial Co., Bangalore.

(3) DIRECTORS OF INDUSTRIES

1. The Director of Industries, Madras.
2. The Director of Industries, U. P.
3. The Director of Industries, C. P.
4. The Director of Industries, Bengal.
5. The Director of Industries, Punjab.
6. The Director of Industries, Bihar.
7. The Director of Industries, Mysore.
8. The Director of Industries, Hyderabad-Deccan.
9. The Director of Industries, Baroda.
10. The Director of Industries, Travancore.
11. The Director of Industries, Jammu and Kashmir.
12. The Director of Industries, Bombay.

ANNEXURE III.

LIST OF GENTLEMEN WHO APPEARED BEFORE THE COMMITTEE FOR DISCUSSION.

I. INDIAN STATES

A. Hyderabad (Deccan)—

1. The Hon'ble Mr. Ghulam Mohammed, C. I. E., Finance Minister, H. E. H. the Nizam's Government.
2. Lt. Col. E. W. Slaughter, C. B. E., Adviser to the Hon'ble Member, Commerce & Industries.
3. Nawab Mehdi Jung Bahadur, Secretary, Commerce & Industries Department.
4. Mr. Habibur Rehman, Director, Commerce & Industries Department.

5. Dr. K. Habib Hasan, Chief Chemist, Industrial Laboratory.
 6. Mr. Syed Kasim, Director of Mines & Geological Survey Department.
 7. Mr. Syed Arifuddin, Chief Engineer & Secretary, Irrigation Branch (Retd.) and other members of the Board of Scientific and Industrial Research, Hyderabad.
 8. Mr. Mahmood Yar Jung, Secretary, Post-War Planning & Development Deptt.
 9. Representative Industrialists in Hyderabad State.
- B. Baroda.—
1. The Hon'ble Sir V. T. Krishnamachari, Dewan, Baroda State.
 2. Representatives of Federation of Industries, Baroda State.
- C. Mysore.—
1. Mr. Viswanath, Director of Chemical and Engineering Industries, Mysore. } (Representatives of
 2. Dr. K. A. N. Rao, D. Sc., F. I. C., } Mysore Government)
 - Technical Secretary, Mysore Board }
of Scientific & Industrial Research. }
- D. Travancore.—
- Sir C. P. Ramaswami Iyer, K. C. S. I., Dewan, Travancore State.
- E. Gwalior.—
- The Hon'ble Sardar Mahadik, Commerce & Industries Minister, Gwalior State.
- F. Rampur.—
- The Hon'ble Mr. B. H. Zaidi, Chief Minister, Rampur State.

II. UNIVERSITIES

- A. Calcutta.—
1. Dr. Radha Binode Pal, D. L., Vice-Chancellor.
 2. Dr. S. P. Mookerjee, M. A., Ph.D., Bar-at-Law.
 3. Prof. P. N. Ghosh, Ph.D., Sc.D., F. N. I., Head of the Department of Physics, University College of Science.
 4. Dr. M.N. Goswami, Dr.-en-ch, Head of the Department of Applied Chemistry, University College of Science.
- B. Bombay.—
1. Lt. Col. Sir B. J. Wadia, M. A., Bar-at-Law, Vice-Chancellor.
 2. Dr. K. Venkataraman, D.Sc., Head of the Department of Chemical Technology, Bombay University.
- C. Madras.—
- Dr. Sir A. L. Mudaliar, M. D., LL.D., D.Sc., F. R. C. O. G., F. A. C. S., Vice-Chancellor.
- D. Annamalai.—
- Mr. M. Ruthnaswami, C. I. E., M. A., Bar-at-Law, Vice-Chancellor.
- E. Travancore.—
1. Mr. H. C. Papworth, O. B. E., M.A., Pro-Vice-Chancellor.

2. Dr. K. L. Moudgil, M. A., D. Sc., Principal & Director of Research, Travancore University, Trivandrum.

F. Andhra.—

- Dr. S. Bhagavantam, D.Sc., Principal, University College of Science, Guntur. (Representative of Andhra University).

G. Mysore.—

- Dr. S. Sanjeev Rao, D.Sc., Principal, Central College, (Representative of Mysore University).

H. Osmania.—

1. Hon'ble Dr. Nawab Sir Mehdi Yar Jung Bahadur, M. A. (Oxon.), LL.D., Vice-Chancellor.
2. Prof. Qazi Mohamad Husain, M. A., B.A., LL.B., (Cantab), Pro-Vice-Chancellor.

I. Dacca.—

1. Khan Bahadur Mohd. Hassan, M. A., B. L., D.Phil. (Oxon), Bar-at-Law, Vice-Chancellor.
2. Dr. J. K. Choudhury, Ph.D., (Berlin), Dean of the Faculty of Science.

J. Utkal.—

1. Prof. P. Parija, M. A. (Cantab), B. Sc., F. N. I., I. E. S., Vice-Chancellor.
2. Dr. H. B. Mahanti, D.Sc., Professor of Physics, Ravenshaw College.

K. Allahabad.—

- Prof. K. S. Krishnan, F. R. S., (Representative of Allahabad University).

L. Aligarh Muslim.—

- Dr. Md. Afzal Hussain Qadri, M. Sc., Ph.D. (Alig.), Ph.D. (Cantab), (Representative of Muslim University, Aligarh).

M. Delhi.—

1. Prof. D. S. Kothari, Ph.D., F. N. I., Head of the Department of Physics.
2. Dr. S. B. Dutt, D.Sc., Head of the Department of Chemistry. (Representatives of Delhi University).

N. Agra.—

- Rai Bahadur Dr. K. C. Mehta, M. Sc., Ph.D., Sc.D., Dean of the Faculty of Science. (Representative of Agra University).

III. GOVERNMENT OFFICIALS.

1. Brig. Woolfe, R. D. T., C. I. E., M.C., I. A., Controller-General of Inspection, M. G. O., Branch.
2. Mr. A. A. Waugh, C. S. I., C. I. E., I. C. S., Secretary, Supply Department.
3. Mr. G. C. Mitter, O. B. E., Chief Assayer, His Majesty's Mint, Bombay.
4. Dr. H. K. Sen, M.A., D. I. C., D. Sc., (Lond.), F. N. I., Director of Industries, Bihar.
5. Dr. P. N. Ghosh, Ph.D., and Dr. R. L. Dutta, D. Sc., Vice-Chairman and Secretary, Bengal Industrial Research Board.

6. Mr. K. Rama Pai, O. B. E., Controller of Patents and Designs, Calcutta.
7. Mr. J. J. Rudra, Principal, Engineering College, Madras.
8. Dr. A. H. Pandya, D. Sc., (Eng.), Principal, Bengal Engineering College (on deputation).
9. Sir Lakshmipat Misra, Member, Engineering, Railway Board.
10. Mr. W. A. Nightingale, Deputy Chief Controller, Standardisation (Mech.), Central Standards Office for Railways, Calcutta.

IV. SCIENTISTS AND REPRESENTATIVES OF RESEARCH INSTITUTIONS.

1. Prof. Sir C. V. Raman, F. R. S., N. L.,
2. Dr. J. D. Bernal, F. R. S.,
3. Prof. K. S. Krishnan, D. Sc., F. R. S.,
4. Prof. D. S. Kothari, Ph. D., F. N. I.
5. Dr. G. R. Paranjpe, D. Sc., I. E. S., Principal, Royal Institute of Science, Bombay.
6. Dr. D. M. Bose, D. Sc., Director, Bose Research Institute, Calcutta,
7. Mr. D. L. Sen, M. Sc., (Tech), (Manch), A. I. I. Sc., F. I. C., Off. Director, Cotton Technological Laboratory, Bombay.
8. Prof. Mata Prasad, D. Sc., Royal Institute of Science, Bombay.
9. Dr. L. C. Verman, Ph. D. M. S., F. Inst. P., Director (Physical Section), Delhi Laboratories, C. S. I. R.
10. Dr. S. Siddiqui, Ph. D., D. Phil. (Nat.), Director (Chemical Section), Delhi Laboratories, C. S. I. R.

V. SCIENTIFIC AND TECHNICAL SOCIETIES

- A. National Institute of Sciences.—
Prof. S. P. Agharkar, Ph. D., F. L. S., F. N. I., Secretary.
- B. Institute of Engineers (India).—
 1. Mr. S. N. Ghosh, M. I. E. (Ind.).
 2. Mr. J. Ganguly, M. I. E. (Ind.).

VI. CHAMBERS OF COMMERCE AND INDUSTRIAL ASSOCIATIONS

- A. Federation of Indian Chambers of Commerce & Industry.—
 1. Sir Badridas Goenka, C. I. E.,
 2. Mr. D. P. Khaitan.
 3. Lala Karam Chand Thapar.
 4. Mr. Satya Paul Virmani.
 5. Mr. M. A. Isphahani.
- B. Indian Merchants' Chamber, Bombay.—
 1. Mr. M. A. Master, Vice-President.
 2. Mr. C. S. Patel.
 3. Mr. P. T. John.
 4. Mr. S. L. Shah.
 5. Mr. J. K. Mehta.
- C. Bengal National Chamber of Commerce.—
 1. Mr. B. C. Ghosh, B. Sc., (Lond.)
 2. Mr. D. C. Ghosh.

D. Indian Chamber of Commerce, Calcutta.—

1. Mr. B. M. Birla.
2. Mr. K. D. Jalan.
3. Mr. M. L. Shah.
4. Dr. H. Ghosh.

E. Muslim Chamber of Commerce, Calcutta.—

1. Mr. M. A. Isphahani.
2. Dr. P. N. Bhaduri, M. Sc., Ph. D., D. Sc.
3. Mr. A. B. Chowdhury, B. Sc., A. M. Ch. E.
4. Mr. B. Hasan.
5. Mr. H. Mumtazuddin.

F. Southern India Chamber of Commerce, Madras.—

1. Mr. Yusuf Sait (President).
2. Rao Bahadur T. M. Rangachariar.
3. Mr. D. C. Kothari.
4. Mr. P. Raghavan Nair.

G. Andhra Chamber of Commerce.—

1. Mr. C. Sheshachalam (President)
2. Mr. T. V. Ettirajulu Chetty.
3. Mr. C. Anna Rao.
4. Mr. I. V. Ratnam.
5. Mr. J. Satyanarayan.

H. Committee of Mysore Chamber of Commerce.—

I. Representatives of Federation of Industries, Baroda.

J. Indian Jute Mills Association.—

Mr. M. P. Birla, Vice-Chairman, Indian Jute Mills Association Research Institute.

K. Indian Tea Association.—

1. Mr. H. C. Bannerman (Chairman).
2. Mr. A. Mo Zaren (Vice-Chairman).
3. Mr. P. J. Griffiths, C. I. E., M. L. A.

L. Representatives of Ahmedabad Mill Owners' Association.—

M. Committee of Indian Chemical Manufacturers' Assn., Calcutta.—

N. Indian Paper Mills Association, Calcutta.—

1. Mr. N. K. Bajoria.
2. Mr. G. P. Birla.
3. Mr. C. D. Thakkar.
4. Mr. P. Subramanyam.

O. All-India Manufacturers' Organisation, Bombay.—

1. Mr. Sankal Chand G. Shah.
2. Mr. S. N. Haji.
3. Mr. D. D. Deshpande.
4. Mr. M. P. Ghandi.
5. Mr. G. N. Bannerji.
6. Mr. P. L. Badami.

P. Indian Sugar Mills Association.—

1. Mr. R. L. Nopany.
2. Mr. K. C. Thapar.
3. Mr. F. D. Furman.
4. Mr. R. B. Tewari.

VII. INDUSTRIALISTS

1. Sir Ardeshir Dalal (Tata Iron & Steel Co., Ltd.)
2. Sir Shri Ram.
3. Rai Bahadur L. Maha Narain.

VIII. OTHERS

Mr. L. S. Davar, A.-M. I. E. (Ind.), Chartered Engineer and Patent Agent, Calcutta.

LIST OF GENTLEMEN WHO HAVE SUBMITTED WRITTEN NOTES OR MEMORANDA ON SPECIFIC SUBJECTS :

1. Sir Maurice Gwyer, K. C. S. I., K. C. B., D. C. L., Vice-Chancellor, Delhi University.
2. Sir S. Radhakrishnan, M. A., D. Litt., Vice-Chancellor, Benares Hindu University.
3. Dr. Sir S. S. Bhatnagar, O. B. E., F. R. S., Director of Scientific and Industrial Research.
4. The Hon'ble Mr. Ghulam Mohamed, C. I. E., Finance Minister, H. E. H. the Nizam's Government.
5. Prof. P. C. Mahalanobis, M. A., B. Sc., F. N. I., I. E. S., Chairman, Statistics Committee. C. S. I. R.
6. Mr. G. C. Mitter, O. B. E., Chief Assayer, His Majesty's Mint, Bombay.
7. Mr. N. N. Sen-Gupta, M. Sc., (L'pool), Director, Government Test House, Alipore.
8. Dr. K. N. Mathur, D. Sc., F. Inst. P, Assistant Director (Planning), National Physical Laboratory Scheme, C. S. I. R.
9. Mr. R. B. Pai, M. A., Patent Assistant, C. S. I. R.
10. Mr. B. N. Adarkar, M. A. (Cantab), Assistant Economic Adviser to Govt. of India.
11. Mr. M. V. Divatia, M. Sc., (Columbia), Statistical Officer, Industries & Civil Supplies Deptt., Government of India.

LIST OF GENTLEMEN WHO HAVE SUBMITTED ESTIMATES OF SCHEMES FOR SPECIALISED RESEARCH INSTITUTES :

A. National Chemical Laboratory.—

Dr. Sir S. S. Bhatnagar, O. B. E., D. Sc., F. R. S., Director of Scientific and Industrial Research.

B. Electro-Chemical Research Institute.—

1. Dr. Sir J. C. Ghosh, D. Sc., F. N. I., Director, Indian Institute of Scienc.
2. Dr. B. K. Ram Parshad. Chief Engineer, Mysore Jog Project.
3. Mr. P. B. Advani, Special Officer (Electric Grid), Bombay.

C. National Metallurgical Laboratory.—

Sir J. J. Ghandy, C. I. E., Agent, Messrs. Tata Iron & Steel Co., Ltd.

D. Plastics Institute.—

Dr. H. K. Sen, M. A., D. I. C., D. Sc., (Lond.), F. N. I., Director of Industries, Bihar.

E. Institute of Fermentation Technology.—

Dr. Sir J. C. Ghosh, D. Sc., F. N. I., Director, Indian Institute of Science.

F. Leather Research Institute.—

1. Rai Bahadur B. M. Das, Superintendent, Bengal Tanning Institute.
2. Mr. K. Sheshachalam Chowdhury, Leather Research Chemist, Leather Trades Institute, Madras.

G. Institute for the Designing & Fabrication of Industrial Plants.—

Dr. Sir J. C. Ghosh, D. Sc., F. N. I., Director, Indian Institute of Science.

H. Road Research Institute.—

Mr. G. M. McKelvie, I. S. E., Consulting Engineer to the Government of India.

I. Scheme for Cellulose Research.—

1. Registrar, Dacca university.
2. Mr. M.P. Bhargava Officer-in-Charge, Paper & Pulp Section, Forest Research Institute, Dehra Dun.

Places visited by the Committee.

1. Bombay.
2. Ahmedabad.
3. Baroda.
4. Hyderabad (Deccan).
5. Madras.
6. Delhi.
7. Bangalore.
8. Calcutta.

(Most of these were selected as centres where gentlemen from outside could conveniently meet the Committee).

ANNEXURE IV.

SURVEY OF EXISTING RESEARCH ORGANISATIONS.

The existing institutions in India conducting scientific and industrial research fall into four distinct categories: (1) Institutions established under Government auspices, (2) Government-aided institutions, (3) Research organisations of private industry, and (4) Universities. Since the scope of our survey is confined to the field of scientific and industrial research, we do not make any reference to Government institutes conducting research in agriculture, forestry, medicine and public health. In the following paragraphs, a rapid survey, based on replies to the Questionnaire and/or information available in published literature or from the records of the office of the Council of Scientific and Industrial Research, is made of the research activities of institutions engaged directly or indirectly in scientific and industrial research against the background of their respective organisations.

SECTION I

INSTITUTIONS ESTABLISHED UNDER GOVERNMENT
AUSPICES.

2. Among the institutes established under Government auspices the most important are: (1) The Imperial Institute of Sugar Technology at Cawnpore, (2) the Jute Technological Laboratory at Calcutta, (3) The Cotton Technological Laboratory at Matunga (Bombay), (4) The Indian Lac Research Institute at Ranchi, (5) the Harcourt Butler Technological Institute at Cawnpore, (6) The Kerala Soap Institute

at Calicut, (7) The Bengal Tanning Institute, and (8) the Madras Leather Trades Institute. In addition to these specialised institutes there are some important scientific departments and institutions maintained by the Government of India which include the Meteorological Department, the Scientific Surveys and the organisations for testing and standardisation. There are also the Council of Scientific and Industrial Research constituted by the Central Government and the Boards of Scientific and Industrial Research constituted by Provincial and State Governments. With regard to the institutes relating to sugar, jute, cotton and lac, the industrial and agricultural interests likely to benefit from these bear the expenditure which is met either by the direct levy of a cess, as in the case of lac and cotton or from central revenues to which such interests contribute in the form of export or excise duties, as in the case of jute and sugar.

3. The Imperial Institute of Sugar Technology at Cawnpore was established in 1936 as a result of the recommendations made by the Indian Sugar Committee of 1920 and the Tariff Board of 1930. It is under the administrative control of the Imperial Council of Agricultural Research. The expenditure of the Institute which is estimated at Rs. 3,66,200 (1944-45) is met by a contribution from the Sugar Excise Fund. The Institute has laboratories for research and instruction in sugar technology, sugar engineering and sugar chemistry (including organic chemistry, physical chemistry and biochemistry). It undertakes research on problems of sugar technology in general and those of the sugar factories in India in particular, utilisation of the by-products of the industry, the testing of new varieties of sugarcane under factory conditions and the general problems of sugar engineering and chemistry. To enable students to supplement the theoretical training given at the Institute with practical training and to provide necessary facilities for research work, a small experimental sugar factory has been attached to the Institute. The Institute also provides facilities for the training of students, in all branches of sugar technology and sugar engineering and for refresher courses for men already employed in the industry with a view to meeting the demands for specialised technical staff for working in Indian factories. Besides these activities, the Institute maintains a Bureau of Sugar Standards.

Imperial
Institute
of Sugar
Technology,
Cawnpore.

4. The existing staff of the Institute is considered to be very inadequate for carrying on applied research in close co-operation with the industry which ensures that problems in which the industry is directly interested are taken up, and also that the work is done in a commercial atmosphere and the commercial value of the results obtained can be assessed by the industry more readily under such conditions. A scheme for co-ordinated research and experimental work on problems arising in sugar factories was drawn up in 1939, but progress in this direction has been handicapped by inadequacy of staff for working simultaneously at a number of factories. "Moreover the demands for technical advice which are received from factories during the same period and have to be dealt with by the same staff have necessarily to be given priority over the demands for research work. As a result it generally becomes extremely difficult to render as much services to the industry as the Institute would like to give". In future, however, the condition is likely to improve as the Institute placed under the control of the newly formed Indian Central Sugar Cane Committee is expected to be brought by the latter into closer contact with the industry.

The Jute
Technological Laboratory,
Calcutta.

5. The Jute Technological Laboratory at Calcutta is under the administrative control of the Indian Central Jute Committee. The expenditure involved is met from the Government of India grant to the Indian Central Jute Committee. The investigations undertaken at the Technological Laboratory pertain mainly to the testing of the spinning qualities of samples of jute fibre with a view to finding out the connection between the various measurable characteristics of the fibre and its spinning quality. The main object of the investigations carried at this Laboratory is to find out the relative merits of the different qualities of jute fibre in order to help the trade on the one hand and to advise the Agricultural Departments of the Provincial Governments on the other, as to what steps should be taken to improve the qualities of jute. The work is designed to lead eventually to the grading and standardisation of jute on a scientific basis. In addition to these activities, the Jute Technological Laboratory is also interested in the utilisation of jute wastes.

Cotton
Technological Laboratory,
Matunga,
(Bombay.)

6. The Indian Central Cotton Committee maintains a well-equipped technological laboratory in Bombay and an Institute of Plant Industry at Indore. The two main objects of the Cotton Technological Laboratory, are (1) to test new strains and improved varieties for the Agricultural Departments, and (2) to study the relationship between the measurable characteristics of the cotton fibre and its spinning value. The first includes such work as furnishing the cotton breeder with authoritative report regarding the fibre properties and spinning value of particular varieties of cotton. The second object helps in accurately expressing the spinning variety of cotton in terms of its measurable characteristics and the results of fibre test on a representative sample of cotton to enable the breeder to decide whether to continue its cultivation or to discard it. Correct relationship formulae are derived at the laboratories after applying statistical analysis based on a sufficiently large number of results obtained under known conditions. These formulae are useful not only to the breeder but also to the spinner as they would enable him to adjudge the spinning value of any commercial variety.

Indian Lac
Research
Institute,
Rauchi.

7. Under the auspices of the Indian Lac Cess Committee research on different problems of lac is being carried out at the Indian Lac Research Institute, Ranchi. The expenditure of the Institute on lac research in India was little over Rs. 2 lakhs in 1941-42. Research work on lac is divided into three sections: Silviculture, Chemical and Entomological. The Silviculture and Entomological sections of the Institute have done valuable work on the possibilities of improvements in cultivation, the control of predators of lac insect, etc. The work in the Chemical section is largely concerned with the utilisation of lac and its by-products. Moulding powders for both compression and injection moulding, varnishes and lacquers, laminated boards of paper, jute, etc., baking enamels from refuse lac, and the development of adhesives are some of the prominent contributions of this section. The Institute does also basic researches in the physical and chemical properties of lac. The research organisation of the Lac Cess Committee embraces a Lac Research Laboratory at Edinburgh School of Mines working under the auspices of London Shellac Research Bureau and also at Brooklyn Institute of Technology, United States of America, which have been doing work in developing new uses of lac.

The
Harcourt
Butler
Technological
Institute.

8. The Harcourt Butler Technological Institute, Cawnpore (established in 1920 on the recommendation of the Indian Industrial Commission) is a research institute to which a post-graduate teaching section was added in 1921. The present budget of this Institute is about one lakh of rupees. The aims and objects of the Institute are

to provide a centre of technical research with a view to promote the industrial development of the United Provinces and also a recruiting centre for technologists qualified to occupy positions on the senior staff of some selected industries. The Institute has two sections, viz., (i) Oils and (ii) General Research. The Oils section undertakes technical research connected with oil and allied industries. During the war, the activities of this section have received a great stimulus for meeting special requirements relating to oil milling, refining and bleaching and deodorising of oils, hydrogenation of vegetable oils, soaps, pigments, paints, varnishes and lubricants, etc., The General Research Section deals with the problems connected with chemical industries other than oil, particularly relating to sugar and glass. The Institute provides short term courses in the allied subjects which have been of great assistance in the training of skilled personnel and labour.

9. The U. P. Government has also set up a Glass Technology section in the Department of Industries, which is in charge of a Glass Technologist. This section has as its objects the development of the glass industry and provides necessary technical and other guidance in the construction of complete factories, improvement of furnaces and equipment, introduction of new processes and manufacture. In addition to these activities, it conducts research both in pure and applied fields concerning glass.

10. This Institute was established in 1914-15 and is interested mainly in applied research relating to oils, fats and products manufactured therefrom such as soap and cosmetics. It also undertakes testing and consultation work in connection with essential oils, perfumes, insecticides and anti-malarial preparations. The research activities of the Institute are almost entirely financed by the Madras Government.

Kerala Soap
Institute.

11. The Bengal Tanning Institute is maintained by the Government of Bengal to help the development of the local tanning industry by conducting researches in different problems pertaining to it and also by training students to cater for its needs in respect of technical personnel. The experimental tanneries attached to the Institute have been of special value in discharging these functions. The researches conducted at the Institute are of two different types: (1) Fundamental and (2) Applied. Fundamental researches relate to the chemistry, bacteriology and microscopy of tanning, and applied researches to the manufacture of different varieties of commercial leather from Indian hides and skins. Research is also done for the manufacture of leather dressing and other materials used in the leather industry. The Institute does testing and consultation work, e.g., analysis of tanstuffs, chemicals and other materials used in the leather industry, and of leather. Schemes for tanneries, boot and shoe and leather goods factories are also prepared on requisitions. The Institute is under the administrative control of the Director of Industries, Bengal, and has an advisory board which includes members from the local tanning industry and hides and skins trade.

The Bengal
Tanning
Institute.

12. This Institute is provided with experimental tanneries where students are given training in semi-large scale operations. Along with training, it has also undertaken research work. Some of the important problems in which the Institute has been engaged relate to the utilisation of tannery by-products, investigation of suitable indigenous tannages as substitutes for imported wattle bark, manufacture of different varieties of leather, problems relating to insecticides, etc.

Leather
Trades
Institute,
Madras.

**Provincial
Industries
Departments
Laboratories**

13. It may be added in this connection that the departments of Industries in almost all the major Provinces, have laboratories placed under qualified Industrial Chemists, which cater to the research needs of the various minor industries. The primary concern of these laboratories is to undertake research on locally available raw materials with a view to their utilisation, undertake analytical work and also help in solving the day to day problems of the small industrialist.

**Meteorological
Department.**

14. A large number of observatories (about 500 in number) manned by part-time observers, who take daily a number of meteorological observations, form the ground-work of the organisation of this Department. The winds are studied by another network of upper-air observatories. A system of storm warnings and warnings for gales and other obstructive meteorological phenomena, the issue of aviation forecasts for routine flights all over the country are some of the "routine" daily activities of this Department. The large volumes of data collected are collated and conclusions regarding the structure of the atmosphere under different conditions, the characteristics of atmospheric disturbances like cyclones, etc., are arrived at. The Department has laboratories at Delhi and Poona for upper air meteorological work. A separate section of agricultural meteorology has been a recent and very useful adjunct to the Department in its contributions to microclimatology. In addition, the Solar Physics Observatory at Kodaikanal, the Magnetic and Electric and Seismological Observatories at Bombay make valuable contributions to the study of problems of more academic interest like the physics of the Sun, atmospheric electricity, terrestrial magnetism and the analysis of earthquakes. On the applied side, the Department is mainly self-sufficient and most of its instruments are manufactured in the departmental workshops.

**Scientific
Surveys.
(i) Survey
of India.**

15. The Great Trigonometrical Survey of India began in 1800 to provide a geodetic framework (a) to unify detached surveys and (b) to determine the Earth's dimensions. Chains of triangulation with some astronomical fixings and a network of precise levelling based on tidal observations were extended over the country. With the fulfilment of these original objectives, the necessity of a more detailed study of the Earth's figure was felt and the organisation to-day has a framework of gravity survey. The geodetic work done by the Department has disclosed widespread anomalies of gravitational attraction and has led to a reconsideration of the theory of isostasy. A Magnetic Survey was carried through after 1900. The scientific work of the Department includes the prediction and annual publication of tide tables for Indian Ocean ports. The geodetic framework of the Department forms a sound basis for irrigation and other projects and also for geophysical work, which contributes towards exploitation of India's mineral resources. Recently, a War Survey Research Institute has been formed which embraces the scientific work of the Geodetic Branch and is being expanded. The immediate object is to serve the war effort directly by introducing new observational methods and instruments of military survey, special projections, tidal predictions, etc., as well as the training of personnel in such matters; and, indirectly, by developing in collaboration with other interested organisations, the geophysical search for minerals.

16. Under the auspices of the Survey of India, the Mathematical Instrument Office was organised in 1830. In peace time, it is mainly concerned with the manufacture and repair of scientific instruments and apparatus for Central and Provincial Government Departments. Its activities are not concerned with research as such other experimental

work in regard to items of its production or in the manufacture of special apparatus for Government Departments. Since 1941, the Mathematical Instrument Office has been under the control of the Department of Survey and its activities have been concentrated on the production of optical instruments for the services. The particular section of the M. I. O. dealing with the repair of aircraft instruments has since been extended considerably with necessary steps taken for the equipment of the section for this class of work.

17. The Geological Survey of India was inaugurated in 1846 with a view to making a geological examination of the coal formations of India in order to provide accurate information on the mode of occurrence of the coal seams. By 1857 the activities of the Department included a systematic Geological Survey of India. These investigations have helped not only in preparing accurate geological maps but also in predicting to a certain extent the possible occurrence of new deposits. The results of mineralogical and petrographical surveys are confirmed by chemical investigations for a proper understanding of the quality of the mineral ores. The results obtained by the Department are published in three series of publications, Memoirs, Records and Palaeontologica Indica. Recently, a special branch of the Survey has been established, known as Mineral Utilisation Branch, intended to undertake exploratory work on mineral deposits for determining the feasibility of their commercial working. Besides these problems of a geological nature, the Department is also interested in the investigation of problems relating to flood control and drainage, earthquake damage, etc. Mention should, in this connection, be made of the Geological Department of Mysore, which in collaboration with the Geological Survey of India has done considerable work in the understanding of Archaen Rocks, which constitute the main body of the Peninsular shield and are the carriers of the principal ore deposits of the country.

(ii) Geological Survey.

18. The Botanical Survey of India, founded in 1889, consists of three sections: the Botanical Gardens, Cinchona and Quinine and the Indian Museum, each in charge of a Superintendent. The Botanical Survey like that of Geological Survey has got an academic and an economic aspect, and its activities have an important bearing on agricultural science and forestry. The general work of the Department consists of investigations and researches into the systematics, linology, distribution of plants, ecology and the economic botany of plant life.

(iii) Botanical Survey.

19. The Zoological and Anthropological sections of the Indian Museum were converted in 1916 into the Zoological Survey of India. The main functions of the Survey are to investigate the fauna of India and to preserve these sections in the Zoological and Anthropological galleries of the Indian Museum. In recent years as a result of fishery investigation carried out by the staff of the Zoological Survey of India, the Madras Fisheries Department and the Zoology Departments of some universities, notably those of Calcutta and Madras, considerable progress has been made regarding the bionomics and life history of several species of commercial importance.

(iv) Zoological Survey.

20. The institutions concerned with testing and standardisation comprise the following:—

- (i) Government Test House, Calcutta.
- (ii) Metallurgical Inspectorate, Tatanagar.
- (iii) Central Revenue control Laboratories, Delhi.
- (iv) Bio-Chemical Standardisation Laboratory, Calcutta.
- (v) Mathematical Instrument Office, Calcutta.

Organisations for Testing and Standardisation.

- (vi) Ordnance Laboratories, Cawnpore.
- (vii) The Indian Roads Congress.

The scope and functions of these are set forth briefly in Section VIII of the Report. In the present context, some special features of their organisation bearing on research are indicated. Although for most of these institutions testing and standardisation were the initial objective, research has been taking a place of increasing importance in the organisation of some of them as a development incidental to their main activity.

Bio-chemical
Standardisation
Laboratory.

21. This laboratory was organised in 1937 when its main objectives were commercial testing of drugs for manufacturers and dealers, preparation and maintenance of standards of strength, purity and quality of drugs and also the standardisation of the methods of analysis and tests with due regard to climatic and other conditions in different parts of India. Even so, research has, from the very outset, come to occupy an important place in its functions because in a laboratory of this type which set before itself the task of elaborating newer and more accurate methods of analysis and of modifying older and established methods of assay in the light of variations due to climatic and other factors, research work must necessarily be carried out side by side with the routine. In regard to this particular aspect of its activities, the Bio-chemical Standardisation Laboratory has been particularly assisted by its proximity to and intimate contact with the School of Tropical Medicine, Calcutta.

Ordnance
Laboratories
Cawnpore.

22. Prior to the war, the Ordnance Laboratories at Cawnpore which are under the administrative control of the War Department of the Government of India through the M.G.O. Branch, General Headquarters, had a very restricted scope and their main concern was to deal with chemical stores for routine testing and reporting on the samples supplied in response to Government contracts. The war has given a very great impetus to these laboratories by expanding their scope and has also led them to take up research as an important line of their activities. They are now engaged on a fairly extensive scale, in applied research on Ordnance General Stores and have well-equipped laboratories for Chemical (organic, inorganic and paints), Industrial (engineering and small tools), Textiles (cotton, woollen, silk and fibres) Lubricants and Fuels, Surgical Instruments, Parachute Components and Allied Equipment, Timber and Woodware, Biological (entomology, microbiology, zoology), Leather and Rubber. Research as such, now occupies a prominent position in the Biological, Engineering, Chemical, Lubricants and Fuel, Textiles and Medical and Surgical branches of the Laboratories. In the Biological branch research is directed to the identification of insects causing damage to materials and the study of the preventive and protective methods. The subjects of research in this branch cover insecticides, rot proofing, conservation of rubber stocks, indigenous antiseptics, indigenous gums, minor forest products, vegetable oils, fats and waxes. The problems tackled in the Engineering section include designing of various items of military stores like field cookers, development of small tool manufacture (particularly the heat treatment thereof) and substitution of non-critical metals in short supply. In the Chemical branch research is undertaken for the development of new chemicals, paints stores as well as chemically treated fabrics and anti-gas stores, particularly with the object of making up the deficiencies in the supply of many essential imported materials by utilising indigenous materials. The problems dealt with in the Lubricants and Fuels section include discovery of suitable indi-

genous substitutes for imported lubricants used in equipment of British and American manufacture, development of new types of hydraulic brake fluid, cleaning emulsions and corrosion preventives ; and use of vegetable oil blends in place of imported mineral oils. In the Textile branch research has been undertaken for the utilisation of various kinds of indigenous fabrics for the manufacture of important military stores. In the Timber branch research has been directed to the task of tackling various emergency problems particularly with reference to substitutes for metals and metallic containers. In the Medical and Surgical section useful research has been done in regard to the manufacture of certain surgical instruments, testing of Plaster of Paris and also in connection with certain kinds of glass ware and dental rubber.

23. The origin of this organisation is to be traced to the emergency created by the present world war which deprived many of the established industries in India of their usual supply of essential materials imported from abroad and also required development of many new ones in this country at a forced pace, in order to make India industrially self-sufficient and an effective source of war supplies. The need for a central research organisation was keenly felt for the attainment of these objectives and this led to the establishment of the Board of Scientific and Industrial Research by the Government in April 1940, as a part of the Department of Commerce. The then existing Industrial Intelligence and Research Bureau which was created in 1935 was kept in abeyance for the time being and its functions were eventually amalgamated with those of the Board. Shortly thereafter the Industrial Research Utilisation Committee was set up for advising the Government on the commercial utilisation of the processes evolved under the auspices of the Board. In April 1942, the Council of Scientific and Industrial Research was brought into existence as a registered body with a comprehensive scope and the Board of Scientific and Industrial Research and the Industrial Research Utilisation Committee were merged in the Council as its two Advisory Committees.

Council of
Scientific -
and Indus-
trial
Research.

24. The Council finances such schemes of research as are recommended by the Board, universities, research institutions and any other institutions having facilities for research on the subjects concerned. Besides, the laboratories of the Director of Scientific and Industrial Research at Delhi have been placed under the control of the Council since its inception. The scientific work of the Council is carried out through the Director and a number of Research Committees as stated hereunder :—

1. Glass and Refractories Committee.
2. Electro-Chemical Industries Committee.
3. Industrial Fermentation and Biological Products Committee.
4. Dye-stuffs Committee.
5. Fuel Research Committee.
6. Vegetable Oils Committee.
7. Cellulose Research Committee.
8. Heavy Chemicals and Chemical Industries Committee (Including Fertilisers and Salts).
9. Pharmaceuticals and Drugs Committee.
10. Plastics Committee.
11. Atmospheric Research Committee.
12. Essential Oils Committee.
13. Metals Committee.
14. Internal Combustion Engines Research Committee.
15. Distillation and other Chemical Plants Committee.
16. Applied Physics Committee.

17. Radio Research Committee.
18. Statistics, Standards and Quality Control Committee.
19. Leather Research Committee.
20. Building Research Committee.

25. The function of the Research Committees is to keep a watch over the progress of research schemes falling within their respective scope, formulating co-ordinated proposals for further work in their respective subjects and in general to assist the Council in ensuring that the grants made to them are carefully utilised so as to secure the best possible results. It has not, however, been possible till now for the various Research Committees to initiate research schemes on a planned basis and they have hitherto functioned more as expert bodies for examining the merits of specific schemes referred to them. The reason for this was that till now it was more the urgent problems of war importance than any systematic programme of research work that constituted the main preoccupation of the Council. Even so, the Council has not allowed itself to be deflected from the main ideal and during the short period of its existence it has done considerable work in formulating specific schemes for the establishment of five national laboratories comprising the National Chemical Laboratory, the National Physical Laboratory, the National Metallurgical Laboratory, the Fuel Research Station and the Glass and ceramic Research Institute, which have won the approval of the Government of India and a capital grant of Rs. I crore has been sanctioned for the purpose.

26. Apart from the schemes financed by the Council and worked in other institutions, work is being done in the laboratories under the Director of Scientific and Industrial Research which were originally set up at Calcutta and were shifted to Delhi in 1942. Here again the problems of immediate war importance have received special attention, many of the investigations being undertaken at the instance of and in collaboration with the Department of Supply, the Royal Air Force, the United States of America Air Force, the War Department and other Defence organisations of the Government. Since its inception the Council has also been offering facilities to some industrial firms for conducting at its laboratories certain researches of special interest to the latter on the basis of agreed financial contribution by the firms concerned. It would thus appear that although, chronologically, the Council of Scientific and Industrial Research is the youngest of all the institutions belonging to the various categories stated at the outset, it holds a unique position by the comprehensiveness of its functions and scope.

**Industrial
Research
Boards and
Committees
in Provinces
and States.
(i) Provinces**

27. Recently, in all the major Provinces and some of the larger Indian States, industrial research has gained stimulus from the establishment of Industrial Research Committees or Boards. For the inauguration of most of these, the initiative was taken by the Government of India early in 1941, when in pursuance of the conclusions reached at the Twelfth Industries Conference in favour of the establishment of local Research Committees in the Provinces and States to form a liaison with the Board of Scientific and Industrial Research the latter were moved by the Government of India to take early steps for setting up such committees. Prior to this stage, the only Provinces which had research organisations of this kind were Bengal and Bombay. A Provincial Research Board had been set up in Bengal in 1940 'inter alia' for advising the Industries Department in matters relating to industrial research which embraced co-ordination of existing work, indication of new lines of research, allotment of specific re-

searches to universities and technical institutions within the Province for obtaining the best results, examination and recommendation of research schemes and continuance thereof for sanction of grants. Later on, the scope was widened to form a liaison with the Central Board of Scientific and Industrial Research. The Provincial Board receives an annual grant of Rs. 35,000 and finances official and non-official organisations for conducting approved researches. The Government of Bombay had set up a local Committee for industrial research in January 1941 with objects almost identical with those of the Bengal Provincial Board. Like the Bengal Industrial Research Board, the Provincial Industrial Research Committee of Bombay has also formed liaison with the Board of Scientific and Industrial Research in the matter of bringing new research schemes considered to the notice of the central Board. It was, however, more in direct response to the move taken in the matter by the Government of India that Research Committees were brought into existence in the United Provinces, Bihar, Orissa, Madras, Central Provinces and Berar and the Punjab during 1941-42. The scope of the United Provinces Committee is practically confined to the original objective of establishing a contact between the Provincial and the Central organisations for the pooling of knowledge of research activities on both sides and avoidance of duplication. The Orissa Committee had also been set up with the same limited scope and so also the Research Committees of Bihar, Madras and the Punjab with this difference that the last three have been holding more frequent meetings for initial scrutiny of various research schemes received by them and recommending the approved ones to the Central Board (B. S. I. R.) for sanction of grants. The order relating to the establishment of the Madras Committee specifically provided that Committee was not intended to work independently of the Central Board nor was it intended that the provincial Government through its aid should finance local research. The Industrial Research Committee of the Central Provinces and Berar, established in March 1941, was organised with objects similar to those of the Bengal Provincial Board and the Bombay Committee. As, however, the Province has limited research facilities, the Committee has been working in close conjunction with the Board of Scientific and Industrial Research and the co-operation has resulted in the initiation of several researches with grants sanctioned by the Council of Scientific and Industrial Research for schemes recommended by the Provincial Committee.

28. Among the industrial research organisations of the Indian States, those set up in Hyderabad, Mysore, Travancore and Baroda deserve special mention. The Scientific and Industrial Research Board of Hyderabad was established in November 1941, with an initial grant of Rs. 25,000 for the promotion and development of industries in the State by fostering co-ordination between the industrial laboratory attached to the Department of Commerce and Industries of the State Government and other research laboratories within the State. The establishment of contact with the Board of Scientific and Industrial research of the Government of India was also one of its objectives. There are eight Research Committees attached to the State Board for dealing with researches relating to Industrial Fermentation, Pharmaceuticals and Drugs, Fuel, Forest Products, Ceramics, Fibre, Vegetable Oils and the Heavy Chemicals. Recently (August 1944) the H. E. H. the Nizam's Government has sanctioned Rs. 15 lakhs for the establishment of an industrial research institute in Hyderabad.

29. In Mysore also, as in Hyderabad, industrial research is being conducted on a planned and comprehensive basis. Till about the middle

(ii) Indian States.

of 1941, the organisation concerned with such research was the Industrial Research Sub-Committee of the Board of Industrial Research, which in May 1941 was reconstituted as the Board of Industrial Planning and Co-ordination whose main preoccupation, however, was to meet the wartime needs. By the end of 1942-43, the Board had ten Sub-Committees set up for the manufacture of Hydrated Lime, Magnesite Bricks, Graphite Electrodes, Plastics, Cement, Asbestos Sheets and Pipes, Abrasives, Cinchona, Sulphur, Bobbins and Parachute Cloth. The Planning and Co-ordination Board has been in regular contact with the Board of Scientific and Industrial Research of the Government of India. Towards the end of 1943, the Government of Mysore, considered it necessary to widen the scope of the Planning Board, particularly in the field of Industrial research and investigations in the State and with this object in view the Board of Industrial Planning and Co-ordination was reconstituted as the Board of Scientific and Industrial Research, Mysore. This is expected to strengthen the liaison with the Central Board.

30. The Travancore State has a Council of Scientific Research which is very intimately connected with the University of Travancore. The Dewan of the State who is the Vice-Chancellor of the Travancore University is the Chairman, and the Director of Researches in the University is the Vice-Chairman of the Research Council. The Council has set up four sub-committees for Engineering, Applied Physics, Applied Biology, Applied Chemistry and Preventive Medicine. Since its inception the Travancore Council has been in close contact with the Board of Scientific and Industrial Research in exchanging views on research schemes of common interest.

31. In Baroda, a Committee (Industrial Advisory Committee) was set up in 1941 with the two-fold object of functioning as a liaison committee to suggest research problems to the Board of Scientific and Industrial Research of the Government of India and advise the State Government on the Utilisation of successful research processes, and also for acting as an advisory committee to the State Government in matters of researches undertaken by the State Department of Industries in the Science Institute and other institutions in the State.

SECTION II

GOVERNMENT-AIDED INSTITUTIONS

32. In the organisational set up of scientific and industrial research in India, a prominent place is now occupied by three non-official institutions receiving Government grants, viz., the Indian Association for the Cultivation of Science, the Bose Research Institute, Calcutta and the Indian Institute of Science, Bangalore.

Indian
Association
for the
Cultivation
of Science.

33. The oldest among these is the Indian Association for the Cultivation of Science which was founded in 1876 as an institution for the advancement of science by means of public lectures and special lectures given in the various sciences to supplement the normal college courses. It has since become one of the foremost centres of research in India and has well-equipped laboratories for researches in Scattering of Light, Spectroscopy, X-rays, Magnetism and Electro and Magneto Optics.

Bose
Research
Institute.

34. The Bose Research Institute, named after the founder Sir J. C. Bose was inaugurated in 1917 for the purpose of post-graduate research in physical and physiological subjects. The scope of the work

of its various departments has considerably increased and these now comprise Departments of Plant and Animal Physiology, Bio-physics and Electro-physiology, Bio-chemistry, Anthropology and Racial Biology, etc. The Institute has a separate department for the construction of apparatus of an exceptionally high order of sensitivity required for the special purpose of research.

35. The Indian Institute of Science, Bangalore, owes its origin to the munificence of the late Mr. J. N. Tata together with the handsome donation made by the Mysore Government and the Central Government. The Institute was founded in 1911 with the object of offering facilities for advanced study and original research in various branches of sciences and to-day consists of Departments of General and Applied Chemistry, Organic Chemistry, Bio-chemistry, Electrical and Communication Engineering, Aeronautical Engineering, Physics and a Cosmic Ray Research Unit. The war has given a great filip, as it did to many other research institutions, to the Institute's activities in the applied science departments, and the work that has been done in the Institute during the last few years, both in pure and applied sciences, is given in the following Annexure on the review of researches in India.

Indian
Institute
of Science.

SECTION III

ORGANISATION OF RESEARCH BY INDUSTRIAL FIRMS

36. Unlike the institutions dealt with in the other two sections of this Survey, the organisation of research by industrial firms in India is a matter of comparatively recent growth and many of the firms still regard it as a secret part of their organisation and as such the information furnished by them in response to the questionnaire issued by the committee is rather meagre. In the first place, the replies received present a small percentage of the total number of questionnaire issued; and, secondly, except in the case of a few, their contents are found to be lacking in many essential details. Among the replies received, there are altogether 58 which provide some useful information and their numerical distribution under important categories of industries is shown as follows :—

(i) Chemical and Allied Industries	29
(ii) Metal Industries	3
(iii) Scientific Instruments	3
(iv) Paper Industry	2
(v) Sugar Industry	3
(vi) Textiles (Cotton, Jute & Silk)	4
(vii) Porcelain, Glass and Enamel	2
(viii) Miscellaneous (Leather, Batteries, Vegetable Oil, etc.)	12
	58

37. In addition replies have been received from the Indian Jute Mills Association, the Indian Tea Association, the Indian Mining Association and the Associated Cement Companies, Ltd., furnishing some general information about the research activities of the respective industries. It is interesting to note that 50 % of the replies have come from chemical and allied industries. The number received from such major industries as paper, sugar and cotton mills has been extremely meagre while none has been received from such industries as engineering and mineral industries (other than coal). Even among metal

industries there are only two replies received from manufacturers of iron and steel (Tata Iron and Steel Co., Ltd., and the Mysore Iron and Steel Works) and another received from producers of copper (Indian Copper Corporation, Ltd.).

38. The reason for the paucity of replies received from the major industries may be that research as such does not yet constitute an important concern of most of the major industries. Some are pursuing only the standard technique of manufacture and have not yet interested themselves in the exploitation of the by-products which call for research, while for some of the other important Industries, the necessary research work is being conducted in centralised research institutes, organised by Government. Among other major industries, the problems of these making use of timber and bamboo as their basic material *e.g.* paper, are being tackled at the Forest Research Institute, Dehra Dun. The laboratories of the Departments of Industries in the provinces are also rendering some help to the various minor industries which do not have the resources for taking up any research on their own. These circumstances provide an explanation why the replies have been received from a very limited number of industries.

39. Regarding the contents of the replies it is a matter of regret that those received from firms which are resourceful enough and have years of experience behind them were found to be surprisingly brief and very general in character and therefore of very little help in the Committee's investigation. Many of them have their central research organisations abroad and rely on the research work of their parent firms. It is not known whether the reticence of these firms is due to their anxiety for continuing the present arrangements and a reluctance for affording support to the various progressive measures envisaged in the questionnaire.

40. In the circumstances stated in the foregoing paragraphs the task of scrutinising the replies naturally involved some difficulties. The paucity of the number of replies was itself a handicap and provided a contrast to the number of cases recently examined (October 1943) by the Federation of British Industries Research Committee who had the opportunity of examining statements relating to about 500 firms of standing and yet found them inadequate except for indicating some general tendencies on the basis of the total number of research workers employed in the various firms and the total amount of their expenditure on research and development. The response to our questionnaire has, however, one redeeming feature in that the firms that have sent in replies include some of the pre-eminent concerns in their respective lines of manufacture. Despite the numerical handicap, an analysis of the replies actually received reveals certain relevant facts from which it is possible to draw some important conclusions relating to the research organisation of our industries and the present condition of their development. These are examined below under several heads.

1. Chemicals and Allied Industries.

41. Taking the chemical and allied industries first, it is found that their field of research activities covers mostly organic and inorganic chemistry and biological preparations; most of the concerns are engaged in the manufacture of fine chemicals, medicines, synthetic drugs, biological products, etc. There are a few firms such as Tata Chemicals, Ltd., Pioneer Magnesia Works and the Bengal Chemical and Pharmaceutical Works Ltd., who manufacture heavy chemicals, while some of them are specially interested in the development of coal tar products. One in the Mysore State is engaged in the manufacture of chemicals

and fertilisers. Few of these, whether big or small, are interested in fundamental research. As a rule their laboratory activities are confined to applied research and testing in relation to their respective manufacture of chemical products.

Field of
Research
Activities.

42. Regarding their expenditure on research, most of the smaller factories do not make any special provision in their annual budget on this account which indicates that research has not yet come to occupy its deserved position of importance in their programme of activities. Indeed, in some cases the staff doing routine work is relieved for doing research, as and when necessary. Only in one case (The Alpha Chemicals Ltd., Poona) the expenditure on research staff and research work is correlated to the value of the annual production of the firm on a percentage basis (1% for research staff and 2% for research work). A firm in Bombay (CIPLA) states that out of its total expenditure of about Rs. 8 lakhs as provided in its latest annual budget, roughly Rs. 1 lakh is for experimentation and research purposes. Among the rest of the firms that have furnished specific figures, only eight are found to be spending a total amount of more than Rs. 25,000 per annum as shown hereunder :

Expenditure
on Research

Name.	Research Staff Rs.	Research Work Rs.	Other Allied Expenditure Rs.
1. Alembic Chemicals	48,270	18,135	
2. D. C. M. Chemical Works	24,000	80,000	
3. Bengal Chemical	30,000 to 40,000		
4. Raj-der-kar & Co.	18,000	8,000	
5. Shalimar Tar Products	18,000	15,000	6,768
6. Bathgate & Co.		40,000	
7. Standard Pharmaceutical Works	25,000	25,000	
8. The Mysore Chemical & Fertilisers, Ltd.	35,000	25,000	

The Pioneer Magnesia Works spend about Rs. 16,000 (Rs. 10,000 for staff and Rs. 6,000 for research work). The Research expenditure of the remaining firms is less than Rs. 10,000 per annum.

43. It appears from the 29 replies received from chemical firms that only eight of them have necessary pilot plant facilities as detailed hereunder.

Pilot Plant
Facilities.

Name of the firm	Chemicals for which Pilot Plants have been set up.
1. Alembic Chemicals, Baroda.	(a) Vegetable Oil refining and Hydrogenation. (b) Chloral Hydrate. (c) Ethyl Chloride. (d) Methyl Chloride. (e) Caffeine. (f) Ephedrine.
2. CIPLA, Bombay.	(a) Alkaloids. (b) Lactic Acid. (c) Nikethamide. (d) Nicotonic Acid.

3. Indian Turpentine and Rosin Co., Bareilly. Turpentine (a small still with a boiler and condenser).
4. Bengal Chemical, Calcutta (engaged in the manufacture of (i) mineral acids, fine and heavy chemicals, (ii) pharmaceutical drugs, biological sera, and vaccine, and (iii) scientific instruments.) Pilot plants are designed by the firm itself.
5. Pioneer Magnesia Works, Bombay. (a) Improvement of Anhydrous Calcium Chloride.
(b) Bromine and Bromide Compounds.
(c) Improvement of Calcium Carbonate.
(d) Recovery of Basic Magnesia from by-products of Calcium Chloride.
(e) Manufacture and improvement of Barium Compounds.
6. Raj-der-kar & Co., Bombay. Formaldehyde from Methyl Alcohol.
7. Phoenix Chemical Works, Bombay (interested in the manufacture of aluminium stearate, preparation of wetting out agents, penetrants, emulsifiers, etc.) Pilot plants are set up as and when required from necessary unit processes machines available for use in a particular combination such as Autoclave, Still, Filtr Press, Centrifuge Blower, Electrolysis Apparatus a low voltage Dynamo, a Refrigerator, etc.
8. The Mysore Chemicals and Fertilisers, Ltd. Pilot plants are available for manufacturing Ammonium Carbonate, Ferric Chloride and Chloramine T.

The Shalimar Tar Products, Ltd., has also necessary pilot plant facilities for coal tar distillation and refining, of which, however, the details have not been furnished. The D. C. M. Chemical Works, Delhi, have their plants in process of erection and the Tata Chemicals Ltd., has such plans under contemplation in connection with the developments of new lines, on a large scale, in future.

- II. Jute. 44. In respect of jute, the Indian Jute Mills Association has set up a well-equipped technological laboratory. It deals mainly with problems relating to the manufacture of jute goods,—and this distinguishes it from the present functions of the Government Jute Technological Laboratory,—and the benefit of the results of investigations conducted in this laboratory goes to all the constituents of the Association. This laboratory, organised and financed by the industry itself, has taken up all kinds of research, fundamental and applied (with reference to cellulose, textile and jute in particular), testing and control and is also interested in investigations relating to designing large scale plants, development and operation, economies, etc.. The laboratory has the

necessary resources for manufacturing and installing pilot plants according to requirements. The expenditure involved in running the laboratory (known as the Indian Jute Mills Association Research Institute) in 1943 was Rs. 2,25,000 approximately.

45. In the iron and steel industry, it appears from the reply received from the Tata Iron and Steel Co., Ltd., that in its organisation research is now assigned a place of very great importance, judged by the nature and variety of investigations undertaken or the total amount of expenditure involved. The researches undertaken at the laboratories of this company are related not only to metallurgical problems such as the exploration of the possibilities of developing new steels, study of the influence of alloying elements on the physical and micro-characteristics of steel, manufacture and heat treatment of various types of steel not previously made in India, manufacture of ferro alloys, etc., but also numerous allied chemical problems such as calorimetric and micro-analysis, general beneficiation of ores and other minerals and properties of industrial fuel. The research activities of the firm extend also to physical problems such as spectro-chemical analysis of metals and various other problems relating to development and manufacture of refractories used in the iron and steel industry from Indian raw materials. The investigations also include such geological problems as the prospecting of new ore deposits and raw materials used in iron and steel manufacture.

III. Iron
and Steel

46. The impressive variety and resources of the research activities of the firm are fully reflected in its pilot plant equipments which include the following :—

- (a) Vanadium extraction plant (in course of construction).
- (b) Ferro alloy vertical arc reduction furnace.
- (c) Refractory brick manufacture.
- (d) Welding electric plant.
- (e) Coal washing plant.
- (f) Iron ore washing plant.

47. Besides, the following pilot plants are worked by the firm under the auspices of the Coal Blending and Coking Research Sub-Committee, B.S.I.R.—

- (g) One electric coke oven with arrangements for measuring swelling pressure.
- (h) One gas fired pilot coke oven with arrangement for measuring swelling pressure (as used by Midland Coke Research Committee, England).

48. The firm has given in its reply the following interesting details of its annual expenditure on research staff and research work :—

	Total expenses on Technical Services (1942-43)	Approximate expenses on Research 1942-43 (roughly estimated).
1. Chemical Lab.	3,30,400 at 2½%	8,260
2. Met. Dept. (excluding inspection & Phy. Lab.)	1,69,800	1,69,800
3. Physical Lab.	80,000 at 5%	4,000
4. Energy & Economy	1,18,000 at 10%	11,800
5. Prospecting Deptt. (excluding chem. analysis)	1,19,000	1,19,000
6. Refractories	24,000	24,000

7. Research Account	7,400	7,400
8. Co's contribution to Coal Blending & Coking Research Committee, B.S.I.R.		26,000
	8,49,000	3,70,000

Note :—The above figures are for recurring expenditure and do not include that on capital account.

49. The research work undertaken at the Mysore Iron and Steel Works is on a moderate scale, being in fact confined to a chemical laboratory (organic and inorganic). It has not been developed yet to include metallurgical research. There is no special staff employed for research work. Regular operatives take up research work in addition to their routine duties in the subjects of special interest to them. A sum of Rs. 25,000 to Rs. 75,000 per year is provided in its budget for research work.

IV. Tea.

50. The Indian Tea Association maintains a research organisation known as 'Tocklai Experimental Station' at Cinnamara (Assam). Its field of research activities relates to tea biology including particularly genetics, plant physiology, plant pathology (mycological and entomological) and agriculture. The research is mainly of an applied character, but advice is given to tea companies in respect of testing and control. The Station has laboratory facilities for bacteriological, botanical, chemical, entomological and mycological researches; its research activities also extend to agricultural field and experimental areas. The annual budget for scientific research staff is Rs. 3,50,000 approximately and about Rs. 1,10,000 for research work.

V. Other Industries.

51. In respect of industries other than chemical, jute, iron & steel and tea it appears from a scrutiny of the replies that research has not yet established itself as a feature of comparable importance in their respective organisations. In regard to coal mines, the reply of the Indian Mining Association states that apart from the chemical and physical laboratories installed by the large coke producing plants, some of the collieries also have set up laboratories for fuel research. It is stated that the total expenditure involved runs into many lakhs of rupees if the Tata Iron & Steel Company's laboratory is included. The Association, however, has not organised any laboratory for the benefit of its constitutions, as in the case of jute. The reply of the Associated Cement Companies Ltd., likewise makes a general statement that each of the 13 factories comprised in the organisation is equipped with a laboratory and that while the main concern of these laboratories is applied research, testing and control, they are also interested in fundamental research to some extent. The reply adds that the organisation of a central research laboratory is under the active consideration of the combine.

Selection of Superior Technical Staff.

52. As a rule, industrial firms in India follow the practice of selecting their superior staff by advertisement and interview. Recommendations and qualifications are given due weight. In a few cases, the recruitment is made for a period of apprenticeship training for appointment in due course. One British firm states that its superior staff is recruited in England through its London Agents, although in recent years opportunities are also being given to graduates of Indian universities possessing necessary qualifications. The research staff

of the Indian Tea Association is entirely non-Indian and is recruited in Great Britain through a scientific committee of the Indian Tea Association, London. Among the Indian firms, the Tata Iron & Steel Co., Ltd., drafts foreign experts from time to time for highly specialised lines for which suitable men are not locally available, but it is stated that their number has been steadily falling off. It is urged that the firm offers all possible opportunities to Indians and that even in cases where foreign experts are appointed, Indians are given such training in the particular lines as may eventually qualify them to take their place.

53. The Industrial firms rarely seek the assistance of the universities in the matter of selecting their technical staff. There are a few exceptions, mostly belonging to the category of chemical industries; but the replies do not indicate whether their contacts with the universities in the matter have anything more than purely local significance. Unfortunately, the replies relating to this particular subject do not clearly indicate whether these apply to the recruitment of the research staff as such or of the whole technical personnel of the industrial firms. In most cases, the replies seem to apply to both. In the matter of getting suitable men for research no special difficulties are urged by any, except by one of the eminent chemical firms which states that it has had considerable difficulties in finding qualified technologists experienced in actual research work. There is, however, no indication given of the specific lines of research for which the firm has been looking for expert research staff.

54. In regard to the general technical personnel there is an almost universal complaint that the scientists coming out fresh from the universities are much too academic in their training and outlook to be of any immediate help to industries. Some of the firms have suggested that the training given in the universities may be suitably modified and changes made in the curriculum. They also urge the equipment of university laboratories with up-to-date appliance and the establishment of more intimate contact between scientists employed in industrial concerns and the university departments for training of research workers. In this connection, some of the firms have reported their difficulties in getting the right type of chemical engineers and bacteriologists and also suitable men for the manufacture of specific chemicals such as aniline, phosphorus, acetic acid, coal-tar distillation products, etc.

55. The majority of the firms from whom replies have been received are not members of any research associations. This is to be attributed not so much to the individualistic tendencies of the firms as to the paucity of industrial associations in India that have taken up research as a part of their organised activities. Almost all the major industries in India comprising cotton, jute, coal, sugar, tea, chemicals, paper and cement have their respective associations but these with the exception of a few have been set up particularly to deal with problems of production and marketing. As already pointed out, organised research for the benefit of the industry as a whole has been initiated so far only by the Indian Jute Mills Association and the Indian Tea Association on an appreciable scale by setting up research institutes of their own. A welcome move in this direction has recently been taken also by the Bombay Cotton Mill Owners' Association by donating a sum of Rs. 3½ lakhs to the University Department of Chemical Technology for developing lines of research in which the mills are interested. Most of the other major industries have not yet so

Research
Associations

far evinced similar interest in organising research through their respective associations. The sugar industry urges that it is much too heavily taxed for undertaking corporate research on a large scale while the chemical manufacturers contend that their financial position has not been strong enough and their post-war prospects remain very uncertain for encouraging immediate adoption of any expensive scheme of corporate research. It is, however, interesting to note in this connection that the potential benefit of such research is gaining recognition among the planting interests in India. At the recent annual meeting (August 1944) of the United Planters Association of Southern India, the President strongly put forward a plea for the unification of research in tea, coffee, rubber and cardamom and observed that while under such a scheme the extension work would be undertaken at sub-stations on account of the variety of climates and elevations, the proposed central organisation might take up the directive work and also the task of collecting, correlating and issuing information.

56. Among the medium-sized industries of the country, associations have been started in particular provinces by a number of these of which particular mention may be made of soap and glass. These associations have, however, very inadequate financial resources which have, not only retarded their growth but have also made it difficult for them to set up any research organisations, although the paramount necessity of research with a view to consolidating the position of these industries by increasing their productive efficiency (whether by improved technique or utilisation of by-products) have gained almost universal recognition.

57. A scrutiny of the replies received reveals that the major firms in this country interested in manufacture of paper and iron and steel have been getting, in some instances, the benefit of the help and guidance of research associations set up in foreign countries, particularly the United Kingdom and the United States of America. The Mysore Paper Mills and the Upper India Couper Paper Mills state that they are corporate members of the Technical Associations of the Paper and Pulp Industry of America. This Association provides its constituents with publications and information and offers standard directions and industrial facilities. The Tata Iron and Steel Co., Ltd., is a member of as many as 9 research associations interested in the manufacture of iron and steel, refractories, metals, fuel, mining and metallurgy and so on set up by the industries either in England or in the U.S.A.

Assistance
from Govt.
Departments
and
Government
Services

58. The majority of the firms state in their replies that they have not obtained any assistance from the research departments and Government services. It is not clear from the replies whether such assistance was sought by them and if so whether the desired help has not been forthcoming despite such requests; or whether the assistance provided has not been of much practical value to the firms. The firms interested in the manufacture of paper, however, point out that they have been getting all necessary help from the Forest Research Institute, Dehra Dun. Among two non-Indian firms interested in the manufacture of chemicals, while one makes an appreciative reference to the assistance received from the Government departments, particularly in connection with essential oils, the other stresses the meagreness of such assistance and incidentally states that the research institutions are too "royalty minded." The metal industries acknowledge assist-

ance from the Department of Geological Survey. The reply of the Tata Iron and Steel Co., Ltd., adds that it has been receiving assistance from the Alipore Test House as well, and also from the Calcutta University and the Indian Institute of Science, Bangalore.

59. The majority of the firms state that they keep in touch with the latest developments through periodicals and other publications, both Indian and foreign, subscribed by them. A few of the larger firms maintain fairly well-equipped reference libraries. The non-Indian firms having their central research departments abroad keep abreast of the latest developments through the latter. Some of the Indian firms that are affiliated to foreign industrial research associations also utilise the services of the latter in this respect. Besides, their senior staff includes, in some instances, persons who are members of Indian, British and American scientific and technical societies. In some rare instances, the firms consult university professors in regard to latest developments. Only a few of the larger firms are reported to arrange investigational visits of their staff to foreign countries and when necessities arise. The majority of the firms are, however, in favour of the establishment of a central scientific information bureau.

Contact with latest Scientific Development.

60. The replies do not give any useful information regarding the post-war research plans of the industrial firms as most of them appear to have mistaken "research," for "development" or "expansion". It appears, however, that the Indian Jute Mills Association has under contemplation the establishment of some new laboratories in its Research Institute as additional provision for pilot plant developments and bulk processing. The Indian Mining Association has suggested the following lines for post-war research in the coal industry :—

Post-War, Research Plans.

- (a) Compilation of comprehensive bibliography and index of all useful information relating to fuel technology and safety in mines with special reference to applicability to Indian conditions, but not so restricted.
- (b) Chemical and physical survey of India's coal fields with special reference to quality and industrial uses of coals and possibility of special preparation prior to use.
- (c) Carbonisation problems, including low temperature carbonisation.
- (d) Briquetting of fine coals.
- (e) Conversion of coals into oils.
- (f) Investigation of washability or cleaning of coals.
- (g) Extension of use of Indian coals and cokes in gas producers.
- (h) Compilation of formulae for specifications for purchase and sale of coals.
- (i) Coal dust problems.
- (j) Gases in coal and heating problems.
- (k) Domestic fuel.

SECTION IV.

UNIVERSITIES.

Types of
Universities.

61. There is a manifest lack of uniformity in the organisation of scientific and industrial research in the universities in India of which there are now 19 inclusive of those in the Indian States (vide Annexure VI). Some of the universities like the Agra, Patna and Utkal universities are of the affiliating type and do not themselves provide any facilities either for postgraduate teaching of science or for research. The organisation for teaching and research in such cases is provided for in individual colleges and institutions affiliated with the respective universities like the St. Johns College (Agra) and Holker College (Indore) affiliated with the Agra University, the Patna College of Science affiliated with the Patna University and the Ravenshaw College (Cuttack) affiliated with the Utkal University. The affiliated colleges mentioned above embrace, however, both post-graduate and under-graduate teaching. The Travancore University also belongs to this category and has affiliated colleges where post-graduate teaching of science with allied research facilities is provided for. Likewise the Bombay University is mainly an affiliating university but along with a number of affiliated colleges and institutions having provision for post-graduate teaching and research, this university has under its direct control the Department of Chemical Technology which has been specially organised for such purpose. A comparable position is held by the Laxminarayan Institute of Technology which is maintained by the Nagpur University but it is the only institution under that university devoted to post-graduate teaching and research. In the Madras University the post-graduate departments of science are concerned with research alone, post-graduate teaching being provided for in individual affiliated colleges. The other universities have centralised post-graduate departments which embrace both teaching and research, though a few of them like the Calcutta University have a very limited number of affiliated colleges running post-graduate classes in certain scientific subjects and providing necessary facilities for research.

Scientific
Departments.

62. The organisation of the scientific departments of universities has considerably expanded during the last two decades, particularly in the matter of technological and applied research. The science subjects taken up for post-graduate teaching in most of the universities other than those of the affiliating type are Mathematics, Chemistry and Physics. In about half the total number Botany and Zoology are also included; four of the universities provide 'inter alia' for the teaching of Geology. Only one has taken up Physiology. The latest additions to the subjects are Bio-chemistry and Pharmacology which are now taught in a limited number of universities, the former in the Universities of Calcutta, Punjab and Madras and the latter in the Osmānia, Benares, Bombay, Punjab and Calcutta Universities. A few universities like the Allahabad, Aligarh Muslim and Dacca universities are taking special interest in botanical subjects allied to agriculture. Only one University has so far undertaken the teaching of Mining and Metallurgy, viz., the Benares Hindu University. A tabulated list of the subjects taught in the various universities is set forth in Annexure VI.

63. It will be noted from this statement that in many of the universities the applied subjects are steadily coming into pro-

minence. The initial trend in this respect is perhaps attributable to the recommendation of the Indian Industrial Commission who observed that technological training in certain lines could with advantage be undertaken by universities. It was after the last Great War that some of the older universities organised their departments of applied sciences; some of these have not only set up laboratories for the purpose but also workshops and foundry and even pilot plants for undertaking experiments on a semi-commercial scale. Such an expansion has taken place particularly in the Calcutta University. The Benares Hindu University which came into existence much later was organised from the very outset with the object of giving specialised training in certain applied lines and even to-day it stands by itself in this respect as being more of the nature of a technological university. The tempo of the activities of the applied departments in universities has been increased to some extent by the development of industries in India during the inter-war period which opened opportunities for employment for young men trained in applied sciences and also by the growing recognition of the potentiality of the applied departments at least among the progressive sections of Indian industrialists. The best result of this welcome change is embodied in the Department of Chemical Technology of the Bombay University which in its present form has been brought into existence quite recently with the help of substantial endowments made to the university by some business magnates and industrial organisations. Like the Applied Departments of the Calcutta and Benares Universities, the Technological Department of the Bombay University has also been organised with full complements of workshop and equipment required for pilot plant experiments. The establishment of the Laxminarayan Institute of Technology which also provides facilities for research on problems of industrial importance up to the pilot plant and semi-commercial stage is also to be traced to these welcome developments of comparatively recent origin.

64. Although the importance of research is now accorded due share of recognition in practically all the universities, the facilities available in most of them remain far too inadequate and unsatisfactory mainly as a result of the meagreness of their financial resources. The creation of special chairs and endowments of research fellowships and scholarships testify to the growing appreciation of research. But such fellowships and scholarships are still very limited in number and the emoluments originally fixed would now appear to be very poor indeed for attracting talented graduates. Even at the Calcutta University which during its fairly long career has been the recipient of several munificent endowments for research that now yield an annual income of about Rs. 2 lakhs for meeting the expenditure on endowed chairs and attached research scholars, the scholarships awarded by the University are fixed at the level of Rs. 75 per mensem. There are eleven Professors (3 for Physics, 3 for Chemistry and 1 each for Applied Physics, Applied Chemistry, Applied Mathematics, Botany and Zoology) and there are two research scholars working under each Professor; besides there are two research assistants, one for Physics and one for Chemistry. These are all provided from trust funds, but there are some more scholars working under special schemes in the various departments. There is also provision for research fellowship allotted to different departments of science. At Bombay there are twelve research fellowships provided from the funds of the university each of Rs. 75 per mensem; there is only one on Rs. 150. The position of other universities is no better; indeed that of the more recent ones is definitely worse, judged either by

Financial
Resources.

the number or the value of scholarships. In one of the universities in South India the scholarship is fixed as low as Rs. 30 per month. At the Delhi University where Honours and M.Sc., classes have been instituted only during the last three years no provision has yet been made for research scholarships in science.

65. In recent years a new development has taken place in this regard as a result of research grants made by some organisations like the Council of Scientific and Industrial Research, the Imperial Council of Agricultural Research, Jute and Cotton Committees, Provincial Research Boards, etc., to some of the universities for conducting research on specific schemes which provide for the appointment of research assistants and scholars on an appreciably higher honorarium. This has involved a striking disparity in the emoluments of research scholars working in the same university and is reported to have had an unfortunate reaction on the enthusiasm of those who are paid according to the lower scale of university scholarships. The award of scholarships by outside organisations has thus created a complication which, it is urged, can be avoided only by general levelling up. With reference to the provision of proper facilities in universities it has been strongly emphasised by some of them that "it is absolutely essential that the first-rate men remain in the universities which are nurseries for the scientists of future generations."

66. The responsibility for guiding research in the scientific departments of universities devolves on senior members of the staff who in many cases are over burdened with teaching duties, except in the Madras University where the post-graduate departments do not take part in teaching. In most cases the members of the teaching staff themselves undertake research on their own account and have thus to overstrain in themselves. "The Professor in an Indian university gives on an average over 150 lectures a year and has to spend a large amount of his time in administrative work and in supervising the laboratory, and as such he is not able to devote that time and sustained effort which is essential for attacking fundamental problems in science (The basic amount of university lecturing done at Cambridge by a teacher is believed to be from 30 to 60 hours a year)."

67. It is universally urged that the paucity of finance has been thwarting the attempts of the universities at initiating desirable improvements in the organisation of research. Not much light, however, can be thrown on this aspect of the problem by the present volume of expenditure of the various universities on research. In the first place, many of the universities do not maintain separate accounts for teaching and research. Secondly, even those which do are found to be the recipients of research grants from some outside organisations as already referred to. These grants are sanctioned for working specific schemes and cannot be relied upon for strengthening permanently the research organisations of the universities. The following statement furnished in regard to the Calcutta University for the year 1944 will indicate the relative significance of grants received by that university from other organisations, to its research activities :—

	Grants from bodies other than University	No. of scholars appointed
Chemistry ..	Rs. 31,570	17
Applied Chemistry ..	" 74,176	22
Physics ..	" 35,421	12
Applied Physics ..	" 9,449	6

68. The Universities of the Punjab and Bombay also receive considerable research grants from some of the outside organisations mentioned in an earlier paragraph. Considered from this point of view the expenditure of the Madras University on only three of its post-graduate departments of science which are concerned with research alone would appear to be quite substantial; the following figures are furnished by the University for the year 1944-45 :—

Bio-Chemistry	..	..	Rs. 34,531
Botany	..	..	26,588
Zoology	..	..	28,172
			89,291

69. The inadequacy of the resources of the universities of comparatively recent origin becomes at once manifest from the amount of their research expenditure in the scientific departments. In one of them the total expenditure on this account amounted to Rs. 8,480 in 1942-43, Rs. 3,450 in 1943-44 and Rs. 7,550 in 1944-45. In another case the institution entrusted with post-graduate teaching and research under the university states that only when any saving accrues from the sanctioned grant after meeting the expenditure on teaching a specified number of students in the I.Sc., B.Sc., and M.Sc. classes, that the balance is used for research purposes; and it adds, "We have about half a dozen research students working in the laboratories and it would be difficult to find room for more considering the large number of undergraduate students in the colleges."

70. Some of the universities, indeed, categorically stress in their reply that some useful lines of research can be taken up by them if only the necessary funds are made available. The Andhra and Annamalai Universities urge this point in connection with the organisation of well equipped departments of oil technology in respect of which the extensive seed growing tracts in the neighbourhood offer a very good field for useful research. The Utkal University makes similar claims for developing the mineral and forest resources of Orissa by organising a suitable institute for research. The Zoology Department of the Lucknow University states that it can undertake useful work "if a recurring grant of Rs. 10,000 per annum is made towards post-graduate teaching and research in Entomology for which there is great scope and urgent need in an agricultural country like India." The Delhi University suggests a capital grant of Rs. 10 lakhs as a modest estimate of the amount required for raising its laboratories to a satisfactory level. The Dacca University has urged its special advantages for taking up research in cellulose if suitable financial facilities are made available to it. Indeed, similar demands have been made by practically every university including the University of Calcutta which points out that its recent acquisition of a cyclotrone was possible only for the grant received by the University for this purpose from the Tata Memorial Trust Fund.

71. It is only during the last five years or so that the activities of the universities in India in industrial and applied research have marked a significant expansion and this, as already indicated, has been due mainly to the financial support accorded to them by such organisations as the Imperial Council of Agricultural Research, the Council of Scientific and Industrial Research, the Research Fund Association, Provincial Research Boards and the Central Cotton and Jute Committees. These organisations sanction grants from their respective funds for cer-

Applied
Researches.

tain approved investigations of concern to their respective spheres being undertaken in universities which have suitable facilities for research ; this is done often at the instance of members of the university staff who have specialised knowledge of and/or some research experience in the lines and put up specific schemes with detailed estimates of expenditure. Except in the case of the Council of Scientific and Industrial Research, however, the financial assistance forthcoming from the organisations mentioned above is more or less of a sporadic character. The assistance offered by the Council of Scientific and Industrial Research, on the other hand, has been more substantial and continuous. As a matter of fact, of the research grants made annually by the Council for specific schemes, amounting to about Rs. 4-5 lakhs, a considerable proportion has been allotted to the universities, and the grants contain specific provisions for expenditure on equipment, staff and contingencies on condition that on the termination of the investigations the equipment purchased with the grant and unconsumed materials should be returned to the Council. In some cases such grants have been made available even for pilot plant experiments. Some of the universities like those of Bombay and Calcutta have also been receiving contributions from industrialists and industrial organisations for undertaking applied research of both basic and specific types. Indeed, in the organisation of the Department of Chemical Technology in the University of Bombay such contributions are expected to occupy a place of increasing importance in the development of its research activities. For the majority of the universities, however, this kind of support to research by industry is conspicuous by its absence.

72. The specific lines of industrial and applied researches which are being conducted in the various universities are too numerous to be recounted in a general survey. These are indicated in the "Review of Researches" in universities and other research institutions in India set forth in Annexure V.

ANNEXURE V.

REVIEW OF RESEARCHES (PURE AND APPLIED)

PHYSICS.

Optics and
Raman
Effect.

Studies in the optical anisotropy of crystals have been undertaken at (4) and (43). At (43) considerable amount of work is being done both on the theoretical and experimental aspects to elucidate the nature of the vibrational spectrum of a crystal and, in general, the properties of matter in the crystalline state—like the elastic behaviour of crystals, their specific heats and the nature of interionic and interatomic forces. The work on Raman Effect continues to occupy great prominence in many of the laboratories, particularly on problems relating to the chemical constitution and structure of molecules, and the effect of change of state and other physical conditions on the phenomenon. A large number of papers have been published on these aspects and the chief centres of research have been (4), (8) and (43).

X-Rays.

X-Ray investigation of crystals for the elucidation of crystal-structure has been the subject of a series of intensive investigations

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- (4) Andhra University.
 - (8) Calcutta University.
 - (43) Indian Institute of Science.

at (8), (9) and (43). A new interpretation of the origin of diffused spots and streaks observed in well-exposed laue-diagrams and described as the quantum reflection of X-Rays with the change of frequency arising from quantum mechanical excitation of infra-red vibration of crystal lattice, created considerable interest and is the subject of extensive X-Ray investigations at (43). X-Ray investigations in crystals have also been undertaken at (40). Work on the structure of cellulose and other fibres by means of X-rays is of considerable interest and is pursued at (8), (41) and (43).

Work on the dia—and para-magnetic susceptibilities of various substances, and the dielectric strength of these in different solvents has been carried out at (5), (7), (8), (13), (15), (17) (62) and particularly at (40). Work on magneto-chemistry has been carried out at (8), (15) and particularly at (17). The determination of the dipole moments of organic and inorganic substances in various states of aggregation is carried out at (43) and also at (7) to elucidate the structural properties of the molecules.

Magnetism.

The interest aroused in 1920 in the study of spectroscopy of elements, has been maintained at (4), (8), (9) and (13) work on the band spectra of simple inorganic and organic molecules is carried at (4), (6) and (8).

Spectroscopy.

Researches on the ionosphere are being continued at (3) and (8) and have now formed the subject of a planned programme of research at (21). Work on atmospheric is being continued at (5), (8), (21), (28) and (43). Methods of production of ultra-high frequency radio waves, measurement of the field intensity of wireless waves by electronic oscillation, studies in the behaviour of thermionic valves with internal resistance are some of the subjects of investigation at (43).

Wireless.

Researches on various branches of Astrophysics are actively pursued both in the theoretical and experimental aspects at (8), (10) and (28). Spectro-photometric methods have been developed and used at (28) to determine line and band contours with theories of origin. These researches resolve themselves largely into a series of problems of atomic and molecular physics. At (8) and (10) theory of stellar objects and the constitution of stars form the chief subjects of investigation.

Astrophysics.

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- (3) Allahabad University.
 - (4) Andhra University.
 - (5) Annamalai University.
 - (6) Benares Hindu University.
 - (7) Bombay University.
 - (8) Calcutta University.
 - (9) Dacca University.
 - (10) Delhi University.
 - (13) Mysore University.
 - (15) Osmania University.
 - (17) Punjab University.
 - (21) All-India Radio Research Station.
 - (28) India Meteorological Department.
 - (40) Indian Association for the Cultivation of Science.
 - (41) Indian Central Cotton Committee.
 - (43) Indian Institute of Science.
 - (62) Royal Institute of Science.

Cosmic
Rays.

This is a subject of recent origin and has attracted the attention of theoretical physicists all over the world. A new and active school of research on cosmic rays is being developed at (23), (28), (43) and (17). Investigations in cosmic rays concern themselves in the statistical measurement of the intensity of these rays at different parts of the country, the production of high penetrating cosmic ray showers consisting of protons and other fundamental particles, the study of their interaction and scattering under thick layers of material as also the theoretical interpretation of these phenomena according to modern quantum mechanical theories.

CHEMISTRY.

Physical
Chemistry.

Work on photo-chemical action of sunlight and on photosensitizers has been in progress in (3) and (4), studies on many photo-chemical reactions and the dependence of quantum yield on the exciting radiation which has been the subject of investigation over a number of years at (9) is now being continued at (43). Interaction of different gases under electric discharge has been studied at varied applied potentials. Study at (6) of electrical discharge in a number of gases under irradiation has led to an interesting observation of diminution of discharge current on irradiation, and the optimum conditions for this observed effect have been studied. Diamagnetic susceptibilities of some of the inorganic and organic molecules have been investigated at (15), (17), (19) and (62) for the elucidation of their constitution. Determinations have been done at (7) and (43) of dielectric constants and densities of some of the inorganic salts and the results are interpreted in relation to the nature of the chemical bond and polarisation. Work has been done at (5) on the electro-chemical synthesis of some of the inorganic compounds and electro-deposition of metals. Work on the various aspects of colloid chemistry is being done at (3), (6), (7), (8), (11), (13), and (62). The kinetics of coagulation has been studied at (6) and (62), by the observed changes in capacity and the anomalous behaviour observed by investigators at (6) of the initial diminution of viscosity during coagulation has been explained as due to a "Zonal Effect" and is shown to be a general feature in many "slow coagulations". Similar experiments are also undertaken at (11) and (62) on the coagulation of the soils in presence of non-electrolytes with a view to understand the sensitization effect. Gels of several metal soaps have been prepared at (62) and viscosity measurements made of the colloidal

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- (3) Allahabad University.
 - (4) Andhra University.
 - (5) Annamalai University.
 - (6) Benares Hindu University.
 - (7) Bombay University.
 - (8) Calcutta University.
 - (9) Dacca University.
 - (10) Delhi University.
 - (11) Lucknow University.
 - (13) Mysore University.
 - (15) Osmania University.
 - (17) Punjab University.
 - (19) Utkal University.
 - (23) Bose Institute.
 - (28) India Meteorological Deptt.
 - (43) Indian Institute of Science.
 - (62) Royal Institute of Science.

systems undergoing gelation in pinene or in several nonaqueous media. The explanation of hysteresis in sorption or desorption of several gels forms the subject of a series of investigations at (13) with a view to understand the nature of the hysteresis in soap. A continuation of this work for the understanding of the soil structure and the problem of retention of moisture of soils is an interesting work done at (13) and (62). Work has been done at (8) and (9) on the base exchange and electro-kinetic properties of synthetic and naturally occurring aluminosilicates. The changes produced in the physical properties by the addition of non-electrolytes to colloidal solutions of hydrogen clays and hydrogen bentonites have been investigated at (8). The study of catalytic gaseous reactions, some of which are of industrial interest is being pursued at (9) and (43).

The main centre of researches in inorganic chemistry continues to be (8) and also (16), (43) and (7). The main lines on which work has proceeded at (8) are studies in valency, complex formation and the use of organic reagents for the quantitative estimation of inorganic radicals. Studies in valency consist of the preparation of trivalent silver compounds and study of their physical properties for the elucidation of their electronic structure. Preparation of complex co-ordination compounds of inorganic salts with organic bases, amines etc. are some of the subjects of study at (8). Preparation and the study of the properties of inorganic hydrides are undertaken at (16). In the same laboratories work is carried out on the measurement of dissociation pressures of some of the pyridine complexes of metallic perchlorates. Study of thermal decomposition of nitrites at (7) and chromites at (43) are studied with a view to understand the mechanism of the reaction. Similar work on thermal decomposition of calcium sulphate in presence of various oxides has been done at (7). The monazite sands containing rare earth metals of cerium and thorium have been studied at (8) and (18), the vanadium bearing ores of Chotanagpur at (8). The preparation of some of the salts of yttrium and erbium and cerium has been done at (32). Use of quantitative spectroscopy as a micro technique for the estimation of trace elements has been studied at (4), (8) and (13).

Inorganic
Chemistry.

Two main lines of research in organic chemistry could be discerned, viz., synthetic and analytical. Extensive investigations on the synthesis of terpenes, bi-cyclic and sesquiterpenes and triterpenes are being actively pursued at (8) and (43). Synthetical investigations on anthocyanine and other groups of plant pigments are continued with renewed interest at (3), (4), (7) and (62). An interesting series of

Organic
Chemistry.

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- (3) Allahabad University.
 - (4) Andhra University.
 - (7) Bombay University.
 - (8) Calcutta University.
 - (9) Dacca University.
 - (13) Mysore University.
 - (16) Patna University.
 - (18) Travencore University.
 - (32) Government College, Lahore.
 - (43) Indian Institute of Science.
 - (62) Royal Institute of Science.

investigations on various synthetic drugs specially antimalarials, organo-metallic compounds and those belonging to the group of sulphanamides are being carried out at (17), (34), (43), (58) and (63). Compounds related to santonin and cantharidine are being prepared by a group of workers at Poona. A large number of synthetic dyes belonging to the classes of thio-indigo are being investigated at (16), and other types of dyes and dye intermediates from coal-tar are being studied at (3), (7), (16), and (58). Many workers are beginning to take active interest in the synthesis of compounds related to sterols, bile acids and other polycyclic organic compounds at (8), (9) and (43). Investigation on the synthesis of higher fatty acids is undertaken at (8), (12) and (43). Compounds related to the acids present in chalmogra oil are being investigated at (7). A group of workers are trying to synthesise muscone and related compounds by new and novel methods at (8).

The analytical type of researches concerns mainly the isolation and characterisation of plant and animal products, and, as in the past, investigations on these lines are being continued. The study of odouriferous constituents of a number of Indian plant materials is being continued at (3), (4), (6), (8), (18), (31), (43) and (92). The work on the isolation and characterisation of plant colouring matter is being carried out at (3), (4), (7), (17), (43) and (61). The study of a number of alkaloids isolated from Indian medicinal plants is mainly pursued at (2), (4), (8), (13), (17), (29), (58) and (61). The investigations pertaining to the isolation and study of sterols from Indian plant and animal products are of recent origin and are being pursued at (9).

Bio-
Chemistry.

Interest has largely centred round the following lines of biochemical research; nutrition and deficiency diseases, enzymes, vitamins and hormones. The main centres of research are (4), (8), (9), (12), (20), (25), (52) and (63).

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- (2) Aligarh Muslim University.
 - (3) Allahabad University.
 - (4) Andhra University.
 - (6) Benares Hindu University.
 - (7) Bombay University.
 - (8) Calcutta University.
 - (9) Dacca University.
 - (12) Madras University.
 - (13) Mysore University.
 - (16) Patna University.
 - (17) Punjab University.
 - (18) Travancore University.
 - (20) All India Institute of Hygiene and Public Health.
 - (25) Central Research Institute.
 - (29) Directorate of Scientific and Industrial Research.
 - (31) Forest Research Institute.
 - (34) Haffkine Institute.
 - (43) Indian Institute of Science.
 - (52) Nutrition Research Institute.
 - (58) Presidency College, Madras.
 - (61) Research Institute, Ayurvedic & Unani Tibbi College.
 - (63) School of Tropical Medicine.
 - (92) Kerala Soap Institute.

The following are the main lines of work carried out in the various laboratories. Assessment of the level of nutrition, determination and development of methods for the estimation of vitamin in various Indian food-stuffs at (52), studies on the conditions affecting the economic manufacture of dehydrated foods are studied at (52) and (43). Nutrition.

Work on this subject is being actively pursued in (9), (12) and (43). The main lines of work relate to the purification of enzymes and the study of their chemical nature and the mechanism of their action. The study of pharmacological properties of snake venom and other drugs is being done at (8). The occurrence of milk coagulating enzymes in plants has been the subject of an interesting investigation at (12) and (37). Among the plants investigated *withania coagulans* is shown to possess a very active milk clotting enzyme. Enzymes.

Such of the work that is being done at present in Indian Laboratories has been in the direction of estimation of these in food-stuffs at (52), preparation of concentrates for the fortification of foods, e.g. vitaminising oils at (8) and (43), finding new sources rich in vitamin A and C. As a result of the latter work, shark liver oil has been found to be richer source of vitamin A than cod liver oil (8), (43) and (52), the Indian Gooseberry is found to be a rich source of vitamin C (12) and (52). The preparation of carotene concentrates from Dub grass and other leafy materials is being investigated at (20) and (39). Investigations at (4) and (43) on the stability of Vitamin C have yielded important results and various stabilisers for Vitamin C have been found. A novel method of estimation of vitamins by insect nutrition has been developed at (43). Vitamins.

Work on this subject is largely being done in (43) and (58). The subjects studied are the determination of various factors responsible for the deterioration of adrenaline and the standardisation of the method for its commercial manufacture. Work on the elucidation of the mechanism of the action of insulin is in progress at (43). Exploration of anti-diabetic principle from plant materials is a subject of study at (9). Harmonus.

Problems concerning animal husbandry, including feeding, breeding and production of fodder crops are being studied at (37) and (39). (37) imparts training in dairy chemistry and special facilities for research are also available in this subject. Work on the various methods of preparing ghee and their influence on the quality of ghee and on the detection of adulteration of ghee is being carried out at (37) and (43). Dairy Chemistry.

The main lines on which research has proceeded on this subject have been in the study of the principal tropical diseases such as malaria, cholera, kala-azar, plague, dysentery and influenza. Significant contribu-

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- (4) Andhra University.
 - (8) Calcutta University.
 - (9) Dacca University.
 - (12) Madras University.
 - (37) Imperial Dairy Research Institute.
 - (39) Imperial Veterinary Research Institute.
 - (43) Indian Institute of Science.
 - (52) Nutrition Research Institute.
 - (58) Presidency College Madras.

Medical Research, Pharmacology & Pharmaceutical Chemistry.

tions have been made in the study of these diseases ; and the production of prophylactic vaccines by (22), (25), (34), (46), (56) and (63). Researches have also been carried out at (24) and (25) and also at (29) and (63) on the investigation of the active principles of the indigenous medicinal plants for the production of drugs and the study of their pharmacological action.

Agricultural and soil chemistry.

The centres of research in the various branches of study in agricultural science have been (36) and (47), the Provincial and State Organisations for agriculture, (43) and the active school of research on soil colloids at (8). Work done has been mainly on the following lines ; fundamental studies on plant breeding, plant nutrition and soil deficiency diseases and their control, insect pests and their control by the production of insecticides. The methods developed at (43) for the disposal of the sewage and to the practice of composting are significant contributions to the subject.

Forestry and Forest Product.

The main centre of basic researches on the various aspects of forestry such as silvicultural research, research on regeneration problems, forest entomology, is (31). The industrial aspects of forestry such as wood preservation, paper and newsprint manufacture, seasoning, etc. have occupied greater attention. Mention may be made here of the important work done at (43) on the spike disease of sandal.

APPLIED RESEARCHES.

The researches in applied science which were meagre prior to 1938 received a great filip after the outbreak of the war. The creation of the Board of Scientific and Industrial Research greatly stimulated these activities. The great volume of work that has been done during the last 3 or 4 years and the significant contributions made to the solution of the many problems confronting the Defence Departments and the new industries that have come into being as a result of the researches initiated or subsidised by the Board and later the Council of Scientific and Industrial Research as the central organisation are evidences of the energy with which applied research has been carried out under its auspices. The Board has also initiated surveys for the establishment of some of the basic industries. Reference may be made here to the reports on the manufacture of Internal Combustion Engines, Essential Oils, the Dye-stuffs prepared under the auspices of the Board of Scientific and Industrial Research.

In the following paragraph a broad survey is made of the various applied researches that are being carried out in the different laboratories. A special mention of the facilities available for pilot plant

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- (8) Calcutta University.
 - (22) Biochemical Standardisation Laboratories.
 - (24) Carmichael Medical College.
 - (25) Central Research Institute.
 - (29) Directorate of Scientific and Industrial Research.
 - (31) Forest Research Institute.
 - (34) Haffkine Institute.
 - (36) Imperial Council of Agricultural Research.
 - (43) Indian Institute of Science.
 - (46) Kings Institute.
 - (47) Lawley Institute.
 - (56) Pasteur Institute.
 - (63) School of Tropical Medicine.

work is made. The researches that have been completed and the results of which are being utilised for large scale production are also given.

APPLIED PHYSICS

Investigations in applied physics are in general not capable of giving results of immediate value and as such the contributions in this line have not been very striking. But with the keen interest evinced by the two committees viz., Applied Physics Committee and the Radio Research Committee, formed under the auspices of the Council of Scientific and Industrial Research various research schemes have been undertaken at (8), (16) and (62). Work has been completed on photo-sensitizing dye-stuffs at (16) and the methods for the manufacture of photographic plates at (28) and (62). Methods have been developed at (8) for the manufacture of vacuum pumps. Attempts have been made at (29) to utilise high power ultrasonic generator for the extraction of iodine from potassium iodide, and for formation of emulsions. The Radio Research Committee has undertaken systematic survey of the raw materials available in India for the purpose of setting up of an industry for the manufacture of the several components and radio sets.

APPLIED CHEMISTRY.

With the stoppage of imports from abroad and with the necessity of finding substitutes for things which are in short supply, the researches in the applied chemistry are largely concerned with the scientific study and a proper utilisation of the immense resources of forest, mineral and other natural wealth of the country.

India is one of the world's largest oil-seeds producing countries. With the fall of exports at the outbreak of the war, Indian trade in oil seeds suffered enormously. Accordingly, researches for the better utilisation of these seeds in the country itself have received considerable attention. The use of refined groundnut oil and other vegetable oils in admixture of small percentages of mineral oils as lubricants and fuels for Diesel engines is one of the outstanding contributions made by (29). It is important to mention here, that consequent on the fall of exports, the price of ground-nuts came down enormously. With a view to provide a reasonable benefit to the cultivator, His Majesty's Government agreed to adopt a scheme according to which a rebate based on the difference between the price which His Majesty's Government had agreed to pay to the shippers and the prevailing market price in India, would be collected from the shippers of ground-nuts and was to be earmarked for the benefit of the producers. One of the schemes sanctioned under the above fund relates to research on the industrial utilisation of ground-nuts undertaken at (29). The plan of research extends over a period of 5 years and is on the following aspects: (1) fuels, (2) fat splitting, (3) plastics, (4) sulphonated oils, and (5) drying oils.

Oils, fats
and oil
cakes.

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- (8) Calcutta University.
 - (16) Patna University.
 - (28) India Meteorological Department.
 - (29) Directorate of Scientific and Industrial Research.
 - (62) Royal Institute of Science.

Splitting of oils for the manufacture of stearic and oleic acids has been successfully investigated at (8) and is under commercial exploitation by the Calcutta Chemical Co., Ltd., Calcutta. Work done at (8), (15) and (29) has resulted in the use of dehydrated castor oil for a variety of purposes. (15) possesses a pilot plant for the manufacture of dehydrated castor oil. It has been found that dehydrated castor oil is a very good substitute and in fact superior in certain respects to tung oil for use in varnishes. As a result of work carried out at (7), (8), (29) and (43) suitable sulphonated oils have been produced for use in textile and other industries. A number of synthetic wetting agents and detergents are proposed as a result of research done at (7).

Work done at (29) on the use of the oil expressed from Bhilawan has resulted in the production of a stoving type of black enamel which is under production by Jay Engineering Works, Calcutta. Various shades of baking enamel are also successfully developed from the nitrated product. Chemotherapeutic studies on Bhilwanol are also in progress in the same laboratories. Similar work on the production of enamels from cashew shell oil has been done at (43).

Experiments are also under way at (15) and (43) on the use of tobacco seed oil as a quick drying oil in varnishes. Neem oil as a denaturant is being investigated at (6). Throat gargles and insecticide emulsion sprays have also been developed at (29) from the alkaloidal components of neem oil. The development of shark liver oil industry in the country is due to the energy and initiative shown by some of the industries departments in the Provinces and States, notably (72), (73), (78) and (79).

The production of resins and moulding powder from fixed oils for the manufacture of plastics has been successfully done at (8) and a company has been recently started for their manufacture.

Work on the suitability of a large number of cheaper oils for the manufacture of soaps has continued to receive attention. A pilot plant of $\frac{1}{2}$ ton capacity for the manufacture of toilet soap is available at (14), and (18). (92) possesses a well equipped section for investigations on oil.

India has large resources of oil cakes which are at present employed either as cattle fodder or as manure. In recent years the export of oil cakes has become considerable. The economic value of the oil cake lies in its 'combined nitrogen' or protein content. Experiments at (43) have resulted in the production vegetable casein from seed

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- (6) Benares Hindu University.
 - (7) Bombay University.
 - (8) Calcutta University.
 - (14) Nagpur University.
 - (15) Osmania University.
 - (18) Travancore University.
 - (29) Directorate of Scientific and Industrial Research.
 - (43) Indian Institute of Science.
 - (72) Director of Industries, Bengal.
 - (73) Director of Industries, Bombay.
 - (78) Director of Industries, Madras.
 - (79) Director of Industries, Mysore.
 - (92) Kerala Soap Institute, Calicut.

cakes which gives as good an adhesive as milk casein and the preparation of an edible flour from ground-nut cakes has also been successfully completed. laboratory investigations have been completed at (29) on the production of artificial wool from the extracted proteins of the groundnut cake and pilot plant is being set up in order to study the economics of the process.

Though India has an extensive supply of the necessary raw materials for the manufacture of natural synthetic perfumes, this industry is hardly developed in India—except for the sandalwood oil industry in Mysore. However, attempts are being made to manufacture the “isolates” from Indian essential oils by some manufacturers. Methods for the preparation of ionine have been standardised at (8) and the process is awaiting commercial exploitation. A number of schemes financed by the Council of Scientific and Industrial Research on the preparation of many synthetic aromatics are being worked out at (3), (8) and (43).

Essential oils and synthetic aromatics.

An important contribution on this subject has been the development of processes by (29) and (31) for the hardening of the indigenous wood for the manufacture of shuttles, required in the textile industry. Successful work has also been done in developing suitable adhesives for use in plywood manufacture. A new use of sawdust as a filling material has come to the forefront with the development of plastics.

Wood and other Cellulosic substances.

In the field of tanning, the problems that have come up for consideration with the outbreak of the war is the finding of a suitable substitute for wattle bark as a tanning material. Survey conducted by (29) have resulted in the discovery of a new leguminous plant *Ptero-carpus marisupium* with a high tanning content. It is hoped that the commercial feasibility of this raw material as well as the leather produced by tannage with the above tanning will be investigated. Another important work done by the Provincial and State Forest Departments has been to try to acclimatise and grow wattle under the Indian conditions. As an attempt in this direction, experimental plantations have been undertaken in Nilgiris and Kodaikanal Hills.

Tanning.

An important development in this field is the utilisation of shellac and shellac compositions for the manufacture of moulding powders. Two such compositions are under production with trade names, Lakelite and S. H. P. moulding powders. A large amount of work has been done at (29) and (44) on the production of laminated sheets using paper, cloth and jute as base for the fabrication of various articles of commerce. Special mention may be made here of the development of the unburstable containers made from cloth, jute or plywood by (29) which had been of great value in the present. The work done at (29) and (44) on the conditions for the productions of depolymerised lac and the study of its properties have resulted in its use for slushing varnishes, petrol pump diaphragms, the development of self-sealing petrol tanks at (29).

Lac and Shellac

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- (3) Allahabad University.
 - (8) Calcutta University.
 - (29) Directorate of Scientific and Industrial Research.
 - (31) Forest Research Institute.
 - (43) Indian Institute of Science.
 - (44) Indian lac Research Institute.

Work done at (43) on the determination of dielectric strength of lac films, urolacs and other lac complexes are of industrial interest.

Coal.

With the limited availability of first class coking coals useful for metallurgical industry, research on coals has been largely directed towards using the low grade coals for processing of better type of coking coals with the simultaneous development of tar oils and pitch. The most important centres of coal research in India have been (8), (9) and (45). In recent years these problems are being studied at (15) and (18) also. At (8), low temperature distillation and coking of non-coking coals are receiving attention and significant work has been done to standardise the conditions by which relatively large yields of tar oil are obtained which after suitable blending could be used as fuel for internal combustion engines.

The de-ashing of coals by means of physical methods has been the contribution made by (45) and the same has been achieved at (9) by chemical treatment with alkali and subsequent lixiviation. The problem of economic briquetting of coal or coke dust has been worked out by (45). The production of liquid hydro-carbons from water-gas is receiving attention in (43).

Carbon and Graphite.

Work on the manufacture of electrodes for large electro-chemical industries, for dry cells, and arc lamps has been in progress at (29) and (43). Of these, the small carbon electrodes for use in dry cells are being manufactured by the Estrella Battery Co., by the method developed at (29). Work on the manufacture of activated carbons from agricultural wastes is being done on the pilot plant scale in (18), (43) and (47). The possibility of manufacturing colloidal graphite from indigenous graphite is being investigated at (43).

Chemicals (Inorganic).

In the field of chemicals much valuable work has been done and has resulted in some of the processes being utilised on the large scale. The utilisation of the sulphur ore in Baluchistan and the development of methods for its purification are engaging considerable attention at (29), (43) and (67). The work done at (29) for the manufacture of barium chloride from barytes and the manufacture of potassium chlorate by a process developed at (43) deserve mention. The above two processes are being worked out by Mettur Chemicals Ltd. Research on the utilisation of the large deposits of phosphatic nodules at Trichinopoly for the production of citric soluble fertiliser has been successfully completed at (43) on a pilot plant scale and is awaiting exploitation. The recovery of zinc from the brass foundry wastes by methods developed at (29) is being done at Gatsila. Methods have been developed at the Central Revenue Laboratories for the Crystallisation of Sodium

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- (8) Calcutta University.
 - (9) Dacca University.
 - (15) Osmania University.
 - (18) Travancore University.
 - (29) Directorate of Scientific and Industrial Research.
 - (43) Indian Institute of Science.
 - (45) Indian School of Mines.
 - (47) Lawley Institute.
 - (67) Geological Survey of India.

sulphate from Didwana deposits. The recovery of bromine from Kharagoda bitters and the extraction of iodine from sea-weeds has been done at (62). The processes developed on the pilot plant scale for the manufacture of calcium gluconate at (8), (17) and (43), potassium salts from molasses at (8) and (43), titanium dioxide from red mud at (29) and from illmenite at (18) and (43) are some of other important problems awaiting commercial exploitation.

Of the organic chemicals, the process worked out at (29) for the manufacture of phthalic anhydride is now being used for the manufacture by the Shalimar Tar products (1935) Ltd., Work on the catalytic oxidation of methyl alcohol for the production of formaldehyde has been completed and is being done on a semi-large scale at (43) and (121). The conditions for the manufacture of nitro-benzene, aniline at (43) and dimethylaniline at (29) and (43) have been worked out. Pilot plants have been put up for the preparation of urea at (43) and (44) and of thiourea at (44).

(Organic)

A process has been developed at (43) for the manufacture of starch from sweet potato on the pilot plant scale. The starch so manufactured is reported to be superior in certain respects to that produced from maize or tapioca and this method has been taken over by the Neclec Chemicals Ltd., for large scale production of starch. The extraction and recovery of agar-agar from the naturally occurring sea-seeds of Travancore is an important work concluded by (18) in collaboration with (29) and a factory has been started for its manufacture. Tamarind seeds have been found to be by (31) a rich and an economical source of pectin and methods have been standardised for its production.

Sugar, Starch and other products.

Work has been done at (43) and (58) on the manufacture of adrenaline and pituitary powder from slaughter house waste. Large scale manufacture of these both in the powder form and as ampoules are undertaken at (43) and (58) to meet the immediate requirements of the Director-General, Indian Medical Service. An easy method of manufacture of ephedrine and its salts from Indian ephedras has been developed at (31). The methods for the manufacture of atoxyl and carbarosone developed at (43) are utilised by the Zandu Pharmaceutical Works, Bombay. Investigations have been in progress for the preparations of a number of synthetic drugs in various laboratories. A new method by which the growth of penicillin could be increased by change in the substratum has been discovered at (43) and arrangements are being made for the large scale manufacture of this drug in several places (34) and (43). Papain is being manufactured at (43) on a large scale. Pancreatic amylase used in textiles for desizing and papain are being produced on the pilot plant scale in (43).

Drugs,

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- (8) Calcutta University.
 - (17) Punjab University.
 - (18) Travancore University.
 - (29) Directorate of Scientific and Industrial Research.
 - (31) Forest Research Institute.
 - (34) Haffkine Institute.
 - (43) Indian Institute of Science.
 - (44) Indian Iac Research Institute.
 - (58) Presidency College, Madras.
 - (62) Royal Institute of Science.
 - (121) Mysore Iron and Steel Works, Ltd.

Dyes. With the non-availability of coal-tar dyes, attempts made during the last 3 or 4 years have been directed towards the preparation of dyes from vegetable sources. The successful work done at (7) has resulted in the production of dye extracts from the barks of *Terminalia arjuna* and *Butea frondosa*: the process for dye extracts from tamarind seed testa has been taken up by Messrs. Howrah Trading Co. The process for annatto dye extracts evolved at (7) is being used by the Dairy Products and Equipment Manufacturing Company, Bombay.

Metals. The development on this subject has been mainly on the ferrous metals, the outstanding contribution being by Tata's Laboratories where surgical steel, steel for magnets and the special bullet proof armour plate have been developed.

Plastics There is hardly any article of every day use which cannot be substituted by plastics with better utility and aesthetic sense. Ever since the discovery of bakelite the march of progress in plastics has been phenomenal and the present day has witnessed "Nylon" fabrics. During the present war, the strictest economy in the use of metals is demanded for the very essential war equipment and as substituted plastics are employed for a variety of purposes for which it was hitherto not thought of.

A mention has already been made of the possibilities of lac as a raw material in plastic industry in India. The work done at (8), (29) and (44) during the last 3 or 4 years for the development of laminated boards and of plastics or moulding powder from coffee and tea waste, bagasee, oil cakes and horn-waste by (29) are some of the interesting contributions in this subject. A useful product resulting from investigation on some of these lines is the development of air foam, a fire extinguishing solution, by (29).

Army Research, A very large amount of work has also been carried out by the various institutions for the solution of problems faced by the military and Defence Departments. Much of this work is of a secret nature.

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- (7) Bombay University.
 - (8) Calcutta University.
 - (29) Directorate of Scientific and Industrial Research.
 - (44) Indian Lac Research Institute.

ANNEXURE VI.

Statement relating to Departments of Science and Research Expenditure of the Universities. (Figures relate to the latest financial year except where otherwise indicated).

Name of the University	Departments of Pure Sciences.	Departments of Applied Sciences.	Remarks.
1	2	3	4
1. Agra			An affiliating University.
2. Aligarh	<p style="text-align: right;">Rs.</p> Physics .. 32,478 Chemistry .. 60,405 Zoology .. *26,877 Botany .. *27,286 <hr/> 1,47,046		<p style="text-align: right;">Rs.</p> Total Expenditure on Pure Sciences .. 1,47,046 Total Expenditure on Teaching (Physics & Chemistry) .. 56,978 Total Expenditure on Research (Physics & Chemistry) .. 35,904
			<p><i>Chemistry</i> :—Inter & B. Sc. classes included. Expenditure ear-marked for Research is Rs. 1,250 for Chemicals and Rs. 10,000 on Staff.</p> <p><i>*Botany & Zoology</i> :—(Including inter Sc. B.Sc., M.Sc. & Ph.D. courses). Grant too meagre for doing research work or for efficient teaching. Research subsidised by the I. C. A. R. for 2 schemes, one for Rs. 3,900 and another for Rs. 1,250.</p>
3. Allahabad	Physics Chemistry Botany Zoology	Botany :— Genetics of Cereals, Mutation & Plant Pathology	No separate account maintained for research.

ANNEXURE VI.—(Contd.)

Statement relating to Departments of Science and Research Expenditure of the Universities. (Figures relate to the latest financial year except where otherwise indicated.)

Name of the University,	Departments of Pure Sciences.	Departments of Applied Sciences	Remarks.
	Rs.	Rs.	
4. Andhra	Physics ..	Technology 26,150	Total Expenditure on Pure Sciences ..
	Chemistry..		Total Expenditure on Applied Sciences ..
	Natural Sciences ..		Total ..
			Expenditure on Teaching (95. 1%) ..
			Expenditure on Research (4. 9%) ..
			All the courses are Graduate or Post-Graduate courses. Expenditure under teaching represents salaries of Teaching Staff and Laboratory Staff and cost of Chemicals & Apparatus.
			Expenditure under Research represents grants sanctioned to members of teaching staff for doing Research. Figures are for the current year and approximate.
5. Annamalai	Physics ..		The subjects cover post-graduate and under-graduate courses. Present research work of the university is mainly in Physics and Chemistry and also Mathematics and is academic in character.
	Chemistry..		
	Botany ..		
	Zoology ..		
6. Benares Hindu	Physics ..	Agriculture ..	Total Expenditure on Departments of Pure Sciences ..
	Chemistry..	(Industrial Chemistry) ..	1,42,059
	Botany ..	Ceramics ..	(includes expenditure on teaching staff of the entire Department and the expenditure on *M. Sc. & Research) ..
	Zoology ..	Pharmaceuticals 14,599*	Total expenditure on Applied Deptts. ..
	Geology ..	Glass Technology ..	Grand Total ..

Expenditure on Teaching .. Rs. 2,34,577
 Expenditure on Research .. Rs. 10,000 roughly

*Only M. Sc. & Research.

*includes Expenditure on B. Sc. & the teaching staff of the entire Department.

Chemistry :—

7. Bombay :
 Department
 of Chemical
 Technology.

Textile Chemistry,
 Chemical Engineering
 Foods, Drugs Pharma-
 ceuticals & Dyestuffs

Mainly an affiliating University. The Department is post-Graduate in character but no allocation is made separately for Research except for the provision made for one fellowship of Rs. 150 and 12 Research Scholarships of Rs. 75 P. M. maintained by the University. The total expenditure involved is Rs. 3,50,000 of which roughly 36-3% is spent on research, academic and Industrial. Pilot plant facilities are available.

		Rs.		
8. Calcutta	Physics ..	98,348	Mathematics	38,428
	Chemistry ..	89,695	Physics ..	48,774
	Botany ...	43,692	Chemistry ..	60,844
	Zoology ..	43,025	Psychology	7,753
	Psychology	56,056		
	Physiology & Biochemistry	18,274		
	Geology ..	14,605		
	Total Rs. ..	3,63,965		

Total expenditure on Pure Sciences	..	Rs. 3,63,965
Total expenditure on Applied Sciences.	..	Rs. 1,55,799
Total	..	Rs. 5,19,764

No separate Staff and Laboratory Expenses maintained for Teaching & Research. Research Scholarships & grants particularly for Research to Teachers amount to Rs. 53,407 (included in the total).

9. Dacca
 Mathematics
 Physics
 Chemistry

No figures are available regarding the expenses on Research and Teaching separately.

ANNEXURE VI—(Contd.)

Statement relating to Departments of Science and Research Expenditure of the Universities. (Figures relate to the latest financial year except where otherwise indicated).

Name of the University.	Department of Pure Sciences. Rs.	Departments of Applied Sciences,	Remarks.
10. Delhi	Physics 51,710-15-3 Chemistry 43,894-1-0		Total Expenditure on Departments of Pure Sciences *Rs. 95,605 0 3 Total Expenditure on Teaching Rs. 62,972 4 0 Total Laboratory Expenses Rs. 32,632 12 3 *Under-graduate Teaching included.
11. Lucknow	Physics Botany Zoology Chemistry Mathematics		No marked distinction of expenditure between Undergraduate and Post-graduate Teaching & Research. Total Expenditure on Applied Research ... Rs. 10,500 Facilities for Post-graduate Research exist in the Zoology dept.
12. Madras*	(1943-44) Bio-Chemistry 30,619 Botany .. 15,233 Zoology .. 20,174		The Departments are concerned with Post-graduate research and the figures represent expenditure on both Pure & Applied research. Total expenditure on Pure & Applied Sciences (Research) only. .. Rs. 66,026 (43-44) Total expenditure on Pure & Applied Sciences (Research) only .. Rs. 90,164 (40-41) Bio-chemistry .. Rs. 31,943 Botany .. Rs. 29,263 Zoology .. ,, 28,958
	*The College of Technology recently started by the University is expected in due course to carry on applied research in the various branches of Technology involving an estimated expenditure of Rs. 2 lakhs for both instruction & research.		<hr/> 90,164

13. Mysore * Physics, Chemistry, Botany, Geology, Zoology, Psychology and Mathematics.

No separate budget for Research.

14. Osmania
 Physics .. 5,400 *Chemistry*
 Chemistry .. 11,900 Hy. Chemicals*
 Zoology .. 5,000 Ceramics
 Botany .. 5,000 Vegetable oils
 Geology .. 1,000 *Fuel.* Rs.
 Mathematics .. 1,200 Chemistry 8,000*
 29,500 Recurring
 *for both undergraduate and post-graduate

*These Researches are being financed by the B.S. I. R., Hyderabad, Deccan and the C. S. I. R., Delhi.

The Technical Chemistry Laboratories of the University provide facilities for Industrial Research in Mineral Chemistry, Vegetable Oils, Ceramics, Pharmaceuticals & Drugs and Fuel.

Applied Chemistry non-recurring expenditure ..	2,00,000	Rs.
Total Expenditure on Deptts. of Pure Sciences ..	29,500	
“ “ “ Applied Sciences ..	8,000	
“ “ on Teaching ..	80%	
“ “ on Research ..	20%	

15. Nagpur (Luxminarain Institute) Chemical Engineering & Technology for B.Sc., (Tech.) courses.

	Rs.	Rs.
*For post graduate only	43-44	44-45
Total exp.	69,636 12 6	95,130 0 0
Total exp. on Teaching (Staff & Lab. exps.)	68,341 14 0	86,630 0 0
Total Expenditure on Research	1,294 14 6	8,500 0 0

Facilities available for Research upto the pilot plant stage and semi-commercial stage.

16. Patna (Science College) Physics .. 15,580* Chemistry
 Chemistry .. 16,179*
 Physical Chemistry 31,759
 Organic

*Annual grant for apparatus & chemicals includes expenditure for I. Sc., B. Sc., & M. Sc. students.

Facilities exist for Post-graduate Research (Pure & Applied) to a limited extent in physics & chemistry.

ANNEXURE VI—(Contd.)

Statement relating to Departments of Science and Research Expenditure of the Universities. (Figure relate to the latest financial year except where otherwise indicated).

Name of the University.	Departments of Pure Sciences.	Departments of Applied Sciences.	Remarks.			
			Additional grants	Cont.	Books	Periodicals.
			Physics	3,800	1,000	1,000
			Chemistry	5,100	1,000	1,000
				8,900	2,000	2,000
			Total Exp. on Pure Sciences		4,000	
					31,759	
					44,659	
	Rs.	Rs.				
17. Punjab	Chemistr .. 87,478	Technical	Total Exp. on Deptts. of Pure Sciences	..	1,77,877	0 0
	Physics .. 15,360	Chemistry .. 31,537	Total Exp. on Deptts. of Applied Sciences	..	31,537	0 0
	Zoology .. 32,263				2,09,414	0 0
	Botany .. 35,770		Exps. on Teaching (Staff & Laboratoty expenses included).	..	86% 1,80,214	0 0
	Astronomy .. 7,006		Exp. on Research	..	14% 29,200	0 0
					2,09,414	0 0
			Pilot plant facilities available for desiccation of foods. Well-equipped for all types of Basic & Applied Research.			
18. Travancore	Physics .. 39,835	The activities of the Department of Pure Science include under-graduate teaching. These Departments are under the control of the University and together constitute the Central Research Institute. Research in Applied Science covers such subjects as Industrial Chemistry, water and Food analysis, Agricultural Chemistry, Economic Botany, Mycology and Entomology involving a total expenditure (including routine work and assistance to Government Departments of Rs. 79,618.- in 1944-45) and also Marine, Biology and Fisheries (Expenditure Rs. 21,288.-).				
	Chemistry .. 31,880					
	Botany .. 16,730					
	Zoology .. 11,742					
19. Utkal		An affiliating University.				

ANNEXURE VII.

EXPLANATORY NOTE ON THE DIAGRAMMATIC REPRESENTATION OF THE RESEARCH ORGANISATION RECOMMENDED BY THE COMMITTEE

The chart on the next page is based as closely as possible on the recommendations of the Committee set forth in the Report. The organization of scientific and industrial research centres round the National Research Council which is composed of representatives of science (including universities and scientific and technical bodies), industry, labour and administration. The diagram shows the straight line of responsibility of the National Research Council and the Research Board which is the executive body of the Council, to the Hon'ble Member in Charge of Planning and Development.

Technical Standing Committees function as advisory bodies both to the Council and the Research Board. The Budget Committee is to scrutinise the budget prepared by the Research Board and report to the Council. The Grants Committee is to make recommendations for the allocation of budgeted grants to universities, etc., after necessary consultation with Provincial and State Research Councils; the latter will set up laboratories in their respective areas.

The Board of Standards and the National Patent Trust are shown as two major bodies set up as self-contained units under the auspices of the National Research Council.

Coming directly under the Research Board are the National Laboratories and Specialised Institutes to be established by the Council. Indication is given of the desirable co-ordination between these research institutions and other Government and aided laboratories, Industrial Research Associations and the Provincial and State Research Laboratories.

The contact between industry and universities is also indicated.

DIAGRAMMATIC REPRESENTATION OF THE RESEARCH ORGANIZATION
RECOMMENDED BY THE
INDUSTRIAL RESEARCH PLANNING COMMITTEE.

