

C O N T E N T S .

(Govt. of India)  
Industrial Research Bureau.

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**GOVERNMENT OF INDIA**  
**INDUSTRIAL RESEARCH BUREAU**



**REPORT**  
**FOR THE YEAR**  
**1935-36**



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1936

## ANNUAL REPORT OF THE INDUSTRIAL RESEARCH BUREAU FOR THE YEAR 1935-36.

### CHAPTER I.

#### INTRODUCTION.

The question of the organisation of industrial research was considered by the Fifth Industries Conference in July 1933, by the Provincial Economic Conference in April 1934, and by the Sixth Industries Conference in July 1934. In a memorandum placed by the Government of India before the Sixth Industries Conference the position was summarised as follows :—

“ The subject Co-ordination of Industrial Research was discussed at the Fifth Industries Conference held at Simla in July 1933 (*vide* Bulletins of Indian Industries and Labour, No. 50) and the following conclusions were arrived at :—

- (1) Some central co-ordinating authority should be set up for the collection and dissemination of industrial intelligence, co-ordination of research, and organisation of industrial exhibitions.
- (2) The Imperial Council of Agricultural Research could not suitably undertake these functions.
- (3) Direct financial assistance under the present Provincial State Aid to Industries Act could only be partially effective in the development of industries in the absence of a central agency of co-ordination, particularly in respect of methods not available to provincial Governments.
- (4) The Central Advisory Agency should also advise on the centres at which adequate facilities exist for training in the subjects recommended.

“ 2. The subject was discussed again at the recent Provincial Economic Conference, and as a result of these discussions the Government of India have in their Finance Department Resolution No. F. 16 (1) F./34, dated the 5th May 1934, announced their decision to establish a Central Bureau of Industrial Intelligence and Research which will be attached to the Indian Stores Department.

“ 3. It has been held that it is at present not a practicable proposition to endeavour to set up in India an industrial research organisation on the lines of the great research organisations which exist in some of the more advanced industrial countries, but that something could and should be done to make a beginning and to lay the foundations on which a research organisation suitable for the needs of the country could later on be constructed. The Indian Stores Department in its day to day work is in very close touch with many of the important industries in India, and particularly with many of the industries

which have only been established within recent years, and will be able to obtain the goodwill and interest of manufacturers in the new venture. The Department has at its disposal well-equipped laboratories which are almost wholly engaged on the work of examining the products of these industries, and, as a purchasing authority, it has the power to assist industries by purchasing their products. It is also in a position, from the inspection and examination of the articles which it deals with, to indicate directions in which research should be undertaken in order to improve standards and qualities. It is essential that the industrial research authority that may be set up, should prominently keep in mind the necessity of giving the greatest attention to research which will yield practical results rather than research of a purely academic character. For these reasons it has been decided that the Indian Stores Department could most appropriately be entrusted with the duties of organising and supervising the new venture. The Bureau will, for the present, form a branch of the Indian Stores Department and will be under the general control of the Chief Controller of Stores, but with a large measure of independence in its day to day operations. It will be organised on self-contained lines in order that in time it can be separated from the Indian Stores Department and formed into an independent department. The duties which it is proposed to entrust to the new Branch or Bureau are enumerated in paragraph 13 of the Finance Department Resolution of the 5th May 1934 referred to above. Full details of the cost of the organisation have not yet been worked out, but on the figures which have been placed before them, the Government of India have tentatively decided to provide funds in the first instance to the extent of Rs. 5 lakhs spread over three years. This expenditure, it is anticipated, will suffice to give the Bureau a fair start and to enable the Government of India to test the value of such an organisation."

The Conference subsequently adopted a detailed scheme based on proposals drawn up by Sir James Pitkeathly, the Chief Controller of Stores. This scheme was accepted by the Government of India and was put into operation from the 1st of April 1935. The present report therefore deals with the first year of its working.

The organisation for Industrial Research as it now exists comprises three bodies :—

- (a) The Industrial Research Council.
- (b) The Industrial Research Bureau.
- (c) The Research Branch of the Government Test House.

The Industrial Research Council which is an advisory body, has been established with a view to the co-ordination and development of Industrial Research. It includes representatives and non-official nominees of the central, the Provincial and the leading State Governments. The Council at present meets



once a year when all important questions of policy are brought before it. Questions arising during the year which cannot be delayed until the Council meets are dealt with by correspondence.

The Industrial Research Bureau is responsible for carrying out the policy laid down on the recommendations of the Council and in general with all the administrative work of the organisation.

The Research Branch of the Government Test House has been formed in order to deal with the research programme drawn up by the Council and also with such minor problems as may arise from time to time from references made to the Bureau.

## CHAPTER II.

### INDUSTRIAL RESEARCH COUNCIL.

The first session of the Industrial Research Council was held in Simla on the 8th and 9th of July 1935 under the chairmanship of Mr. A. G. Clow, Officiating Secretary to the Government of India, Department of Industries and Labour.

The question of the co-ordination of industrial research in different laboratories was considered and it was decided that, in the first place, a committee should be appointed to survey the research already conducted and in progress on fatty oils, soaps and essential oils and to advise on the co-ordination of this research generally and in particular on the allocation for future research to suitable centres.

In order to ascertain the position with regard to publications in India on industrial matters, it was recommended that particulars of all industrial bulletins published since 1921 be sent to the Bureau, which should publish and circulate a catalogue and that thereafter lists of fresh bulletins should be sent at intervals and a combined list be issued by the Bureau. It was also recommended that the Bureau should publish bulletins giving the results of its own researches and enquiries and should consider memoirs sent to it for publication.

The following items of research work were approved for the Research Branch of the Government Test House :—

- (a) The investigation of the properties of different paint formulae in connection with the protection of structural steel and other painting purposes.
- (b) The investigation of the behaviour of vegetable oils for the lubrication of internal combustion engines.
- (c) A preliminary investigation of the possibility of using vegetable oils as fuels for internal combustion engines.
- (d) The investigation of the behaviour of Indian and British cement when tested under Indian conditions in accordance with the proposed British Standards specifications. The investigation of the properties of sands and gravels when used in making mortars and concretes for the standard tests required in the proposed new British Standards Specification.
- (e) *Lime and Cement Concretes.*—The investigation of the following problems :—
  - (i) The pozzolanic effect of surki and the effect on the pozzolanic action of different methods of preparations of surki.
  - (ii) The influence on the properties of lime concrete of the addition of molasses.
  - (iii) The effect on the properties of lime of different methods of slaking.

- (iv) The effect on the properties of lime when stored as lime paste under water.
- (v) The effect on the properties of mortar and concrete when lime is mixed with portland cement in various proportions.
- (f) *Dry Cells*.—The investigation of the effect of the properties of dry cells of systematic variation in the composition of the ingredients.
- (g) *Sands and Felspars*.—The analysis of the different known Indian sands and felspars with the view to their utilization in the manufacture of glass.

The problems of the glass industry were considered at some length and it was eventually recommended that the Bureau should undertake a survey of the glass factories in India and publish a review of the whole position and also that it should investigate the question of the production of glass suitable for the manufacture of bangles on a cottage industry basis.

A Sub-Committee was appointed to consider the question of the award of prizes for industrial papers for which purpose a sum of Rs. 10,000 had been set aside from the funds of the Bureau.

In order to enable the officers of the Bureau to judge to what extent it is likely to be practicable to take active steps for industrial standardization and also in some cases to make suggestions for the modification of specifications in order that Indian products are not unnecessarily excluded Directors of Industries or corresponding officers were requested to obtain from consuming departments of their Governments copies of specifications used by them and to forward them to the Bureau with their remarks. The Railway Board and the Indian Stores Department were also requested to refer all draft specifications to the Bureau before final issue.

The question was considered of co-ordination with the Imperial Council of Agricultural Research and it was decided that the Director should discuss with the Imperial Council measures which could be adopted to ensure close collaboration between the two organisations.

*Oils and Soap Committee of the Industrial Research Council*.—The Oils and Soap Committee met in Calcutta on November the 25th and 26th, 1935. A number of sub-committees was appointed to deal with different aspects of the subjects under discussion and it was decided that a further meeting of the full committee should be held in Simla later. It was subsequently arranged that the second meeting should take place in June 1936.

*Prizes Sub-committee*.—The Prizes Sub-committee drew up a set of conditions for the award of prizes and the terms of the competition were announced in October 1935. The number of papers received was fifty-seven and the entries were still under examination at the end of the year.

## CHAPTER III.

### RESEARCH BRANCH OF THE GOVERNMENT TEST HOUSE.

To enable the Research Branch of the Government Test House to be formed additional staff, comprising one Research Officer, one Assistant Research Officer, four Chemical Assistants and four Physical Assistants, was sanctioned by the Government of India. With the exception of the Research Officer who has been selected and will join his appointment in July, all these officers were recruited by the Public Service Commission and have taken up their duties. The Assistant Research Officer arrived on the 23rd September 1935, four Chemical Assistants on various dates in July 1935, one Physical Assistant also in July, one in October, one in January 1936, and one in March 1936.

After a preliminary period for training and examination of the subjects for investigation, and consideration of additional plant and equipment required, a beginning was made on the work of each of the special subjects, enquiries issued for the additional plant and equipment considered to be necessary, and orders placed for these in due course. The majority of the individual items of additional plant and apparatus have been delivered only towards the end of the period under review, and in the meanwhile the greater part of the work on each subject has perforce been of a preliminary and analytical character. Details of the work so far carried out in each subject, together with statements of the plant and equipment acquired in connection therewith, and now in process of installation, are given below.

*Paint.*—A comprehensive programme of paint testing has been arranged to include the following types of plant: white, red lead, grey, black, green and red oxide. During the year 15 black paints composed of magnetic oxide of iron together with other black pigments in different proportions have been prepared and exposed. Prior to the period under review 34 black paints were prepared and exposed and will be taken as included in this series. These consist of lamp black, carbon black, bone black, mineral black, magnetic oxide, genuine and mixed with other pigments and also certain proprietary paints. A series of white paints numbering 36 in all have been prepared in the stiff form and will subsequently be used for exposure tests. These include white lead, zinc white, antimony oxide and titanium oxide, genuine and reduced, and mixtures of these pigments in various proportions. Similarly, a series of 35 red oxide stiff paints has been prepared. These include genuine and reduced red oxide of different types, natural and artificial, both Indian and imported. A series of 64 red lead paints has been prepared in order to determine the setting properties of red lead under different conditions.

The following equipment for work on paint has been obtained:—

- 3 Small Vortex Mixers.
- 2 Small End Runner Mills.
- 1 BWM-C Type Weather-o-meter.

Three test fences each 180 feet long have been erected to carry test panels.

*Dry Cells.*—The work done so far in connection with this subject consists of (1) detailed examination of the construction of dry cells and (2) complete analysis of the component materials. Dry cells of well known makes were obtained direct from the manufacturers' principal agents, opened carefully both in sections and in layers in order to ascertain the structural details as well as to collect the different ingredients in a pure state. The chemical examination of discharged cells as well as of certain fresh cells of cheaper makes will also be undertaken shortly.

The collection of the necessary component ingredients from indigenous sources and the purchase of various items of machinery, etc., required for the experimental preparation of these cells in the Government Test House on the lines suggested by the data so far collected, is in progress. The following apparatus is being obtained for this purpose :—

- (1) A shearing machine for cutting zinc sheets to the correct size of strip.
- (2) A small Roller Mill for giving zinc strip the required thickness, with central action and simultaneous pressure motion.
- (3) A tinsmith's Rolling Mill for giving zinc strips the correct cylindrical shape.
- (4) A Punching Machine or Press for punching out zinc cylinder ends, and also for making brass terminal caps.
- (5) A Drop-type Compressor for compressing the depolarising element into the desired shape.
- (6) A Hand Compressor, to determine the comparative effect of the two different methods of compressing the materials to form the depolariser.

*Glass.*—As in the case of dry cells, the work done so far has been mainly of an analytical nature. Six specimens of coloured glass bangles of Indian and Japanese manufacture have been analysed completely and their compositions determined, with special reference to the nature and quantity of the colouring materials employed in the various cases. The results are sufficiently conclusive in some cases, but somewhat vague in the others ; this is presumably due to the indefinite nature of the colour of the specimens themselves. In order to elucidate the matter further, qualitative tests have been undertaken with specimens having well defined colours, selected from samples of glass bangles supplied by the Director of Industries, Bombay.

Eight samples of Indian sand have been analysed completely to determine their suitability for the manufacture of glass. Most of them appear to be of satisfactory composition, and even certain of those that have an iron content of about 0.2% may be suitable for the manufacture of coloured glasses.

The following apparatus for work on glass has been obtained :—

- (1) A compressed air-gas furnace of the Fletcher-Russel type ; designed and made by the University Science College, Calcutta.
- (2) An " Empire " air blower No. 3 ; capable of supplying 32 cu. ft. of air per minute, at a maximum pressure of 5 lbs. per square inch.

*Vegetable oils for Internal Combustion Engines.*—Under this head two investigations have been undertaken, (1) the examination of the possibility of using vegetable oils as lubricants in internal combustion engines, and (2) a preliminary investigation of the possibilities of using vegetable oils as fuels for light diesel engines.

The oils selected for the first investigation were arachis oil, mustard oil, sesame oil, cotton seed oil and castor oil. Arrangements were made for obtaining suitable quantities of these oils in order that they might be examined in detail and their chemical and physical characteristics recorded for future reference. In most cases the oils were expressed in factories but in the presence of a Chemical Assistant of the Government Test House. The following characteristics have been recorded :—

- (1) Specific gravity, (2) Closed flash point, (3) Viscosity at 40°C., 60°C. and 100°C., (4) Saponification value, (5) Iodine value, (6) Acid value, (7) Conradson carbon residue, (8) Ash, (9) Setting point, (10) Rise in viscosity in the Air Ministry oxidation test, (11) Coke number of oil before and after oxidation, and (12) Co-efficient of static friction.

The oils selected for trial as fuel in light diesel engines were received from the Director of Industries, Bombay, and consisted of oil of punnal, oil of Karanj and inferior arachis oil. These are also being subjected to the tests mentioned above.

The following units have been purchased and are now being installed as a combined testing set :—

- (1) A Morris Industrial 4-Cylinder petrol engine set giving 16 B.H.P. at 1500 R.P.M.
- (2) An electrical dynamometer with power dissipating resistances and control switch-gear, for the determination of brake horse-power and for loading purposes.
- (3) A Lister diesel oil engine giving 8 B.H.P. at 1200 R.P.M.

These three units are being mounted on a common base-plate so that either engine can be readily coupled to the dynamometer.

A C.F.R. variable compression engine for the determination of the anti-knock ratings of aviation petrols and spirits was installed and set to work some time ago. This unit is provided with parts to enable it to be converted to a diesel engine, and it was intended to adapt it and use it as such for the fuel oil investigations. It has, however, been found that the C.F.R. engine is likely to be constantly required for tests of aviation spirits for some time to come, and a light diesel engine has therefore been bought. The design of this engine lends itself to modification to provide for variable compression for testing work.

*Lime, Cement, Sand, Surki, etc.*—A comprehensive test programme was drawn up on the lines of the British Standards Institute test programme of

1932 for mortar and concrete tests to be carried out at the Government Test House :—

- (1) On English cement with English sand and gravel, and
- (2) On three varieties of Indian cement with English sand and gravel, and also with Indian sand and gravel.

A programme was also drawn up for similar tests on Indian cements, sand and gravel in England by the Building Research Station on completion of the tests in India. The above test-programmes were forwarded to the Institution of Engineers (India), and accepted by them on behalf of the British Standards Institution.

A number of samples of sand and gravel was collected from various sources in India to enable the most suitable Indian sand and Indian gravel in accordance with the British Standards Institution requirements to be selected for use in the above tests. Seventeen samples of sand and thirteen samples of gravel have been examined and an Indian sand and an Indian gravel were finally selected. The Indian gravel selected, although satisfying the British Standards Institution requirements in every respect, was found to be dissimilar to the corresponding English gravel received for test from the Building Research Station. The matter was accordingly referred, through the Institution of Engineers (India) and the British Standards Institution, to the Building Research Station, who stated that tests with this Indian gravel should give results comparable with English gravel supplied from the Building Research Station.

As the sample of English cement was received in the Government Test House in leaky drums, it was decided in consultation with the Institution of Engineers (India) to abandon the tests on it. The British Standards Institution was accordingly requested to send a further sample of the original English cement. The Institution stated, however, that no sample of the original cement was available.

The Government Test House has recently been informed by the British Standards Institution that the Cement Testing Panel is engaged in examining a new method devised at the Building Research Station of preparing mortar cubes with a view to preparing a new programme of tests. In the new circumstances, the Government Test House was requested to suspend further work in connection with the original test programme.

Two Indian sands have so far been examined in an endeavour to find a substitute for Leighton Buzzard Sand. There are (1) Malarna sand obtained from a river bed in Bundi State and (2) Sone River sand obtained from the bed of the river Sone in Behar. Both these sands are mostly, but not wholly, quartz. Both samples have so far given variable results, presumably owing to their lack of uniformity, and therefore appear to be unsuitable for use as standard sand. Owing to the tests on river sands, so far as they have been carried out, giving variable and unsatisfactory results, attempts are being made to obtain sea sand and other sands of the correct type, shape and grading with a view to examining their suitability for use for this purpose.

An electric furnace has been ordered, suitable for the experimental burning of clays for the manufacture of surki. Specimens of commercial bricks, made

from different clays and of different degrees of burning, have also been obtained and will be ground to obtain surki of various types.

A high calcium unslaked lime and a high magnesian unslaked lime have been selected and obtained for experimental purposes. Tests are now in progress to determine (1) the pozzolanic effect of surki, and also the effect on the pozzolanic action of different degrees of burning of surki (2) the effect on the properties of lime of different methods of slaking, using the materials described above.

The following methods of slaking lime are under examination :—

1. Isothermal slaking of lime at two different temperatures, viz., at 30°C. and 100°C.
2. Slaking of lime into dry powder inside a closed vessel with slight excess of water.
3. Slaking of lime by exposure to water vapour.

The following machines have also been purchased and are in course of erection :—

1. A laboratory edge runner mill for mixing and preparing clay prior to burning.
2. A grinding mill for surki grinding.
3. A sieving machine for sieving surki to various requirements, and also for grading sand and gravel for concrete making.

*Air-conditioned test-room.*—An air-conditioned test-room has been installed and equipped for carrying out tests on cement and dry cells, etc., under constant temperature and humidity conditions. The temperature regulation is satisfactory, but the humidity regulation falls short of requirements and the contractors are taking steps to effect improvement.



## CHAPTER IV.

## INDUSTRIAL INTELLIGENCE.

*Survey of Glass Factories.*—In accordance with the recommendation of the Industrial Research Council a survey of Indian glass factories was undertaken by Mr. E. Dixon, Assistant Director, Industrial Research Bureau, in a series of tours made during January, February and March 1936. In the course of these tours all the principal glass making areas of India were visited. Mr. Dixon has written a report of his survey which will be published shortly.

*Rayon.*—At the request of the Indian Central Cotton Committee an examination has been undertaken of the possibilities of the manufacture in India of rayon (artificial silk) and staple fibre.

*Lubricating oils and paints.*—A number of questions arising in the lubrication of railway rolling stock and in the painting of railway wagons have been examined on behalf of the Railway Board.

*Other Enquiries.*—Various requests for information have been received from other sources and dealt with but the number of enquiries received from industrialists has been disappointingly small.

*Research Programmes.*—The duty of compiling a joint programme of industrial researches in progress in India has been taken over from the Imperial Council of Agricultural Research and also the arrangements for the interchange of information regarding industrial research between the Indian bodies concerned and the Department of Scientific and Industrial Research in Great Britain.

*Scrutiny of specifications.*—In accordance with the conclusion reached by the Industrial Research Council, specifications drafted by the Indian Stores Department and the Central Standards Office, Railway Board, have been received and scrutinised to ensure that Indian products are not unnecessarily excluded.

*Library.*—The library of the Bureau contained on the 31st March 1936, 2,534 publications of all descriptions, excluding journals. The number of Journals received regularly is 37. The contents of the library are classified and indexed according to the "*Classification Decimale of the Institut International de Bibliographie*".

*Bibliography.*—A bibliography of Indian publications dealing with industrial research, or otherwise of industrial importance, was undertaken and completed towards the end of the year. The bibliography has been published recently and it is hoped that it will be of assistance in the avoidance of overlapping of research.

## CHAPTER V.

### CO-ORDINATION WITH IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH.

The conclusion reached on the question raised in item IX of the Proceedings of the First Session of the Advisory Council for Industrial Intelligence and Research, viz., co-ordination with the Imperial Council of Agricultural Research, was that the Director of the Bureau should discuss with the Imperial Council methods which could be adopted to ensure close collaboration. A meeting was therefore arranged with Sir Bryce Burt, Officiating Vice-Chairman of the Imperial Council. The following paragraphs are based on the discussions which took place.

The Imperial Council of Agricultural Research is in some cases interested in industrial matters closely linked with agriculture. The most important of these are :—

- (1) Sugar
- (2) Lac
- (3) Vegetable oils.

*Sugar.*—The Imperial Council is negotiating an agreement with the Government of the United Provinces by which the greater part of the Harcourt Butler Institute will be taken over by the Imperial Council and devoted to sugar research and instruction in sugar technology. This research will be almost entirely on the industrial side. The Government of India has agreed to the expenditure of Rs. 2,50,000 a year for 5 years for recurring expenditure and Rs. 1,50,000 for capital expenditure. The research will be entirely under the control of the Imperial Council and not, as at present, carried out by the Local Government with the help of a grant from the Imperial Council. As the scope of this work is clearly defined, no difficulty in avoiding clashing with the work of the Bureau should arise. It may be added that various Directors of Industries and others have interested themselves, either in the abstract or as a matter of actual research, with the question of the disposal of molasses. In view of the exceptional facilities that will be available at Cawnpore it seems desirable that such questions should be referred to this laboratory, thus enabling the limited facilities of Provincial industrial laboratories to be used for other work.

It may be added that one of the items of research to be undertaken at the Government Test House concerns the utilization of molasses in lime concrete. As this comes rather under the head of research on lime concrete rather than of research on the utilization of molasses, it does not seem necessary to do more than to draw the attention of the Imperial Council to this item.

*Lac.*—Research in lac in all its aspects—arboreal, entomological, chemical and industrial—is carried out at the Lac Research Institute, Namkum, Ranchi, which is under the control of the Indian Lac Cess Committee. The Committee also finances three research officers in England, two at the Teddington Paint and Varnish Research Station and one at the British Thomson Houston Research Station at Rugby (Electrical Industries) and has made two other research grants for research on applications of Lac. It also contributes to the Research Bureau of the U. S. A. Shellac Importers Association, New York. Here again the subject of research is well defined and offers no difficulty.

*Oils.*—Research on fatty oils is also undertaken at the Harcourt Butler Institute but on a different basis from sugar research. The Imperial Council at present, and as a temporary arrangement, makes a grant to the Local Government of Rs. 30,000 a year, substantially the whole cost of the work (instructional and experimental). This is now the second year of this grant. The future arrangements for oil research at the Institute will doubtless depend on the decision of Government on the proposal now before them for the levying of a cess on oil-seeds. If such a cess comes into operation, research in vegetable oils will presumably be financed from the proceeds. If it does not come into operation, the Imperial Council may wish to reconsider its position in connection with the grant. The present arrangement offers no difficulty from the point of view of the Bureau, since the Imperial Council has no objection to the oil research financed by them being reviewed by the Oil Research Sub-Committee of the Industrial Research Council.

There are two separate bodies concerned with oil, *viz.*, the Indian Oil-seed Crushing Industry Committee appointed by the Imperial Council and the Sub-Committee of the Industrial Research Council referred to above. But a perusal of the records of the former committee does not suggest that over-lapping is probable. The Committee has concerned itself but little with technological research in the sense in which this is understood by the Industrial Research Council. It is evident that, with proper liaison, difficulty can be avoided. The Imperial Council have invited a representative of the Bureau to serve on their Committee and it is suggested that a representative of the Imperial Council should also be invited to serve on the Industrial Research Council's Sub-Committee.

*Other Industrial Research.*—The Imperial Council has from time to time financed other minor items of research. It is understood that if, in future, any question of undertaking research of an industrial nature should arise, the question will first be referred to the Bureau for its opinion.

*Cotton.*—Research on cotton is in the hands of the Indian Central Cotton Committee. Although this body is distinct from the Imperial Council, the two are closely connected as the Vice-Chairman of the Imperial Council is the Chairman of the Committee and the Agricultural Expert is a member of the Committee. There is therefore no difficulty in arranging that principles similar to those mentioned in the case of the Imperial Council should apply also to the relations between the Committee and the Bureau. The Committee has to some extent interested itself in industrial work and has recently been engaged in studying the question of the establishment in India of the artificial silk industry. The Technological Sub-Committee of the Indian Central Cotton Committee has also nominated representatives to a small joint committee set up to secure collaboration between the Technological Department of the Bombay University, the Victoria Jubilee Technical Institute (Textile Section) and the Cotton Committee's Technological Laboratory. This is an example of a matter of common interest to the Committee and the Bureau and it is desirable that, if any such question should arise in the future, it should be considered in consultation with the Bureau. Similarly if the Advisory Council should decide to take up any aspect of cotton research, it is desirable that the Central Cotton Committee should be consulted.

## CHAPTER VI.

### STAFF AND EXPENDITURE.

The following statement shows the sanctioned strength of the Industrial Research Bureau and the Research Branch of the Government Test House and the actual strength on the 31st March 1936 :—

#### *Staff.*

	Sanctioned strength.	Actual strength on 31-3-36.
<i>Industrial Research Bureau—</i>		
Director .. .. .	1	1
Assistant Director .. .. .	1	1
Superintendent .. .. .	1	1
Technical Assistants .. .. .	2	2
Assistants and Clerks .. .. .	18	10
Stenographers .. .. .	2	2
Duffries .. .. .	2	2
Duffadar .. .. .	1	1
Peons .. .. .	4	4
<i>Research Branch of the Government Test House—</i>		
Research Officer .. .. .	1	..
Assistant Research Officer .. .. .	1	1
Chemical Assistants .. .. .	4	4
Physical Assistants .. .. .	4	2
Clerks .. .. .	4	3
Laboratory Bearers .. .. .	3	3
Peons .. .. .	3	2
Mistries .. .. .	2	2

#### *Expenditure.*

*Expenditure during the year 1935-36 (preliminary figures).*

	Rs.	s. p.
Industrial Research Bureau .. .. .	81,191	12 11
Research Branch of the Government Test House .. .. .	38,247	3 10
	1,19,439	0 9

GOVERNMENT OF INDIA  
INDUSTRIAL RESEARCH BUREAU



REPORT

FOR THE YEAR

1936-37



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## INTRODUCTION.

This report deals with the activities of the organisation which was brought into operation on the 1st April 1935 to develop Indian Industrial Research, namely, (a) the Industrial Research Council, (b) the Industrial Research Bureau, and (c) the Research Branch of the Government Test House, during the second year of their working.

The relationship of the three parts of the organisation one to another was explained in the beginning of the Report for the year 1935-36, in which the functions of each were also stated. Briefly repeated, these functions are as follows :—

The Industrial Research Council is an advisory body, consisting of representatives and non-official nominees of the Central, Provincial and leading State Governments, in which is vested the duty of co-ordinating and developing industrial research. This body meets once a year in various centres, when all important questions of policy are brought before it for discussion and recommendations are made to the Government of India and other authorities.

The Industrial Research Bureau is responsible for carrying out the work entrusted to it by the Government of India in pursuance of the recommendations of the Council, and for all the administrative work of the organisation.

The Research Branch of the Government Test House has been formed to deal with the research programmes suggested by the Council, and also with other problems which are from time to time referred to the Bureau.



## CHAPTER I.

## THE INDUSTRIAL RESEARCH COUNCIL.

The Council held its second session in the Bengal Legislative Council Chamber in Calcutta on the 2nd and 3rd July 1936, the session being opened by the Hon'ble Sir Frank Noyce, K.C.S.I., C.B.E., I.C.S., Member of the Governor General's Executive Council, in charge of the Department of Industries and Labour. The Hon'ble Mr. A. G. Clow, C.S.I., C.I.E., I.C.S., Chairman of the Council, presided and the session was attended by 19 other members, and the Secretary. Five other gentlemen attended, by request, in connection with various items of the agenda discussed. Eight members were unable to be present.

No change in the personnel of the Council took place during the year.

The following items were included in the Agenda discussed by the Council :—

1. The Report of the Oils and Soap Committee.
2. Allocation of prizes.
3. Research programme of the Government Test House.
4. Road research.
5. Casein plastics.
6. Industrial standardization.
7. Co-ordination with the Imperial Council of Agricultural Research.
8. Publications of the Bureau.
9. Publication of the proceedings of the Council.
10. Procedure in dealing with requests for information.
11. Compilation of information regarding researches.
12. Survey of glass factories.
13. Improvement of glass furnaces.
14. Survey of glass-making materials.
15. Accessories for bangle manufacture.

The discussions which took place on certain of these items of the agenda and the conclusions arising out of these discussions are briefly summarised in this Chapter. In the case of items which have subsequently been the special concern of the Bureau or of the Research Branch of the Government Test House, the subjects have been further dealt with in the subsequent Chapters of this Report, where the developments arising out of the discussions and recommendations of the Council have been fully described.

**1. THE REPORT OF THE OILS AND SOAPS COMMITTEE.**—The Council approved the report of the Committee and the recommendations made therein. The action taken on these recommendations and the present position of the various researches which the Committee proposed are described in Chapter V.

2. ALLOCATION OF PRIZES.—On the recommendations of the Sub-Committee appointed to consider the awarding of prizes for papers submitted for the competition initiated at the first session of the Council, the following papers were awarded prizes of the values stated :—

Subject.	Author or authors.	Value of prize.
		Rs.
The Manufacture of Photographic Plates in India.	N. Kasinathan, M.A., M.Sc., 4, Kali Mohan Banerjee Lane, Bhowanipur Post, Calcutta.	1,000
Process for the Preparation of pure $Al_2O_3$ and $SO_3$ gas from Bauxite-Gypsum Mixtures.	1. Dr. V. S. Dubey, M.Sc., Ph. D., D.I.C., Professor of Economic Geology, Benares.	500
	2. Professor M. B. Rane, M.A., Rampur Professor of Chemistry, Benares.	
	3. M. Kanakaratham, M.Sc., Benares.	
Utilization of Nepheline Syenite Rock.	1. Dr. V. S. Dubey, M.Sc., Ph.D., D.I.C., Benares.	250
	2. P. N. Agrawala, M.Sc., Benares.	
Losses on Electrical Machinery due to Open Slots.	Kenneth Aston, B.Sc., Tech., M.I.E.E., Professor of Electrical Technology, Bangalore.	250
Aromatic Resources of India ..	Sadgopal, M.Sc., Chief Chemist, Hindustani Aromatics Co., P. O. Lanka, Benares.	150
Saponification of Mahwa Oil ..	R. K. Gobhil, B.Sc., A.H.B.T.I., Research Scholar, Harcourt Butler Technological Institute, Cawnpore.	150
A New Process for the Solvent Extraction of Castor Seed with Rectified Spirits.	Dr. N. G. Chatterji, Harcourt Butler Technological Institute, Cawnpore.	150
The Preparation of New Wetting Agents.	1. K. Venkataraman, M.A., M.Sc., Tech., Ph.D., F.I.C.,	150
	2. D. R. Dhingra.	
	3. I. S. Uppal, The University, Bombay.	
The Utilization of Waste Glass in the Manufacture of Sodium Silicate.	1. Dr. R. L. Datta, D.Sc., Deptt. of Industries, Bengal, Calcutta.	150
	2. R. N. Mukerjee, Department of Industries, Bengal, Calcutta.	
The Manufacture of Santonin in India.	1. T. P. Ghose, Forest Research Institute, Dehra Dun.	150
	2. S. Krishna, Forest Research Institute, Dehra Dun.	
Cashew Nut Shell Oil and its Utilization.	N. M. Patel, Royal Institute of Science, Mayo Road, Bombay.	150

The Council appointed a committee consisting of Mr. Advani, Rai Bahadur Ram Lal, the Director of Industries, Mysore, and the Director of the Bureau to formulate a prize scheme for the following year, and to adjudicate on the papers submitted and recommend the grant of awards. The committee were asked to consider the possibility of defining the scope of the competition so as to cover papers which deal with the adaptation of known results to Indian conditions, and of prescribing a subject or subjects for competition. They were asked to consider the making of satisfactory arrangements in respect of rights of publication. The action taken by the Committee on these recommendations is described in Chapter II.

3. RESEARCH PROGRAMME OF THE GOVERNMENT TEST HOUSE.—The work carried out by the Research Branch on the various researches and investigations entrusted to it during the year was noted with satisfaction. The progress made during the year under report is shown in Chapter III.

4. ROAD RESEARCH.—The Council approved the proposal that the Bureau should arrange for the construction of a road test-track at or near to the Government Test House and subsequently supervise the research work in connection with the track, the construction of the track and the research work being financed from the Road Fund. The progress made in connection with these proposals is described in Chapters II and III under this heading.

5. CASEIN PLASTICS.—The question of encouraging the manufacture of casein plastics in India was considered by the Council and supported by the Directors of Industries of the United Provinces, Punjab, and Baroda. The Director of Industries, United Provinces, was asked to prepare a note on the progress made in the manufacture of this material at Dayalbagh, and to report on any difficulties requiring attention. The Bureau was also asked to consult the Imperial Council of Agricultural Research on the bearing of development of this industry on the nutrition question. The present position of this matter is shown in Chapter II.

6. INDUSTRIAL STANDARDIZATION.—The subject was again discussed at the second session, and the advisability of all consuming departments using the same specifications was considered. The Chief Controller of Stores was asked to supply copies of those specifications for which Directors of Industries apply, and Directors were asked to send to the Chief Controller of Stores lists (in a form prepared by him) of articles in common use for which specifications are not available. Chapter II indicates the present position of this matter.

7. CO-ORDINATION WITH THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH.—The memorandum submitted by the Director, Industrial Research Bureau, was noted.

8. PUBLICATIONS OF THE BUREAU.—At the time of the second session, two bulletins, "Bibliography of Industrial Publications published in India from 1921" and "A Survey of the Indian Glass Industry" were complete, and a third publication on the annealing of arsenical copper bar was in proof form. Directors of Industries were asked by the Council to suggest the names of provincial officers who could write bulletins on subjects with which they were familiar. The suggestions made were considered by the Council, and it was agreed

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that four of the gentlemen proposed be invited to write papers on industrial subjects on which they are experts. The progress made in connection with this subject is shewn in Chapter II under the appropriate heading.

9. PUBLICATION OF PROCEEDINGS OF THE COUNCIL.—The Council considered the question of publication of the proceedings and recorded the conclusion that the proceedings should not be published, but that they should be summarised on a somewhat fuller scale than that adopted for the first report, in future Annual Reports.

10. PROCEDURE IN DEALING WITH REQUESTS FOR INFORMATION.—The Council decided that a Director of Industries addressing or answering an enquiry which he regards as likely to be of interest to the Bureau should send a copy to the Bureau. The matter is referred to in Chapter II under the above heading.

11. COMPILATION OF INFORMATION REGARDING RESEARCHES.—The Council recommended that Directors of Industries be asked to send annually to the Director of the Bureau a list of researches in progress and contemplated, and that the Bureau should draw up a combined annual list to be sent to all members of the Council. Reference should in this connection be made to Chapter II.

12. SURVEY OF GLASS FACTORIES.—The conclusions of the Council on this item of the Agenda as well as on items 13, 14 and 15 on connected subjects concerning the Glass industry have been summarised in Chapter IV, where the work carried out during the period under review for the assistance of this industry is also described.

13. VISITS TO INDUSTRIAL LABORATORIES.—The members of the Council visited the Government Test House on the afternoon of the first day of the session, and the Bengal Tanning Institute and the Industrial Research Laboratory of the Government of Bengal on the afternoon of the second day.

## CHAPTER II.

## WORK OF THE BUREAU.

STAFF.—The sanctioned strength of the Industrial Research Bureau and the actual strength on the 31st March 1937 were as follows :—

Rank.	Sanctioned Strength.	Actual Strength on 31st March 1937.
Director .. .. .	1	1
Assistant Director .. .. .	1	1
Superintendent .. .. .	1	1
Technical Assistants .. .. .	2	2
Librarian .. .. .	1	1
Assistants and Clerks .. .. .	13	10
Stenographers .. .. .	2	1
Draftsman .. .. .	1	1
Tracer .. .. .	1	..
Others .. .. .	11	7

Mr. N. Brodie was compelled to proceed on sick-leave for two years out of India in February 1937, and Mr. E. F. G. Gilmore, Superintendent, Government Test House, took over charge of the Bureau during March 1937.

PRIZES COMMITTEE.—The Director of the Bureau, in correspondence with the other members of the Prizes Committee, drew up particulars of the terms and conditions for the submission of papers during 1936-37, and the competition was advertised in various newspapers in November 1936. The closing date of the competition was March 1st, 1937. With regard to the suggestion that subjects for papers might be specified, it was decided that the response in connection with the previous year's competition was not of a sufficiently high standard to indicate that any restriction of this nature would produce good results. Twenty-six papers were received and circulated to the members of the Sub-Committee, and a proportion of them to selected expert referees. A meeting of the Committee will be held in Bombay prior to the Council meeting, when final decisions regarding the recommendation for the award of prizes will be reached and reported to the Council.

ROAD RESEARCH.—Good progress has been made with the design of the equipment for the proposed Road Test Track at Calcutta. The track proposed will consist of two parallel portions of test road, each 16 ft. wide and 150 ft. long, connected together by means of 50 feet radius semi-circles of road, so as to form a closed loop. On either side of the test road single flat-bottomed rails will be carried on concrete pedestals. On these rails will run specially designed mono-rail tractors which have towing arms cantilevered out over the track for towing test bullock carts. The tractors are so designed that nearly the whole of the weight of the tractor will be carried by the rail, the slight out-of-balance load on the end of the cantilever arm being carried by a pneumatic tyred wheel

mounted in a specially designed fork which is adjustable for height. There will be one pair of tractors running on each rail, each pair consisting of a power tractor towing a trailer tractor, and to each of the tractors will be attached a laden bullock cart. In addition to pulling the carts around the track, the tractors are arranged to impart an oscillating movement to them, if required, in order to reproduce the destructive to-and-fro motion to which bullock carts are occasionally prone. Electric power will be carried to the power tractors by an overhead wire and trolley-arm system, the power being supplied from an independent motor-generator set housed near the track. The tractors are arranged to run at 3 or 6 miles per hour. Drawings for the tractors and track equipment have been prepared and tenders will be invited shortly. In this connection reference may also be made to Chapter III of this Report.

It is already evident that other items of equipment for the test-track will eventually be required, such as an accurate dead-beat dynamometer for measuring tractive forces, the design of which will be undertaken by the Bureau.

**CASEIN PLASTICS.**—Copies of the notes on the subject of Casein Plastics provided by the Director of Industries, United Provinces, and the Imperial Council of Agricultural Research in accordance with the conclusion of the Council were circulated to the members of the Council. The Director of Industries, United Provinces, is of the opinion that work on this subject should be undertaken, whereas the opinion of the Imperial Council of Agricultural Research is against the encouragement of this industry on the ground that the milk is required for food.

**INDUSTRIAL STANDARDIZATION.**—Regarding the conclusions of the Council on this subject, five requests for specifications were received from Directors of Industries during the year and complied with. A statement is given below :—

(1) Director of Commerce, Industries and Labour, Baroda.	}	Required a complete set of specifications.
(2) Stores Purchase Committee, Bangalore		
(3) Director of Industries, Bengal ..	}	Required a few miscellaneous specifications.
(4) Director of Industries, Madras ..		
(5) Director of Commerce and Industries Department, Hyderabad Deccan.		

As recommended by the Council, a form was drawn up and circulated to Directors of Industries, who were asked to furnish information on articles in common use by them for which specifications are not at present available. The response has been very small. Of the 15 Directors of Industries to whom the form was sent, Madras, Bengal, Punjab, Bombay, Gwalior, Baroda, Hyderabad (Deccan) and Indore do not require any other specifications than those already in existence. The Central Provinces suggest a specification for sports goods, and Assam, Bihar, United Provinces, Travancore, Kashmir and Mysore have so far not replied.

**PUBLICATIONS OF THE BUREAU.**—In accordance with the conclusion of the Council on this matter, the following experts were invited to contribute papers on the subjects indicated below :—

The Soap Industry	..	..	..	Mr. A. K. Menon.
The Leather Industry	..	..	..	Rai Bahadur B. M. Das.
The Heavy Chemical Industry	..	..	..	Mr. N. N. Sen Gupta.
Researches connected with rape-seed oil and mustard oil.				Mr. D. Y. Athawale.

Mr. Sen Gupta has completed his paper, which has been published as Bulletin No. 8 of Indian Industrial Research. The other papers are under preparation.

The following are the publications issued by the Bureau up to the end of March 1937 in the series of Bulletins of Indian Industrial Research :—

- No. 1.—Bibliography of Industrial Publications published in India from 1921.
- No. 2.—A Survey of the Indian Glass Industry.
- No. 3.—The Effects of Annealing Procedure on the Tensile Properties of Arsenical Copper Bar.
- No. 4.—The Manufacture of Photographic Plates in India.
- No. 5.—Improved Reflex-Copying.
- No. 6.—The Preparation of Alumina and Sulphur Dioxide from Bauxite Gypsum Mixtures.
- No. 7.—The Utilisation of Nepheline-Syenite Rock as a partial Substitute for Soda-Ash in the Glass Industry of India.

**PROCEDURE IN DEALING WITH REQUESTS FOR INFORMATION :**—A suggestion was made by the Director of Industries, Mysore, at the first session of the Council, that requests for information made by one Director of Industries of another Director of Industries, regarding matters coming within the purview of the Bureau, should be made through the Bureau. The matter was further discussed at the second session and it was agreed that a Director of Industries addressing or answering an enquiry, which he regards as likely to be of interest to the Bureau, should send a copy to the Director of the Bureau. Only one copy of an answer to an enquiry has been received from a Director of Industries during the year.

**COMPILATION OF INFORMATION REGARDING RESEARCHES :**—The Council discussed the proposal that the Bureau be requested to compile a list of researches in progress and contemplated in different industrial laboratories, as a summary of this nature had already been made by the Oils and Soap Committee in connection with researches on oils and soaps. The conclusion recorded was that Directors of Industries be asked to send annually to the Bureau, a list of researches in progress and contemplated, and that the Director of the Bureau should compile a combined annual list, copies of which should be sent to all members of the Council.

Directors of Industries were accordingly asked to furnish the Bureau with the necessary information to enable a list of researches in progress and contemplated in the laboratories under their jurisdiction to be compiled. Certain of the Directors of Industries raised the point that they were already supplying this information to the Director of Public Information for transmission to the Department of Scientific and Industrial Research, England. The Directors of Industries were accordingly requested to forward their reports to the Industrial Research Bureau in future instead of to the Director of Public Information. On receipt of all the reports, the list will be furnished to the members of the Council.

#### INDUSTRIAL INTELLIGENCE.

*Rayon.*—The examination undertaken at the request of the Indian Central Cotton Committee of the possibility of manufacturing rayon and staple fibre in India has been continued, and an officer has been lent to the Bureau by the Committee since November 1936 to assist in this work. The viscose and the acetate processes of manufacture are both being studied, and the technical as well as the economic aspects are being investigated. Enquiries are being made in the U. S. A., Germany, Italy, and England in this connection.

*Lubricating oils and paints* :—A number of matters concerning lubrication of railway rolling stock and also the painting of the rolling stock have been examined on behalf of the Railway Board during the period under review.

*Alcohol fuels for I. C. engines* :—A note was drawn up and supplied to the Chief Chemist, Industrial Laboratories, Hyderabad State, at his request showing the present stage of development of the use of such fuels, their characteristics, and their influence on engine performance.

*Hurricane lamps* :—A manufacturer of hurricane lamps near Calcutta applied for advice in connection with tarnishing of the tinned products of the factory when stored. Advice has been given and certain investigations have also been made by the Government Test House.

*Requests for information* :—The number of enquiries received from industrialists, although showing an appreciable increase over last year's figures, remained small. In all, 86 requests for information were received, 26 of these being from Directors of Industries, 18 from other Government Departments, 37 from private sources, and 5 from foreign and semi-official bodies. The majority of the requests were for technical advice and information. Enquiries received from private sources were, wherever necessary, returned to the senders with the request to make the enquiry through the Director of Industries concerned, this being in accordance with the decision of the Council made at the first session.

*Scrutiny of specifications* :—Specifications drafted by the Indian Stores Department and the Central Standards Office, Railway Board, continue to be received for scrutiny to ensure that Indian products are not unnecessarily excluded thereby.



*Library* :—During the year under report 900 publications, mainly technical and scientific, have been added to the library of the Bureau, which now contains 3,430 books of reference, excluding periodicals. The number of periodicals received also increased from 37 to 57, of which 51 are subscribed for and 6 received on a mutual exchange basis. 30,000 index cards containing information have been prepared. Certain other Departments have been permitted the use of the library for technical references.

FINANCE :—The estimated expenditure (Preliminary) during the year 1936-37 on the Industrial Research Bureau and the Research Branch at the Government Test House was as follows :—

					Rs.	a.	p.
Industrial Research Bureau .. .. .	..	..	..	..	1,01,325	12	1
Research Branch at the Government Test House	..	..	..	..	62,140	10	11
				<b>Total</b>	<b>1,63,466</b>	<b>7</b>	<b>0</b>

## CHAPTER III,

## RESEARCH WORK AT THE GOVERNMENT TEST HOUSE.

STAFF.—At the end of the year 1935-36, as stated in the previous report of the Bureau, the superior staff comprising the Research Branch at the Government Test House consisted of one gazetted officer (the Assistant Research Officer), four physical assistants, and four chemical assistants. The following additions to this staff took up their duties in the year now under review:—

The Research Officer—Dr. Lal C. Verma, M.Sc., Ph.D., F. Inst. P., A.I.R.E., in July 1936.

2 Physical assistants,—one in May and one in October 1936.

2 Chemical assistants,—one in October and one in November 1936.

The services of the Assistant Research Officer were terminated on 22nd September 1936, and one of the senior chemical assistants of the Government Test House officiated in the post until 16th March 1937. Steps are being taken by the Federal Public Service Commission to fill the vacancy.

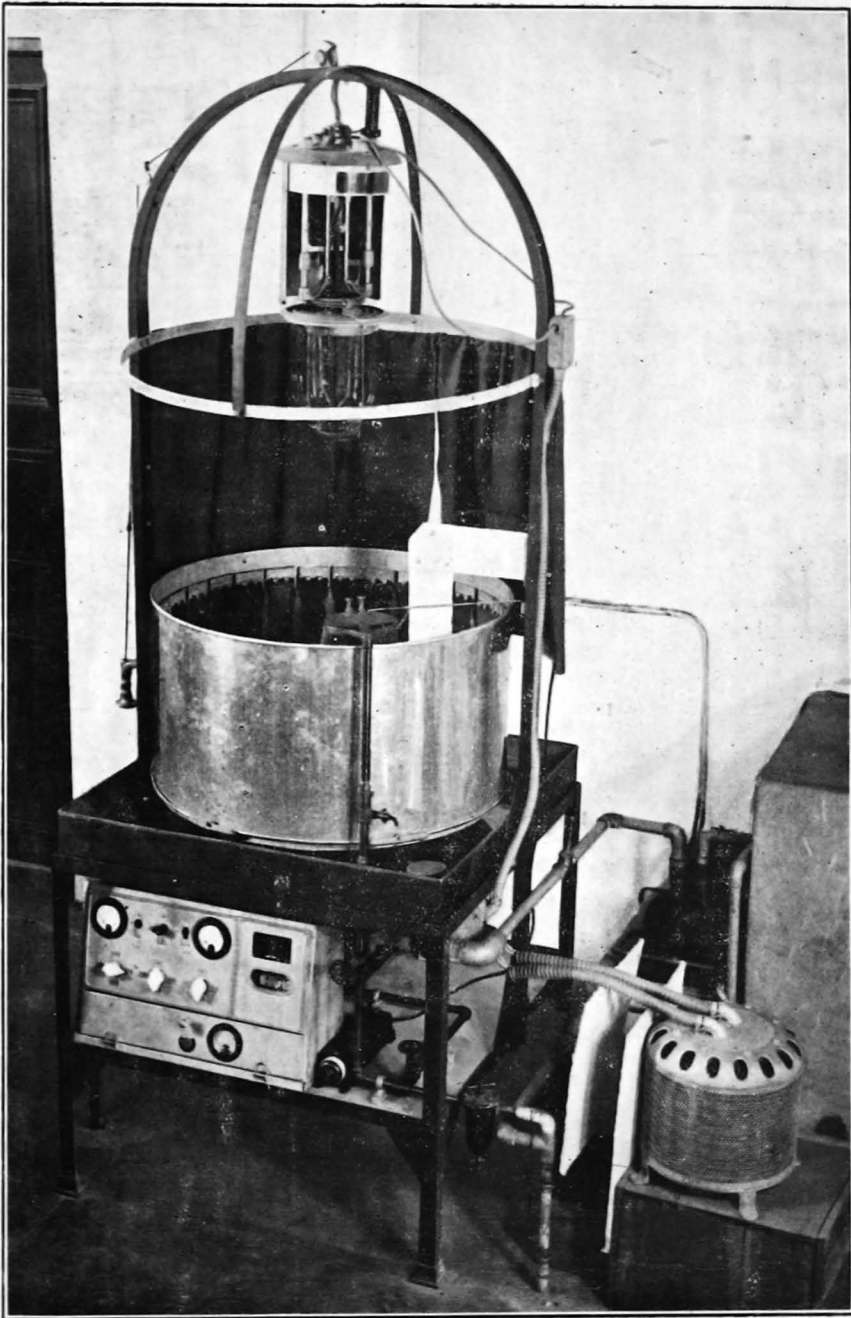
The following statement shows the sanctioned strength and also the actual strength of the Research Branch on the 31st March 1937:—

Rank.	Sanctioned strength.	Actual strength on 31-3-37.
Research Officer .. .. .	1	1
Assistant Research Officer .. .. .	1	..
Chemical Assistants .. .. .	8	6
Physical Assistants .. .. .	8	6
Clerks .. .. .	5	4
Draftsman .. .. .	1	1
Mistries .. .. .	4	4
Others .. .. .	11	10

PROGRESS OF INVESTIGATIONS.—As indicated in the previous report, the work of the Research Branch during the year 1935-36 was of a preliminary and analytical character. During the period under review the staff has gathered experience, good progress in connection with the principal investigations has been made and preliminary results are now becoming available. Moreover, a number of minor investigations have been undertaken and completed. The main items of plant and equipment, delivered about the end of last year or the early part of this year, have been installed and have been actively employed throughout the year. The progress made will be apparent from the following descriptions.

PAINT INVESTIGATIONS.—The superior staff engaged in this work consists of two chemical assistants and one physical assistant, and the position at the end of the year was as follows:—

*Black Paints.*—The exposure tests on black paints have continued, and the number of paints under tests mentioned in the previous report has been



**PLATE I.**

**Weatherometer, open view showing light spray and heater support inside the drum carrying test panels, water circulating pump and arc resistance in the right hand lower corner, carbon arc raised out of the drum on top, and control instrument panel below.**

increased by certain paints made of indigenous materials mentioned under "Miscellaneous Paints" below. It is too early for comparative results from these tests to be available at present.

*Red-oxide Paints.*—In addition to the series of panels prepared and exposed in the previous year, a further 70 panels have been prepared from the paints made in that period and exposed. A further 36 panels, made from 18 additional paints, have also been prepared and exposed. An investigation of the spraying behaviour and setting tendencies of red-oxide paints prepared to various formulæ, for use on railway wagons, was carried out and a report made to the Chief Controller of Stores.

*Red-lead Paints.*—The preliminary investigation to determine the characteristics which tend to affect the setting of red-lead paints has been completed. In the case of both the ordinary red-lead and the non-setting variety of this type of paint, the indigenous products showed a tendency to set quicker than the imported pigments. It also appeared that boiled linseed oil is more conducive to the setting defect than raw linseed oil.

An interim report is under preparation and further investigations have been planned.

*Miscellaneous Paints.*—(i) A red oxide reduced paint, containing gypsum received from the Department of Industries, Punjab, as an extender in place of the usual barytes, was prepared for comparison with a similar paint prepared with barytes. Tests indicate that the paint prepared with gypsum is superior to that prepared with barytes as regards spraying and non-setting properties, but exposure tests carried out under both natural and artificial (Weatherometer) conditions are not entirely favourable to the former. The investigations are being continued.

(ii) Black paints made with magnetite (chiefly magnetic oxide of iron) received from Jodhpur State are being compared with paints made with artificial magnetic oxide, which in certain previous tests have given promising results. The tests are proceeding.

(iii) Samples of untreated and treated titaniferous bauxite ores mined in the Central Provinces are being tested for suitability as paint pigments, and paints made therefrom as well as similar paints manufactured by a Jubbulpore paint factory are undergoing comparative exposure tests.

(iv) Three samples of umber and a sample of bentonite (a clay possessing certain special properties), which were received from Jodhpur State are being tested for suitability as paint ingredients, the former for use as stainers, and the latter as regards its influence on the setting tendencies of paints.

(v) At the request of the Chief Controller of Stores, Indian Stores Department, comparative exposure tests are being carried out between white lead paints made from sublimed white lead (basic sulphate of lead) and the usual white lead.

*Weatherometer.*—Natural weathering exposure tests on paints are by their very nature a slow process. Principally with the object of carrying out accelerated exposure tests so as to give early indications of the comparative durability of paints and of eliminating those compositions which show themselves to be unsatisfactory, various forms of accelerated weathering test apparatus have been devised. The apparatus which was obtained by the Government Test House is known as the "Weatherometer", made in America. A view of the apparatus and accessories, as installed, is shown on Plate I. It has been modified to give test conditions approximating to the outside weather conditions at Alipore as regards the cycle of light period, rain, darkness, and temperature range, and also as regards the chemical composition and pH value range of the artificial rain water used. Sun-light is replaced by carbon-arc light, which is strong in ultra-violet rays. Special care is taken to prepare the test-panels for use in the Weatherometer tests under identical conditions and these are all prepared, painted, and kept till dry in the air-conditioned test-room, in which the temperature is maintained at  $80^{\circ}\text{F} \pm 1^{\circ}$ , and the relative humidity at 70 per cent.  $\pm 1.5$  throughout the year.

*Statistical investigation.*—Professor P. C. Mahalanobis of Calcutta University has kindly agreed to give, and has already given statistical advice and assistance in connection with the planning and utilisation of the paint exposure tests.

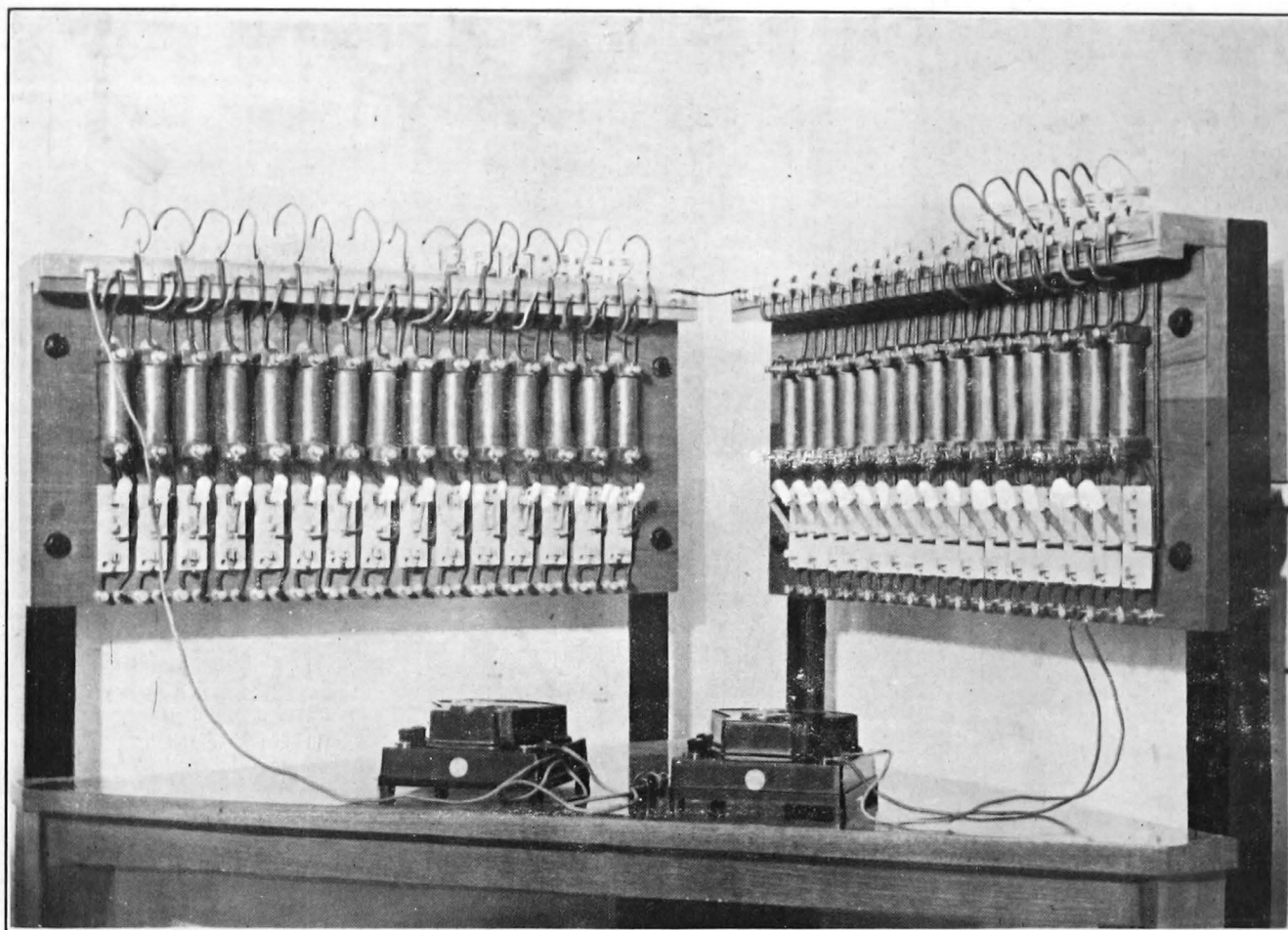
**DRY CELLS.**—The superior staff allocated to this work consists of one chemical and one physical assistant.

The scope of this investigation may be briefly summarised under the following main heads :—

- (a) Detailed examination of the construction, and complete chemical and physical analysis of the component materials of dry cells of reputed makes.
- (b) Determination of the assembly and maturing processes necessary for the production of high-quality dry cells.
- (c) Comparative tests of raw materials with a view to utilising indigenous materials wherever possible.

Stage (a) was practically completed in the previous year and work has been concentrated on stage (b) during the period under review. The difficulty of this phase of the investigations is indicated by the fact that in the early stages of the work a number of cells of three well-known makes were carefully dismantled, and then reassembled under various conditions. In no case were the electrical characteristics of the reassembled cells as satisfactory as those of the unopened cells of the same makes. This is the crux of the investigation, but steady progress is being made in the development of assembly technique.

In connection with this work, attention has also been devoted to development of testing and experimental apparatus. To enable the initial electrical characteristics of components to be determined without actually making a cell, an apparatus has been designed and constructed, which is conveniently



**PLATE II.**

**Dry Cell Testing Equipment mounted on a corner table.**

called the " experimental dry cell ", in which the effect of varying the composition of the depolariser and of the electrolyte, as well as the pressure under which the depolariser is compacted, on the initial voltage, internal resistance, and polarization characteristics can be compared.

The behaviour of cells on accelerated life tests has also been investigated, with a view to speeding up this part of the work. When the test-procedure laid down in British Standard Specification No. 397 is followed in tests of the standard torch size dry cell, type DU. 2, a period of 7 weeks is required by the life test, whereas it has been found that this can be reduced to  $2\frac{1}{2}$  weeks by change of the number of daily discharges, the output capacity under these conditions being reduced by 16 per cent. A photograph of life test discharge apparatus designed and constructed by the Research Branch is shown on Plate 2. This apparatus is installed in the air-conditioned test-room, as this enables the comparative discharge tests to be carried out under constant test-conditions.

VEGETABLE OILS FOR INTERNAL COMBUSTION ENGINES.—The superior staff concerned with this work at the end of the year consisted of two physical assistants and one chemical assistant. During the period under review the determination of the chemical and physical characteristics of the oils mentioned in the previous report has been completed.

A process has been evolved for rendering castor oil miscible with mineral oils of known suitability for use in internal combustion engines, and the effects of the addition of various anti-oxidants have been investigated. Similar investigations are in progress on the other oils mentioned, but the work is still in the laboratory stage.

Meanwhile steady progress has been made with the work of modifying the Morris and Lister engines and of equipping them with test accessories to enable their operating conditions to be completely controllable, a necessity in the case of such experimental work.

With this in view the Morris-petrol engine has been provided with the following accessories, all of which have been designed and made by the Research Section :—

- (i) A neon tube indicator which shows the exact position in the revolution at which the spark takes place at the plug of the end cylinder, in degrees before top dead centre. This, in conjunction with a precisely adjustable magneto contact-breaker advance mechanism, enables the spark position to be completely controlled.
- (ii) Adjustable oil-pressure release valve in the force-feed lubricating system, to control the oil pressure in the lubrication system.
- (iii) Variable speed motor-driven radiator cooling fan, to control the circulating water temperature.
- (iv) Induction mixture electric heater to standardise the temperature of the petrol-air mixture admitted to the engine.
- (v) Thermometer pockets at the circulating water inlet and outlet of the engine jackets.

In the case of the Lister diesel engine the following test equipment is being provided, for the same purpose :—

- (i) A cooling water circulating pump.
- (ii) A variable compression apparatus fitted to the cylinder head to enable the compression-ratio to be varied as required between 8 : 1 and 19 : 1.
- (iii) An ignition lag indicator for determination of delay periods (in equivalent degrees of revolution) of fuel oils of all kinds.
- (iv) Induction air electric heater.
- (v) Thermometer pockets at the circulating water inlet and outlet of the engine jacket.

Considerable economies have been effected in the cost of this experimental engine plant as a result of buying standard units and transforming them into test sets in this way. Moreover, this work has constituted excellent practical training for the personnel engaged in it and has provided valuable experience to all concerned.

The Morris and Lister engines, with the electrical dynamometer between them, have been mounted on a combination bedplate, to form a composite unit. A view of this unit is shown on Plate III.

Engine tests of the oils at present under laboratory investigation, as mentioned above, will be commenced shortly; and to enable preliminary lubrication tests to be carried out without risking early damage to the main engines, a small petrol engine-dynamo set has been installed, to be utilised for this purpose.

*C. F. R. anti-knock rating engine unit.*—To avoid duplication of staff, the C. F. R. engine unit has been taken over by the Research Branch, and it has been arranged that the I. C. engine section of the Branch undertakes the routine engine tests of all aviation petrol and fuel samples received by the Government Test House. Valuable experience is also being acquired by the personnel from this work. The number of routine samples of aviation fuels tested, in accordance with this arrangement, by the section during the last four months of the year amounted to 40.

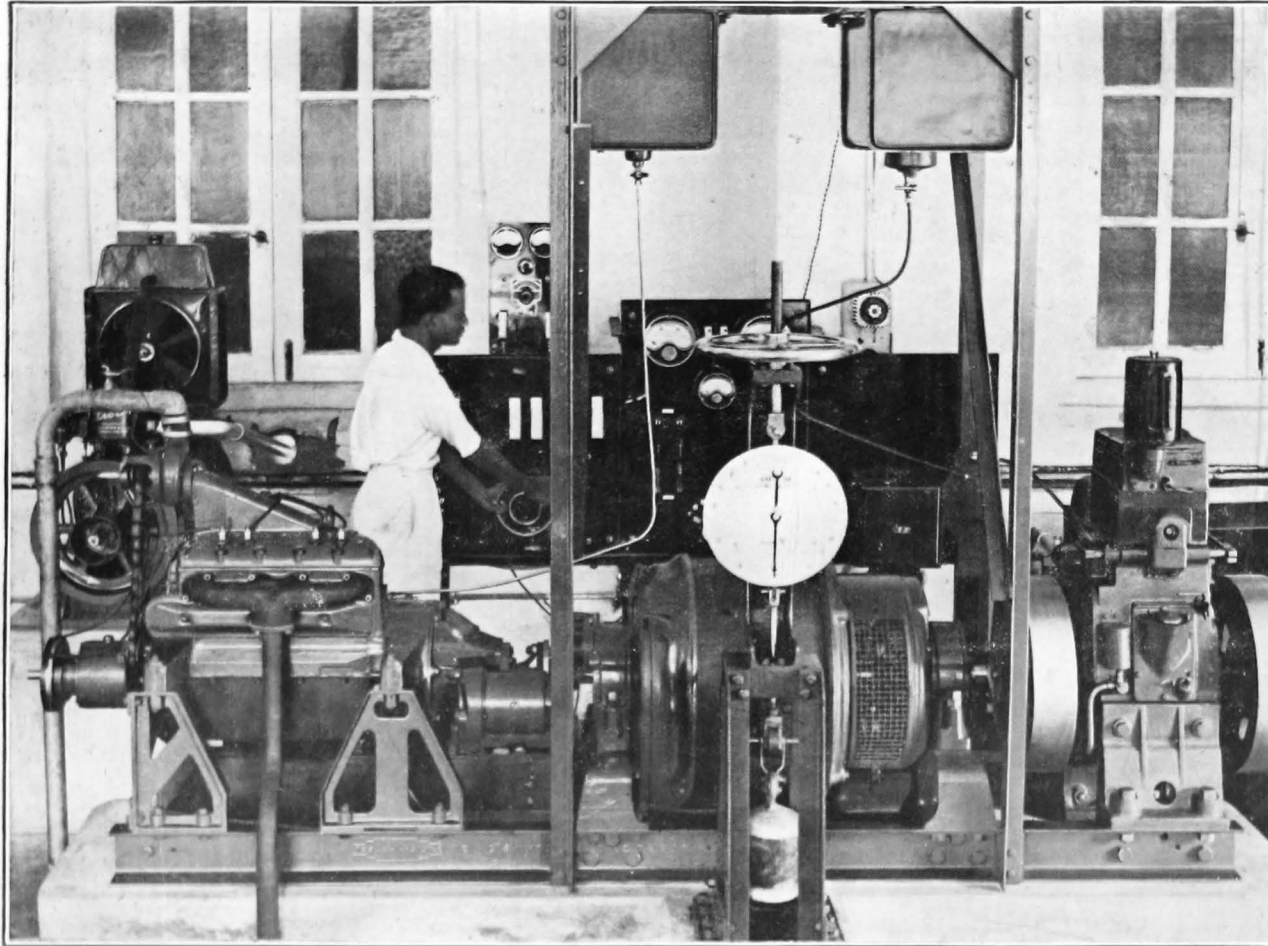
The section has also carried out an important series of investigations on the properties of petrol-benzol mixtures and of the effects of changes in the composition of the benzol utilised for such mixtures. This work was undertaken on behalf of the Defence Department, to which reports have been issued.

*LIME, CEMENT, SURKHI, SAND, CLAY, ETC.*—The superior staff occupied on these investigations consists of one physical assistant, and progress in the various investigations mentioned in the previous report has been as follows :—

*Mortar and concrete tests on behalf of the British Standards Institution.*—The new programme of tests has not yet been received.

*Indian sand substitute for Leighton Buzzard standard sand.*—Five river sands, two sea sands, and three pit sands have been examined during the year and found to be unsuitable. A sample of pit sand from Hadap Hill North, near Taljhari, Bihar, is promising and tests on this sand are still in progress.





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**PLATE III.**

**Internal Combustion Engine Installation, showing Mcrris Petrol engine-dynamometer-Lister diesel engine unit, small house-lighting set in the left back ground, and instrument board in the centre back ground.**

*Surkhi*.—To obtain preliminary information to guide this work, specimen sets of under-burnt, well-burnt, and over-burnt bricks were collected from widely distributed brick-fields utilising clay and silt raw materials, as follows :—

- (i) Two brick -fields using pit clay.
- (ii) Two brick-fields using recent deposits of silt.
- (iii) Two brick-fields using old deposits of silt.
- (iv) A brick-field using a mixture of silt and pit clay.

The bricks were crushed to form surkhis passing through B. S. mesh No. 30 sieve and also surkhis passing through B. S. mesh No. 170 sieve ; 1 : 3 lime-surkhi briquettes were gauged from each surkhi and tested at 14 days, 28 days, 3 months, and 6 months, the lime used being a well-known local high-calcium lime, slaked before use under standardised conditions.

Each surkhi was also examined by chemical analysis. The following general conclusions were deduced from the test results obtained :—

- (a) Higher ultimate strength was given by a surkhi from over-burnt bricks than by a surkhi from well-burnt bricks.
- (b) Similarly, higher strength was given by a surkhi from well-burnt bricks than by a surkhi from under-burnt bricks.
- (c) The strengths given by dry mixes were generally above those given by mixes of a wet consistency.
- (d) The strength of mortar made from coarse surkhi (mesh No. 30) was generally greater than that of a mortar made from the finer material (mesh No. 170).

*Controlled clay-burning for surkhi production*.—An investigation is in progress to determine the best method of burning clay under closely controlled conditions for the production of surkhi. The clay is being burnt both in the loose condition as received, and also after pugging and moulding, ungrogged, into balls approximately  $2\frac{1}{2}$ " diameter. The burning is being carried out at temperatures ranging from 800°C to 1000°C in an electric furnace equipped with a Cambridge Automatic Temperature Regulator.

*Effects of slaking procedure on the properties of lime*.—Freshly burnt samples of a high-calcium unslaked and of a high magnesian unslaked lime were slaked under various controlled conditions. Briquettes were gauged from 1 : 3 lime-surkhi mortars prepared with these limes and surkhi prepared from a batch of well-burnt bricks ground to pass a B. S. mesh No. 170 sieve ; tests are being carried out at periods up to 6 months after gauging. The tests are still in progress.

In view of the results obtained in the surkhi tests described above, it is proposed to carry out a similar series of tests using surkhi made from over-burnt bricks and passing through a B. S. mesh No. 30 sieve.

*Effects of Storage conditions on slaked limes*.—Investigations to determine the effects of different conditions of storage on the physical properties of slaked limes are in progress.

*Bentonite*.—A sample of bentonite was received from Jodhpur State. This material is a natural clay-like substance composed of a hydrous silicate of alumina and having certain peculiar physical properties. True bentonite consists mainly of particles so fine that the material, when in solution, possesses marked colloidal properties. When placed in water it swells to many times its original volume and forms a gelatinous mass, this property being unaffected over a wide temperature range.

Investigations are in progress to determine its effect on the tensile and compressive strength of cement mortar, and also its effect on cement as regards improvement of the water-proofing and fire-resisting properties.

**QUETTA CLAYS FOR BRICK MAKING.**—The personnel of the Research Section co-operated with the staff of the Test House in investigations on a series of clays received from Quetta as regards their suitability for brick making, for use in the reconstruction of Quetta. The work was comprehensive and comprised physical tests, chemical analyses, and burning tests of half-size bricks at various temperatures in the automatically controlled electric furnace. In all cases the selected clays, though giving bricks with good physical properties, burned to a light yellow colour owing to deficiency of iron compounds.

Two methods of producing the normal red-brick appearance were tried, one consisting of pre-mixing an iron oxide with the clay, and the other consisting of dipping the dried brick in a slurry of a red-burning clay prior to burning. The former method gave a red finish throughout the body of the brick, but would be comparatively costly, whereas the latter gave a surface reddening only.

A comprehensive report was made to the Quetta Reconstruction authorities.

**GLASS.**—The work carried out by the Research Branch in connection with the glass industry is described in Chapter IV of this Report.

**ELECTRIC LAMPS, MANUFACTURED IN INDIA.**—A number of electric lamp factories have been started in India with Indian capital and management and certain of them are already operating successfully. To assist such factories with information as to the quality of their products, it has been arranged that periodic tests of groups of their lamps will be carried out on behalf of the Bureau by the Government Test House, free of charge, upon application to the Bureau through the appropriate Director of Industries. On the completion of tests on each group of lamps, the report is forwarded to the Bureau and a copy is supplied to the firm direct.

Three firms in Bengal, one in the United Provinces, and one in Bombay have applied for this facility during the year, and 250 lamps have been tested and reported upon in this connection. In consequence of this, one physical assistant has been posted to the Photometry and Lamp Testing laboratory for this work.

**ROAD RESEARCH.**—In accordance with the conclusion reached by the Council during its second session, the work of planning and constructing a Road Test Track was taken up during the year. A scheme was drawn up and

estimates were submitted to the Consulting Engineer, Roads, to the Government of India, and in due course approved by Government. A site has been selected about  $1\frac{1}{2}$  miles from the Government Test House on land owned by the Calcutta Port Commissioners, and a lease is being arranged.

The lay-out and equipment has been designed, partly by the staff at the Test House, and partly by the staff at the headquarters of the Bureau, to designs proposed by the Bureau and approved by the Roads Congress technical sub-committee, and it is planned to have the test-track in operation by the end of 1937.

MISCELLANEOUS INVESTIGATIONS.—*Refining of river clay for use in pencil manufacture.*—Difficulty experienced in removing sand from river clay used by a factory for the manufacture of pencil cores was brought to the notice of the Bureau, through the Director of Industries, Madras. Samples of the river clay and also of the clay as refined by the factory were obtained and investigations conducted by the Research Branch. A satisfactory peptisation process was devised and a report forwarded to the factory, through the Director of Industries. The work carried out in connection with the investigation has been used as the basis of a bulletin, which has been printed recently and constitutes Bulletin No. 9 of the series of Bulletins of Indian Industrial Research issued by the Bureau.

*Metal polish material from the North-West Frontier Province.*—A sample of material considered to be suitable for the manufacture of liquid polish was received from the Director of Agriculture and Allied Departments, North-West Frontier Province. It was made up into a liquid polish in accordance with a formula devised by the Research Branch and used in comparative tests against a well-known brand of liquid polish. The material was found to make a liquid polish which compared not unfavourably with the brand of polish used for comparison and a full report was made to the Department concerned.

*Shellac cement for the bayonet caps of electric lamps.*—An electric lamp factory in Calcutta experienced trouble with the cement which was being used for the jointing of the bayonet caps to the bulbs, and made application for assistance through the Director of Industries, Bengal.

The factory was visited by the Research Officer to examine the operating conditions, and a series of shellac cements were devised and subjected to preliminary tests. As a result of the preliminary tests the most satisfactory formula was selected, and batches of lamps, having the cap joints made in the factory with cement to this formula were subjected to long-time burning tests with torsion tests on the caps at intervals. The results of the tests were satisfactory, and the formula for this shellac cement has been supplied to the firm and to the Director of Industries.

BUILDING EXTENSIONS.—Certain building extensions for the Government Test House have been sanctioned by Government and will be carried out during the next financial year. These extensions will provide much-needed additional accommodation, for the research work on paints and also on limes, surkhi, etc. It is also planned to provide therein a road-materials laboratory for work in conjunction with the Road Test Track.

## CHAPTER IV.

## WORK IN CONNECTION WITH GLASS.

**SURVEY OF GLASS FACTORIES.**—A report on the survey of the Indian glass industry, conducted by Mr. Dixon, was discussed by the Council, who thanked Mr. Dixon for it. It is now available as Bulletin No. 2 of the Bulletins of Indian Industrial Research.

**IMPROVEMENT OF GLASS FURNACES.**—The survey of the glass industry, mentioned above, indicated that Indian glass furnaces generally are old-fashioned and very inefficient. The Industrial Research Bureau accordingly designed an improved type of furnace on modern lines, adhering, however, as far as possible to the general type of furnace at present in use in India. The chief features of interest in the furnace are :—

1. It is fitted with recuperators.
2. It is fired on the dry-bottom producer principle.
3. It is substantial in construction.
4. It is fitted with a suspended roof in order to prevent roof collapse.
5. It provides for an easy change of pots.

Plans of the furnace were shown to the Council, and the possibility of constructing a furnace of this type in an existing factory was discussed. A memorandum by the Director of Industries, United Provinces, urging the claims of the United Provinces as a suitable locality for the erection of the furnace was duly considered. During the discussion Mr. B. N. Mookerjee of Messrs. Burn and Co., generously offered to bear half the cost of the first furnace built to the new design, provided that the other half of the cost is borne by a glass-manufacturer, and that the furnace materials are ordered from Messrs. Burn and Co., Jubbulpore. The Council reached the conclusion that a site in the United Provinces offered good prospects for a successful demonstration factory, and the Bureau was asked to explore the possibility of establishing a demonstration plant in conjunction with a glass manufacturer and Messrs. Burn and Co.

The Assistant Director of the Bureau accordingly toured the glass factories in the United Provinces and also visited the Upper India Glass Works, Ambala, explaining the design of the experimental furnace and drawing the attention of the factory owners to Mr. Mookerjee's offer to contribute half the cost of this furnace. As a result of this tour, a number of offers to instal the furnace were received. The offers were carefully considered and, after somewhat lengthy negotiations, arrangements have recently been successfully completed for the installation of the improved glass furnace, to the design drawn up by the Bureau, in the glass factory of the Star Glass Works, Firozabad, United Provinces, the proprietor of which has deposited the necessary funds in a Government Treasury. In accordance with the stipulation made by Mr. B. N. Mookerjee when making his offer, the order for the materials will be placed with Messrs. Burn and Co., Jubbulpore, by the Bureau.

The inspection of the materials and the supervision of the erection at Firozabad will be carried out by the staff of the Bureau. It is proposed that the furnace will be open to examination by other glass manufacturers and interested persons by arrangement through the Director of Industries, United Provinces.

**SURVEY OF GLASS-MAKING MATERIALS.**—The Council also considered a proposal received from the Benares Hindu University that a survey of glass-making materials should be carried out by Dr. V. S. Dubey, Professor of Economic Geology in the University. Dr. Dubey, who had been invited to attend the meeting, explained his proposals, and the Council also took advantage of the assistance of Dr. J. A. Dunn of the Geological Survey during consideration of this subject.

The Council approved the proposal, subject to the following conditions :—

- (i) That the programme of work to be undertaken should be subject to the concurrence of the Director, Industrial Research Bureau ;
- (ii) That an endeavour be made to start the work from 1st October 1936 ;
- (iii) That a sum not exceeding Rs. 6,000 be allotted to cover the expenses for the year's work ;
- (iv) That Dr. Dubey be asked to present a report on the year's work.

In accordance with the conclusions of the Council, the Director of the Bureau corresponded with the Pro-Vice-Chancellor of the Benares Hindu University and Dr. Dubey, and it was arranged that Dr. Dubey should confine his survey to a study of the quartz, felspar and other silica-containing deposits of Bihar and adjacent parts of Bengal and Orissa, and also to a study of some deposits in Madras. Dr. Dubey commenced his survey on the 1st October 1936. He has recently applied for sanction to spend Rs. 400, out of the total of Rs. 6,000 allotted for expenses for the year, to cover certain travelling expenses which he will incur during a proposed visit to various glass raw-material centres in Europe. Sanction was granted to this request, as it was thought that the information which will be obtained by Dr. Dubey during his trip should be of value to the glass industry of India and, by comparison, make a useful addition to his final report.

**ACCESSORIES FOR BANGLE MANUFACTURE.**—A memorandum was presented by the Director of Industries, United Provinces, to the Council on the desirability of manufacturing, in India, such bangle-decorating materials as liquid gold and China glass. The Council recommended that a preliminary examination be made by the Bureau of the possibility of manufacturing liquid gold and China glass for the decoration of bangles, and this work was accordingly taken up by the Research Branch of the Government Test House. The progress made is described later.

**GLASS INVESTIGATIONS CARRIED OUT BY THE RESEARCH BRANCH.**—The progress made in connection with work on this subject is indicated by the following description. The superior staff engaged on investigations concerning

this subject at the Government Test House has consisted of two chemical assistants, and the work carried out during the year falls under the following heads :

- (a) Physical and chemical analyses of indigenous raw materials for the glass industry, *e.g.*, sands, feldspars, etc., and their grading for quality.
- (b) Investigation of the possibility of preparing low melting temperature glasses for bangle manufacture.
- (c) Preparation of liquid gold and of China glass for use in bangle manufacture to replace imported materials.

*Raw materials.*—In co-operation with the Directors of Industries of Provinces and States, a large number of sands, sand-stones, limestones, feldspars, etc., have been collected for analysis and physical examination, and a considerable proportion of these has been already examined and reported upon to the Bureau. Special attention has been directed in this work to the iron-contents of these samples and the effect thereon of washing and sieving. A tentative classification scheme has been introduced for classifying the various materials to indicate their suitability or otherwise for making different classes of glass. A bulletin reporting the detailed results of this work will be published in due course.

*Low melting-temperature glasses.*—This investigation was undertaken on the proposal of the Director of Industries, Bombay, and series of silica-lime-soda, silica-boric-acid-lime-soda, and silica-lime-soda-lead glasses have been prepared and tested as regards melting points and water solubility. The proportional increase of soda-ash or the addition of boric acid or lead-oxide in a batch is well known to result in lowering of the melting temperatures, but each of these changes involves increases in the batch cost. Moreover, while borax and lead glasses are satisfactory as regards their durability and mechanical and thermal properties, glasses of high soda content are deficient in these properties. These characteristics have been confirmed in the investigations, and it does not appear that satisfactory low melting temperature glasses of cheap composition are practicable. A report on this work will be available shortly.

*Liquid gold and China glass.*—Samples of these materials have been analysed, and corresponding synthetic equivalents prepared in the laboratory and tested practically to determine the temperature and other conditions most suitable for their use. The working conditions which prevail in the industry as regards their use are being kept in view in this connection, as well as the question of cost of production. A considerable measure of success has been achieved as regards the laboratory preparation of similar substances, and a report will be available shortly.

*Electric lamp bulb glass.*—An investigation comprising analysis, optical transmission, and thermal shock resistance characteristics of glasses used in imported lamp bulbs of repute has been undertaken with a view to assisting Indian glass factories to produce electric lamp bulbs in due course. A number of electric lamp factories are now working successfully in India, but at present all the glass components used by them are made from imported glassware. The work is proceeding.

## CHAPTER V.

## OILS AND SOAPS.

REPORT OF THE COMMITTEE.—The Council at its second session considered and approved a report presented by the Oils and Soap Committee which had been appointed by the Council at its first session, with the following terms of reference:—

1. To survey the research already conducted and in progress on fatty oils, soaps and essential oils.
2. To advise on the co-ordination of this research generally, and, in particular, on the allocation of future research to suitable centres and to report to the Council.

The Committee after meetings in November 1935 in Calcutta and in June 1936 in Simla, drew up a report comprising proposals for future research, including recommendations for the allocation of work to Provincial and State laboratories, and recommendation that the Imperial Council of Agricultural Research be requested to consider the possibility of encouraging the cultivation of certain essential oil-bearing plants. The Committee also suggested that the Bureau should collate and publish a digest of all available information on Indian vegetable oils.

ALLOCATION OF RESEARCHES TO LABORATORIES:—The recommendation of the Committee that specified items of research work on oils and soaps be allocated to certain laboratories in order to avoid duplication and to ensure that the ground will be covered thoroughly, was forwarded to the Government of India. The Government of India accepted the recommendation and addressed the Provincial and State Governments. The replies received are summarised in the following tabular statement:

*Replies from Governments and States regarding acceptance of work allocated to their laboratories on oils and soaps:*

<i>Laboratory.</i>	<i>Work allotted.</i>	<i>Reply from Governments concerned or from Directors of Industries.</i>
Government Laboratory, Hyderabad.	Industrial Rancidity of oil. Sulphonated oils other than fish oil. The use of vegetable oils in wick lamps. The selection of soap stocks. Soap perfumes. Keora oil.	Agreed.
Mysore Soap Factory	.. Patchouli oil ..	Agreed.
Baroda College, Baroda	.. Sulphonated oil other than fish oil. The preparation of polymerised oils. The use of sulphonated oils in soaps.	Agreed.



<i>Laboratory.</i>	<i>Work allotted.</i>	<i>Reply from Governments concerned or from Directors of Industries.</i>
Industrial Bombay.	Laboratory, Cinnamon (Leaf) oil. Citrus oil.	Agreed subject to the sanction of extra staff by the new Legislature.
Government Laboratory, Punjab.	Decolorisers and absorbents. The study of the detergency of soaps. The study of soaps fillers and builders. Vetivert oil. Cassia oil. Keora oil. Rosa oil. Citrus oil.	Agreed.
Industrial Laboratory, Bengal	The selection of soap stocks	Agreed provided the expenditure can be met from the normal grant to the Industrial Laboratory.
The University College of Science, Calcutta.	The rancidity of oil .. Decolorisers and absorbents The cause and cure of rancidity in soaps. The cause and cure of sweating in soaps.	Agreed by the Department of Applied Physics. Agreed by the Department of Applied Chemistry subject to provision of funds by the Bureau.
The Harcourt Butler Technological Institute, Cawnpore.	The examination of oils expressed from different races of Indian Linseed. The splitting of oils Autoclave process. The cause and cure of rancidity in soaps. Transparent soaps. The study of soap fillers and builders. Vetivert oil.	The matter is under the Local Government's consideration.
Kerala Soap Institute, Calicut	The rancidity of oil. Sulphonated fish oil. The splitting of oils, Twitchell process. Decolourisers and absorbents. The selection of soap stocks. The cause and cure of sweating in soaps. The cause and cure of rancidity in soaps. Transparent soaps. The recovery of Glycerine. Geranium oil.	The matter is under the Local Government's consideration.
The Government Test House, Calcutta.	The investigation of boiled oil and stand oil.	Instructed to undertake the work.

ENCOURAGEMENT OF CULTIVATION OF ESSENTIAL OIL PLANTS :—The Imperial Council of Agricultural Research was approached in connection with the Committee's recommendation that the cultivation of certain essential oil-bearing plants be considered and encouraged. The Imperial Council addressed the various Directors of Agriculture, and the following summaries show the replies received up to the present :

Province or State.	Reply.
Madras .. ..	<p>Government may not be able to finance any scheme in this connection.</p> <p>Some of the plants are grown on a limited scale.</p>
United Provinces ..	<p>If funds are provided by the Imperial Council of Agricultural Research, the department will be prepared to examine the possibilities of economic culture of the plants (except cloves and cinnamon).</p>
Bihar .. ..	<p>If staff and funds could be made available it would be possible to start investigation on peppermint, aniseed, citrus and keora.</p>
N. W. F. Province ..	<p>The following can be cultivated, but no staff is available to carry out investigation on them.</p> <ol style="list-style-type: none"> <li>1. Geranium.</li> <li>2. Patchoulie.</li> <li>3. Peppermint.</li> <li>4. Cloves.</li> <li>5. Aniseed.</li> <li>6. Dill.</li> <li>7. Citrus.</li> <li>8. Valerian.</li> </ol>
Punjab .. ..	<p>The following have been grown successfully :</p> <p>Dill, Peppermint, Citronella, Valerian, Citrus.</p> <p>Aniseed will be tried in suitable localities.</p> <p>The cultivation of Rosh grass (<i>Cymbopogon martini</i>), a perennial grass and the source of palmarosa oil, for which there is a well established plantation of about 230 acres and producing 3,000 lbs. of oil every year, can be extended, if any industry for use of this oil within the country can be organized and reasonable price assured.</p> <p>The same applies to Citronella.</p>

Province or State.	Reply.
Bengal	<p>.. .. The encouragement of the cultivation of (only) the following would seem to be a practical proposition as they do well in plains and hills of Bengal according to their habitat :</p> <ol style="list-style-type: none"> <li>1. Vetivert.</li> <li>2. Peppermint.</li> <li>3. Cloves.</li> <li>4. Cinnamon.</li> <li>5. Citrus.</li> <li>6. Dill.</li> <li>7. Keora.</li> </ol>
Assam	<p>.. .. Efforts will be made to grow the following :</p> <p>Citrus, Cloves, Cinnamon, Citronella, Dill.</p>
Burma	<p>.. .. Not in favour of any special investigation or encouragement of cultivation being undertaken, as Burma is unlikely within any reasonable period to compete with the older industries.</p>
Sind	<p>.. .. (1) Aniseed, (2) Dill : grown in Sind on a smaller scale and can be undertaken on a large scale if there is a market for the seeds and with a small subsidy from the Imperial Council of Agricultural Research. (3) Citrus cultivation is extending.</p>
Central Provinces	<p>.. .. Vetivert grows wild all over the province and no special measures necessary to encourage its cultivation.</p> <p>Citronella grows wild in some districts. Attempts will be made to establish the cultivation in other districts.</p> <p>Citrus : Due to wide demand for fresh fruit for direct consumption, the scope for other forms of utilization is restricted. The introduction of grading in marketing would help, as this would raise the question of disposing of the low grade qualities.</p> <p>Peppermint and Aniseed grow in gardens. Areas could be extended if a cheap and efficient method of extracting oil were found.</p> <p>Keora grows wild to a certain extent ; grown in gardens, and as a hedge plant sometimes. At present there is only local demand for the inflorescence used for flavouring. There is not much prospect of its extension.</p>
Orissa	<p>.. .. Attempts will be made to grow the following in the Government Agricultural farm, Cuttack. If the result proves satisfactory, the Department will popularise the growing of these plants.</p> <ol style="list-style-type: none"> <li>1. Vetivert.</li> <li>2. Peppermint.</li> <li>3. Cinnamon.</li> <li>4. Citronella.</li> <li>5. Dill.</li> <li>6. Citrus, which is fast becoming popular in this province.</li> <li>7. Keora, which grows wild in coastal districts of this province.</li> </ol>

Province or State.	Reply.
Bombay .. ..	<p>If special facilities are given to market the produce, the cultivation of the following plants can be undertaken:</p> <ol style="list-style-type: none"> <li>1. Geranium.</li> <li>2. Cinnamon.</li> <li>3. Aniseed.</li> <li>4. Dill.</li> <li>5. Citrus.</li> <li>6. Keora.</li> </ol>
Jammu and Kashmir ..	Can try Geranium, Peppermint and Dill.
Baroda .. ..	<p>Cultivation of Aniseed and Dill which are grown to some extent, and also Keora, might be encouraged if there is a market for them.</p> <p>Citrus is grown; its development as an ordinary fruit product has not reached that stage where attention might be given to flower and peel for essential oil products.</p>

BULLETIN ON INDIAN VEGETABLE OILS.—The third recommendation was that the Bureau should collate and publish a digest of all available information on Indian vegetable oils, and this work was undertaken by Mr. N. Brodie, the Director of the Bureau. The information collected is being published as Bulletin No. 10 of the series of Bulletins of Indian Industrial Research.

**GOVERNMENT OF INDIA**  
**INDUSTRIAL RESEARCH BUREAU**

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**REPORT**

**FOR THE YEAR**

**1937-38**



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## ANNUAL ADMINISTRATION REPORT OF THE INDUSTRIAL RESEARCH BUREAU FOR THE YEAR 1937-38.

### INTRODUCTION.

This report deals with the activities of the organization which was brought into existence on the 1st April 1935, in order to develop Indian industrial research, namely (a) the Industrial Research Council, (b) the Industrial Research Bureau, and (c) the Research Branch of the Government Test House, during the third year of their working.

The relationship of the three parts of the organisation one to another and the functions of each have already been explained in two previous reports and need not be repeated.

The Industrial Research Bureau was established three years ago by the Government of India on the recommendation of the Industries Conference, on a temporary basis in the first instance for a period of three years. This Report records the work carried out by it during the third year of its existence. In a new organization of this kind a considerable amount of time must necessarily be spent in the recruitment of officers and of the technical personnel, in the training of the latter to the stage at which they can tackle confidently and efficiently the problems which are allocated to them for solution, and in obtaining the plant and equipment required for their work.

During this period the directions in which the organization can be of more immediate assistance *vis-a-vis* existing and prospective industries, Directors of Industries, industrialists, and technical departments of Government, and the nature of the varied services which the above departments and interests mainly require from it, and are likely to need to a still greater extent as industrial development proceeds, have become more clearly defined.

From the experience acquired during this period as regards the duties and activities of such an organization, the Government of India have formed the opinion that the Industrial Research Bureau is of value as an instrument for assisting the industrial and technical development of the country. Consequently the Government of India have decided to place the Bureau on a permanent basis with effect from the 1st March 1938.

## CHAPTER I.

## THE INDUSTRIAL RESEARCH COUNCIL.

The Council held its third session in the Committee Room of the Civil Secretariat, Bombay, on the 5th and 6th July 1937. The Honourable Mr. A. G. Clow, C.S.I., C.I.E., I.C.S., Secretary to the Government of India, Department of Industries and Labour, and Chairman of the Council, presided, and the session was attended by 19 members, including the Director, Industrial Research Bureau, who acts as Secretary of the Council. The session was also attended by Mr. R. K. Nehru, I.C.S., Officer on Special Duty, Department of Commerce, Government of India, and by Dr. Lal C. Verman, M.Sc., Ph.D., F.Inst.P., A.I.R.E., Research Officer, Industrial Research Bureau, who attended by invitation.

Sir Martin Forster, Ph.D., D.Sc., F.I.C., F.R.S., had resigned his membership of the Council as he was proceeding out of India, and the Government of India nominated Dr. Gilbert J. Fowler, D.Sc., F.I.C., in his place.

The Chairman, in opening the session, welcomed the new members and referred briefly to the work which had been carried out, and also to the changes which had taken place in the personnel of the Industrial Research Bureau during the year.

The following items formed the Agenda which was discussed by the Council :—

- I. The allocation of research work on Oils and Soaps to laboratories, and the progress made.
- II. The research programme of the Government Test House.
- III. Accessories for glass bangle manufacture.
- IV. Improvement of glass furnaces.
- V. Improvement of glass products.
- VI. Casein plastics.
- VII. Industrial standardisation.
- VIII. Allocation of prizes.
- IX. Publications of the Bureau.
- X. Industrial surveys.

As in the case of the Annual Report for 1936-37, a brief summary of the discussion on certain of the above items of the agenda and of the conclusions arising out of these discussions is given in this Chapter. In the case of items which have since been subjects of investigation by the Industrial Research Bureau office or by the Research Branch at the Government Test House, however, the relevant subjects have been dealt with also in the Chapters in which the work carried out by these two establishments is described, and the developments which have taken place in relation to the discussions and recommendations of the Council have also been indicated therein.

**I. RESEARCH ON OILS AND SOAPS.**—The Council considered the extent to which the allocation of work had been accepted by the various laboratories and establishments concerned, and recommended that the Bureau should invite the Indian Institute of Science, Bangalore, to undertake the work on items of investigation which had not been accepted by certain laboratories and establishments.

The Indian Institute of Science has, however, not yet been able to accept this work, and certain of the subjects still await acceptance. The present position is described in Chapter V.

**II. RESEARCH PROGRAMME OF THE GOVERNMENT TEST HOUSE.**—The various researches and investigations carried out by the Research Branch at the Government Test House, during the year 1936-37, were described to the Council in considerable detail by Dr. L. C. Verman, the Research Officer. The work carried out and progress made in connection with the major items of investigation during the year under report are described in Chapter III of this report.

**III. ACCESSORIES FOR GLASS BANGLE MAKING.**—The Council considered that, on completion of satisfactory laboratory investigations with a view to the preparation of China Glass and Liquid Gold, the Bureau should arrange for semi-commercial scale trial batches of these materials to be prepared and used under normal industrial conditions in a glass factory, and that thereafter investigations should be extended to the production of ruby-red glass.

The investigations in connection with the manufacture of China Glass have been successfully completed in accordance with this programme, but those regarding Liquid Gold have not yet been completed. The work on ruby-red glass will be undertaken on conclusion of the work on Liquid Gold.

A description of the work carried out in this connection during the year under review is given in Chapter IV.

**IV. IMPROVEMENT OF GLASS FURNACES.**—The Council was informed that arrangements for the installation of an improved pot type furnace, in accordance with the experimental designs of the Bureau, had been successfully negotiated with the proprietor of the Star Glass Works, Ferozabad, U. P., and that access to the furnace, both during construction and subsequently when in operation, would be arranged for glass manufacturers and other interested persons through the Director of Industries and Commerce, United Provinces.

The Council recommended that, as soon as possible after the furnace has been tried out, a report on its working, with details and plans, modified if necessary in the light of experience, should be circulated to all Directors of Industries.

The furnace was constructed and put into operation during the year under review, under the supervision of the staff of the Bureau, and certain preliminary comparative tests have been carried out, the details of which are recorded in Chapter IV below.

**V. IMPROVEMENT OF GLASS PRODUCTS.**—It was proposed to the Council that arrangements should be made to carry out the following series of experiments in due course in the presence of officers of the Bureau, using the improved

pot furnace, as it could be anticipated that it would be possible to attain higher working temperatures and to utilise lower grade coals than is possible with the present Japanese type furnaces.

- (i) comparative fuel consumption tests between the improved type furnace and a Japanese type furnace of similar glass capacity ;
- (ii) fuel consumption and temperature tests on the new furnace, using inferior grades of coal ;
- (iii) experiments with high lime batches for blown glass, the investigations to include comparative thermal shock resistance and other tests at the Government Test House, on lamp globes produced from glass made in the new furnace and imported lamp globes ;
- (iv) experiments with batches containing alkali substitutes such as the nepheline-syenite rock proposed by Dr. Dubey, feldspars dolomite, magnesite, etc. ;
- (v) comparative tests as regards strength and durability of Indian, Japanese, and other imported glass pots, with a view to effecting improvements in Indian-made glass-making pots.

It was also proposed that, when the furnace has been put into successful operation, a part-sectional model should be constructed for display at exhibitions and similar functions.

The Council approved the above proposals, and also recommended that special attention be paid to the possibility of reducing the proportions of soda-ash used at present in glass factories, and that the durability of the recuperator bricks and other refractory components of the furnace be observed and recorded.

The tests carried out during the period covered by this report are described in Chapter IV.

VI. CASEIN PLASTICS.—As regards this item of the agenda, the Council were invited to consider what further action should be taken by the Bureau to further the manufacture of casein plastics in India, as considerable difference of opinion was revealed by the discussion on this subject at the second session of the Council, and in communications subsequently received by the Bureau.

The Council decided that the Bureau be asked to investigate the literature on the subject of the preparation of casein and its use for plastics, and to prepare a report on the economic possibilities of manufacture in India.

The action which is being taken is described under this heading in Chapter II of this report.

VII. INDUSTRIAL STANDARDISATION.—The Council noted the report of the Chief Controller of Stores, Indian Stores Department, concerning the supply of Indian Stores Department specifications for which certain Directors of Industries had applied, and on the number of specifications required for articles in common use for which specifications are not available.

The response had been small, and the Council had no specific proposals to make.

VIII. ALLOCATION OF PRIZES.—The papers received in connection with the Prize Scheme of the Council having been circulated previously to members of the Prizes Committee, this Committee met on the 3rd July 1937, and drew up their\* report to the Council.

The Council approved the report of the Committee, and reached the following conclusions regarding its recommendations.

1. That the following four papers and their authors be awarded prizes of the amounts stated :—

Subject.	Author or Authors.	Value of prize.
Clock-making in India	Dr. H. Parameswaran, M.A., Ph.D., D.Sc., F.Inst.P., Chief Professor of Physics, Presidency College, Madras.	1,000
The Chemistry of the manufacture of sulphitation sugar from coloured canes (Purple Mauritius).	S. Venkata Ramanayya, Esq., B.A., M.Sc., Chemical Section, Imperial Agricultural Research Institute, New Delhi.	500
The Manufacture of Optical instruments in India.	S. Hariharan, Esq., M.A., M.Sc., Research Fellow in Physics, Presidency College, Madras.	250
The manufacture of sulphuric acid by the contact process, using Vanadium catalysts.	K. W. Khubchandani, Esq., M.Sc. (Hons.), A.I.Sc., c/o The Ceylon Spinning and Weaving Co., Ltd., Post Box No. 320, Colombo, Ceylon.	150

2. That, in future, papers should not be admitted for the competition unless the work has been done in India and is applicable under Indian conditions.

3. That the recommendation of the Committee in respect of the scope of the competition be accepted.

4. That about two-thirds of the prize-money should, in future, be allocated to a paper on a set subject, the prize to be not less than Rs. 2,000.

5. That the recommendations of the Committee as regards publication rights be accepted.

The Council also agreed that the Prizes Committee for the competition for 1938 should consist of—

Dr. Habib Hasan, L.Ag., M.Sc., Ph.D., Chief Chemist, Government Industrial Laboratory, Commerce and Industries Department, His Exalted Highness the Nizam's Government, Hyderabad ; Mr. S. M. Dhar, I.C.S., Director of Industries, Bihar ; Mr. S. C. Mitter, B.Sc., Director of Industries, Bengal ; and the Director of the Bureau.

This subject is further dealt with in Chapter II.

IX. PUBLICATIONS OF THE BUREAU.—The Council considered the subject of publications hitherto issued in the series of Bulletins of Indian Industrial Research, and discussed proposals as regards other suitable papers which might be prepared or invited for publication in this series. It was agreed that

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\* The report of the Prizes Committee is given in Appendix ' A '.

Mr. K. S. Rao, Bihar, should be invited to contribute a paper on "The Handloom Industry of India" for this purpose, and that the Bureau should arrange for the preparation of papers on the following subjects in due course :—

- (i) the electric fan industry,
- (ii) the electric lamp industry,
- (iii) the construction and economics of the improved type glass furnace,
- (iv) the construction and operation of the Road Test Track,
- (v) the analysis and grading of raw materials from various sources for glass-making,
- (vi) selected prize papers.

It was also agreed that reports received by the Bureau from the Research Branch which are suitable for publication but too short or otherwise unsuitable for individual publication, should be arranged in groups from time to time and published in the Bulletin series.

The Council discussed the question of facilities available for industrial research, and recommended that the Bureau should compile and publish a directory giving particulars of the facilities at Universities, technical colleges, and at other establishments in India for research on industrial problems, which are available to industrialists throughout the country.

The Council also considered that it is desirable that the Bibliography of Industrial Publications (Bulletin No. 1 of the series of Bulletins of Indian Industrial Research) should be supplemented or revised from time to time.

X. INDUSTRIAL SURVEYS.—The important subject of surveys of major industries was considered by the Council, with special reference to the facilities which are or can be made available for such work, the outline scheme which should be followed for each industry surveyed, and the industries which should be given priority in the event of surveys being undertaken.

It was agreed that such surveys should be conducted industry by industry, these being taken up in turn and a uniform scheme followed as far as possible in each case. In accordance with the conclusions of the Eighth Industries Conference, held in 1936, it was also agreed that the surveys within the Provinces and States concerned would be carried out by their own agencies, and that the Bureau would co-ordinate the work, as far as possible.

The Council discussed a general outline scheme, and recommended that the Bureau should address the Directors of Industries with a view to arranging for surveys of (i) the oil-seed crushing industry, (ii) the tanning industry, and (iii) the pottery and ceramics industry, which might suitably be taken up in the order stated.

The action taken by the Bureau in this matter is described in Chapter II.

VISITS TO INDUSTRIAL LABORATORIES.—The members of the Council, during the session, visited the following institutions by invitation :—

1. The Indian Central Cotton Committee's Technological Laboratory, Matunga.
2. The Victoria Jubilee Technical Institute, Matunga.
3. The Bombay University Department of Chemical Technology, Fort.
4. The Laboratories of the Director of Industries, Bombay.

## CHAPTER II.

## WORK OF THE BUREAU.

**STAFF.**—The sanctioned strength of the Industrial Research Bureau, and the actual strength on the 31st March 1938, were as follows :—

Rank.	Sanctioned strength.	Actual strength on 31st March 1938.
Director .. .. .	1	1
Assistant Director .. .. .	1	1
Superintendent .. .. .	1	1
Technical Assistants .. .. .	2	2
Librarian .. .. .	1	1
Assistants and Clerks .. .. .	13	11
Stenographers .. .. .	2	1
Draftsman .. .. .	1	1
Tracer .. .. .	1	Nil
Others .. .. .	10	9

Mr. E. F. G. Gilmore, B.Sc. (Hons.), M.I.Mech.E., was the Director of the Bureau throughout the year under review.

**PRIZES COMMITTEE.**—The terms of the Prize Papers Scheme and the conditions for the submission of papers which had been in operation in the previous year's scheme were amended in accordance with the recommendations of the Council, and the competition was advertised by the Bureau in various newspapers in November 1937. The closing date of the competition was March 1st, 1938. Twenty-one papers have been received and will be circulated to the members of the Committee, after certain of them have been appraised by selected expert referees.

The proposals which have been received in regard to set subject for prize papers in connection with the revised Prize Scheme of the Council will also be circulated to members of the Committee for consideration.

A meeting of the Committee will be held in Madras prior to the fourth session of the Council, for the preparation of the Committee's report to the Council on these matters.

**ROAD RESEARCH.**—During the period under review, the designs and specifications for the various works, plant, and equipment required for the Road Test Track were completed in accordance with the scheme described in the last report. A site at a reasonable distance from the Government Test House, Alipore, situated on land owned by the Calcutta Port Commissioners, was leased from the 28th May 1937, and electric power supply from a near-by sub-station of the Port Commissioners was arranged.

Tenders were obtained and orders subsequently placed for the electrical plant and equipment through the Indian Stores Department. Contracts were made for all civil engineering work by the Superintendent, Government Test House, whose staff is supervising the work of construction and installation ; tenders for the mono-rail electric tractors, the design of which embodies many unusual features, were obtained and the order eventually placed with a Calcutta firm of electrical and mechanical engineers, by the Bureau.

The civil works and the installation of the electrical plant and equipment are now nearing completion, and it is planned to bring the test track into operation as soon as the end of the forthcoming rainy season permits.

The next session of the Indian Roads Congress, at whose instance the test-track is being constructed, will be held in Calcutta in January 1939, and it is anticipated that the test-track will be an object of special interest on that occasion.

**CASEIN PLASTICS.**—A considerable amount of information has been collected as regards the methods of manufacture of casein employed in India and in industrial countries, and also as regards the manufacture of casein plastics. A report on this subject will shortly be prepared by the Bureau, copies of which will be supplied to members of the Council.

**INDUSTRIAL STANDARDIZATION.**—During the period under review a small number of requests for the supply of various Indian Stores Department Specifications have been received from Directors of Industries, and the required specifications have been supplied by the Department. Proposals were also received for the preparation of standard specifications for certain specialised items which cannot suitably be covered by general specifications. The proposers were informed accordingly.

**PUBLICATIONS AND REPORTS OF THE BUREAU.**—With the approval of the Council as a result of consideration of this subject during the second and third sessions, the following authorities were invited to contribute papers on the subjects stated, for publication in appropriate form in the series of Bulletins of Indian Industrial Research :—

The Soap Industry	..	..	..	Mr. A. K. Menon.
The Leather Industry	..	..	..	Rai Bahadur B. M. Das.
The Heavy Chemical Industry	..	..	..	Mr. N. N. Sen Gupta.
Researches connected with rape-seed oil and mustard-seed oil.				Mr. D. Y. Athawale.
The Handloom Industry	..	..	..	Mr. K. S. Rao.

The paper on the Heavy Chemical Industry by Mr. Sen Gupta has been received and published. The paper on the Soap Industry has been received from Mr. Menon and is in the press. The papers on the Leather Industry and on Researches connected with rape-seed and mustard-seed oils have been received, and certain proposed amendments and additions have been referred to the respective authors.

Mr. K. S. Rao has agreed to prepare a paper on the Handloom Industry.

The following Bulletins have been published in the series of Bulletins on Indian Industrial Research during the period under review :—

No. 8—Development of Heavy Chemical Industries in India.

No. 9—Purification of Clay.

No. 10—Indian Vegetable Oils.

No. 11—The Manufacture of Sulphitation Sugar from Coloured Canes (Purple Mauritius).

Draft bulletins on the electric fan industry and the electric lamp industry have been under preparation by the Bureau for some time, but their completion



and publication has been postponed as it is considered to be desirable to defer this until the numbers of firms in these industries in India, eligible for inclusion in the lists of approved manufacturers which are maintained by the Indian Stores Department, are greater than at present. As regards the electric lamp industry, this is not likely to be long deferred, as the number of firms manufacturing electric lamps in India will shortly be increased by the addition of the Mysore Electric Lamp Works, Bangalore, and the Hindustan Electric Lamp Works, Shikohabad, U. P.

The paper entitled " Clock-making in India ", which was awarded a prize in connection with the Prize Scheme of the Industrial Research Council in 1937, is being edited to form a bulletin which will be published shortly. The details of construction and the economics of the improved type glass furnace and also the details of construction and operation of the Road Test Track will also form the subjects of publications in due course.

A directory giving particulars of the facilities at Universities, technical colleges and other suitable establishments in India for research on industrial subjects, and which are prepared to undertake investigations on behalf of industrialists, is being compiled by the Bureau.

Cyclostyled copies of reports on the following subjects were circulated to all members of the Council :—

- (1) Uses of arsenic oxide as an opacifying agent in Lead Glasses and the manufacture of China Glass in India, by Dr. Atma Ram, D.Sc., and Dr. Lal C. Verman, M.Sc., Ph.D., F.Inst.P.
- (2) Interim report on a survey of the glass-making raw materials of India, by Dr. V. S. Dubey, M.Sc., Ph.D., D.I.C.

Other subjects are engaging the attention of the Bureau, and Bulletins will be published thereon or reports circulated as soon as their examination has advanced sufficiently.

COMPILATION OF INFORMATION REGARDING RESEARCHES.—From information supplied by the Directors of Industries and scientific institutions, a list of technical and industrial researches and investigations in progress in India or in contemplation, was prepared and supplied to all members of the Advisory Council.

A copy was also forwarded to the Department of Scientific and Industrial Research, London, in accordance with a reciprocal arrangement. This will be done annually in future.

INDUSTRIAL SURVEYS.—In accordance with the conclusions and recommendations of the Council on the subject of Industrial Surveys, the Director of the Bureau addressed the Directors of Industries in letter No. R-390, dated the 1st December 1937, with a view to initiating a co-ordinated survey of the oil-seed crushing industry, in the first instance. Attention was drawn therein to the relative importance of this industry due to its close connection with the agricultural industry, the need of improving its efficiency to the standard of such industries in industrial countries, the desirability of exporting the oils rather than the seeds so that the seed-cake may be retained and utilised in the country, and the necessity of providing a qualified technical staff to carry out the survey.

## INDUSTRIAL INTELLIGENCE.

*Rayon.*—The examination undertaken at the request of the Indian Central Cotton Committee of the possibility of manufacturing artificial silk (both rayon and staple fibre), by the viscose and also by the acetate processes in India has been continued. Two interim notes have been prepared, and these were considered and discussed by the Committee at their meetings in August 1937, and January 1938, respectively, which the Director of the Bureau attended. Copies of these notes were subsequently supplied to the Directors of Industries, Madras, and Bombay, as they had indicated their interest in this matter, and recently the Government of Bombay have taken up this subject. Co-ordination has been arranged between the Indian Central Cotton Committee, the Director of Industries, Bombay, the Forest Research Institute, Dehra Dun, and the Industrial Research Bureau.

*Lubricating oils and paints.*—The Bureau continues to co-operate with the Central Standards Office, Railway Board, in connection with matters concerning the lubrication and the painting of railway rolling stock. A considerable amount of development work in connection with the former subject has been in progress during the year.

*Hurricane Lamps.*—The factory of the manufacturer of hurricane lamps near Calcutta to which reference was made in last year's report was inspected by members of the staff of the Research Branch, Government Test House, in connection with the tinning defects which were experienced by the factory. A report proposing considerable changes in their technique was prepared, as a result, and forwarded to the firm through the Director of Industries, Bengal.

An industrialist who proposed to set up a factory for the manufacture of these lamps, also near Calcutta, was given detailed information.

*Magnesite, Magnesium, and Dry Ice.*—An industrialist owning considerable deposits of magnesite in the Salem district, Madras, applied to the Bureau for advice as to their utilisation. It is an unfortunate fact that Indian magnesite does not generally contain sufficient iron oxide, which acts as a flux, and consequently is not used to any considerable extent for the manufacture of refractory magnesite bricks for furnace linings such as are used by steel works utilising basic ores. For this reason, large quantities of magnesite refractories are imported into India annually from Austria and elsewhere in Europe.

Magnesium, which is lighter and stronger than aluminium and is being utilised to an increasing extent in the construction of air-craft, is at present prepared from magnesium chloride produced from sea water, though endeavour is being made in many countries to develop methods of preparing it direct from magnesite ores.

Information was given as regards methods of manufacture of magnesium, sorel cement, and, as a by-product of calcination, 'dry ice'. Copies of the correspondence were forwarded to the Director of Industries, Madras, for information.

*Calcium Carbide.*—An enquiry was received from an industrialist who proposed to manufacture calcium carbide in the Mettur district, Madras, where cheap electric power supply would be available.

The annual imports of this material into India amount to some 3,000 tons only, and the modern industrial method of production is by means of very large capacity electric furnace units capable of annual production considerably greater than India's present annual requirements.

Details of small units having an output capacity of 1½ tons per day, which had been designed and constructed by the Cerro de Pasco Copper Corporation, Peru and New York, were obtained and supplied to the enquirer, copies of the correspondence being also forwarded to the Director of Industries, Madras.

*Starch.*—Although India is potentially rich in vegetation suitable for the manufacture of starches, the imports of this material into India are considerable. Requests have been received from several parts of the country for information and advice regarding the plant and methods required for the manufacture of starch from cassava, jowar, grain, and other raw materials. Information is being collected from sources ranging from the Dutch East Indies to British Honduras as regards appropriate plants for different raw materials, and a technical note on this subject will be prepared when sufficient information is available.

*Mahua Seed.*—A firm of oil seed importers in the United States enquired as to the production of mahua seed or mahua seed oil available for export from India. The necessary information is being collected from the Directors of Industries concerned.

A well-known woollen mill at Cawnpore proposed to the Bureau that mahua oil might be rendered suitable for use in wool batching in mill processing. The matter is under consideration.

*Miscellaneous Industries.*—Enquiries have been received from a Director of Industries for technical information regarding manufacture of the following:—

- Spectacles,
- Glass bangles,
- Bakelite,
- Sealing wax,
- Razor blades,
- Typewriter ribbons,
- Buttons,
- Silver thread,
- Galvanised iron buckets, and
- Briquettes from paddy husk.

Detailed information is being collected and technical notes will be prepared in the case of certain of these industries which are likely to be of general interest. It may be mentioned that industries are already established in various Provinces and States for the production of several of these items.

*Requests for information.*—The number of enquiries received from industrialists during the year was 138, as against 86 last year, this being equivalent to an increase of 60 per cent. Twenty-six of these enquiries were received from Directors of Industries, 16 from other Government Departments, 83 from private firms or individuals, and 13 from foreign and semi-official bodies. The majority of the enquiries, concerned the technical aspect of some industry, but certain of them sought information on matters outside the sphere of activity of the Bureau, e.g., method of extraction of honey, standardization of the products of tobacco, requests to arrange for the training of apprentices in various industries, and a request for the Bureau to arrange for a reduction in the price of coal used in an industry.

In general, however, it can be said that the technical standard of the enquiries received is definitely improving, presumably as a result of the increasing interest in industrial matters which is discernible in various directions.

A selection of these enquiries, arranged by Provinces and States from which they were received, is given in Appendix 'B' of this report.

*Scrutiny of specifications.*—Specifications drafted by the Indian Stores Department and the Central Standards Office, Railway Board, continue to be received for scrutiny to ensure that Indian products are not unnecessarily excluded thereby.

**LIBRARY.**—The library contained at the end of the year 3,864 volumes, consisting of the following :—

Text Books and works of reference	..	..	..	1,642
Publications of Government Departments	..	..	..	2,074
Bound volumes of back numbers of periodicals	..	..	..	148
				3,864

The additions to the library during the year under report were as follows :—

Text Books and works of reference	..	..	..	194
Publications of Government Departments	..	..	..	197
Bound volumes of back numbers of periodicals	..	..	..	43
				434

The number of technical periodicals taken by the library is now 63.

**FINANCE.**—The estimated expenditure (Preliminary) during the year 1937-38 on the Industrial Research Bureau and the Research Branch at the Government Test House, Alipore, was as follows :—

					Rs.	A.	P.
Industrial Research Bureau	..	..	..	..	1,03,811	0	11
Research Branch	..	..	..	..	63,977	12	3
					1,67,788	13	2

## CHAPTER III.

## RESEARCH WORK AT THE GOVERNMENT TEST HOUSE.

STAFF.—Several changes took place in the composition and numbers of the superior staff of the Research Branch at the Government Test House during the course of the year, as a result of new appointments and also of resignations.

The post of the Assistant Research Officer remained vacant for the greater part of the year, as Dr Karimullah, who was appointed to the post, did not take up his duties until February, 1938. In consequence, the labours and responsibilities of the Research Officer were considerably increased.

The following staff was added to the Research Branch during the year :—

Dr. Karimullah, Ph.D. (Heidelberg), Ph.D. (Edinburg), Assistant Research Officer, who took up his duties in February, 1938.

Mr. S. L. Banerji, M.Sc., Chemical Assistant, who joined in January, 1938, in place of Dr. S. V. Anantkrishnan, resigned.

Dr. M. Karim, Ph.D., Physical Assistant, who joined in March, 1938

An Instrument Maker was recruited in November, 1937.

The statement below shows the sanctioned strength and also the actual strength of the Research Branch on the 31st March 1938 :—

Rank.	Sanctioned Strength.	Actual strength on 31st March 1938.
Research Officer .. .. .	1	1
Assistant Research Officer .. .. .	1	1
Chemical Assistants .. .. .	8	6
Physical Assistants .. .. .	7	7
Clerks .. .. .	5	5
Draftsman .. .. .	1	1
Instrument Maker .. .. .	1	1
Mistries .. .. .	4	4
Others .. .. .	11	11

PROGRESS OF INVESTIGATIONS.—Steady progress has been made during the year in connection with the principal investigations upon which the Research Branch is mainly occupied, and various minor investigations which have been taken up at the instance of the Bureau from time to time have been completed and reported upon. The following descriptions indicate the progress effected in connection with the subjects which have engaged the attention of the staff.

PAINT INVESTIGATIONS.—The staff allocated to this work during the year has remained unchanged and consisted of two chemical and one physical assistant, and the work carried out has been as follows :—

*Black Paints.*—Ninety-four exposure test panels prepared from five series of 47 types of black paints containing lampblack, boneblack, carbonblack, graphite, magnetic oxide of iron, barytes, asbestine, and silica in different combinations, and which were exposed in previous years, were under observation during the period under review.

*Red Oxide Paints*—Seventy panels representing 35 paint formulæ were under exposure throughout the year. The weathering has not proceeded far enough to enable any final conclusions to be drawn.

In order to study the settling properties of red oxide paints, a series of 39 paints, some of which contain small percentages of certain dispersing agents, were prepared. These were under observation during the year.

*Red-lead Paints*.—A report on the results of the preliminary investigations to determine the characteristics mainly affecting the setting of red-lead paints in India which were completed in the previous year, indicating the conclusions to be drawn from them, was prepared and issued. (R. B. Paint No. 2.)

With a view to further investigating the setting properties of Indian and imported red lead, a revised scheme was drawn up and the work is in progress.

*White Paints*.—A complete series of panels of 36 white paints were prepared, and kept ready to be exposed as soon as new sets of exposure test racks are completed.

*Green Paints*.—The preparation of a series of green paints was commenced during the year.

*Comparison of Sublimed White Lead and White Lead*.—A series of paints prepared from white lead and sublimed white lead, with or without extenders, was subjected to natural weathering tests. Sublimed white lead was found to be inferior to white lead, but a 50—50 mixture of the two pigments yielded a paint superior in durability to paints prepared from either of the pigments alone.

*Gypsum as Paint Extender*.—The comparative weathering tests on the paints prepared with gypsum and barytes as extenders were in progress during the year. In the artificial weathering tests in the weatherometer, gypsum proved to be an inferior extender, due, it is suspected, to its solubility in water. The work is being continued.

*Umber*.—The samples of umber received from Jodhpur State, which were mentioned in the last report, were found to be unsatisfactory in respect of their staining properties. It is proposed to investigate the possibility of increasing the staining power of the umber obtainable from the above source by suitable treatment.

*Magnetite*.—The tests on paints prepared from magnetite received from Jodhpur were continued during the year.

*Titaniferous Bauxite*.—The paints prepared at the Test House from samples of treated and untreated titaniferous bauxite, which were received from a firm at Jubbulpore, were under exposure during the year. The paints prepared from these pigments by the firm themselves were also under exposure.

*Natural Weathering*.—The technique of testing paints for durability under natural weathering conditions received considerable attention during the year, arising from the destruction of a series of test racks during a storm of unusual

violence ; before building new racks the question regarding the disposition and size of future exposure panels was thoroughly considered.

It has been the practice hitherto at the Test House to use 24"×24" steel panels exposed in a vertical position facing east and west, so that they received either the morning or the evening sun. In Europe and America the general practice is to expose paint panels at an angle of 45° from the horizon, facing south, but certain American investigators have recently challenged this procedure. It has, therefore, been decided to continue the existing practice of the Test House to expose panels in a vertical position, facing east and west, and also to run comparative tests on panels facing south at such an angle as would lead to the quickest breakdown. This angle, for Calcutta, has been calculated to be 20° from the horizon, in which position the panels will receive the maximum of the sun's radiation integrated over the whole of the year.

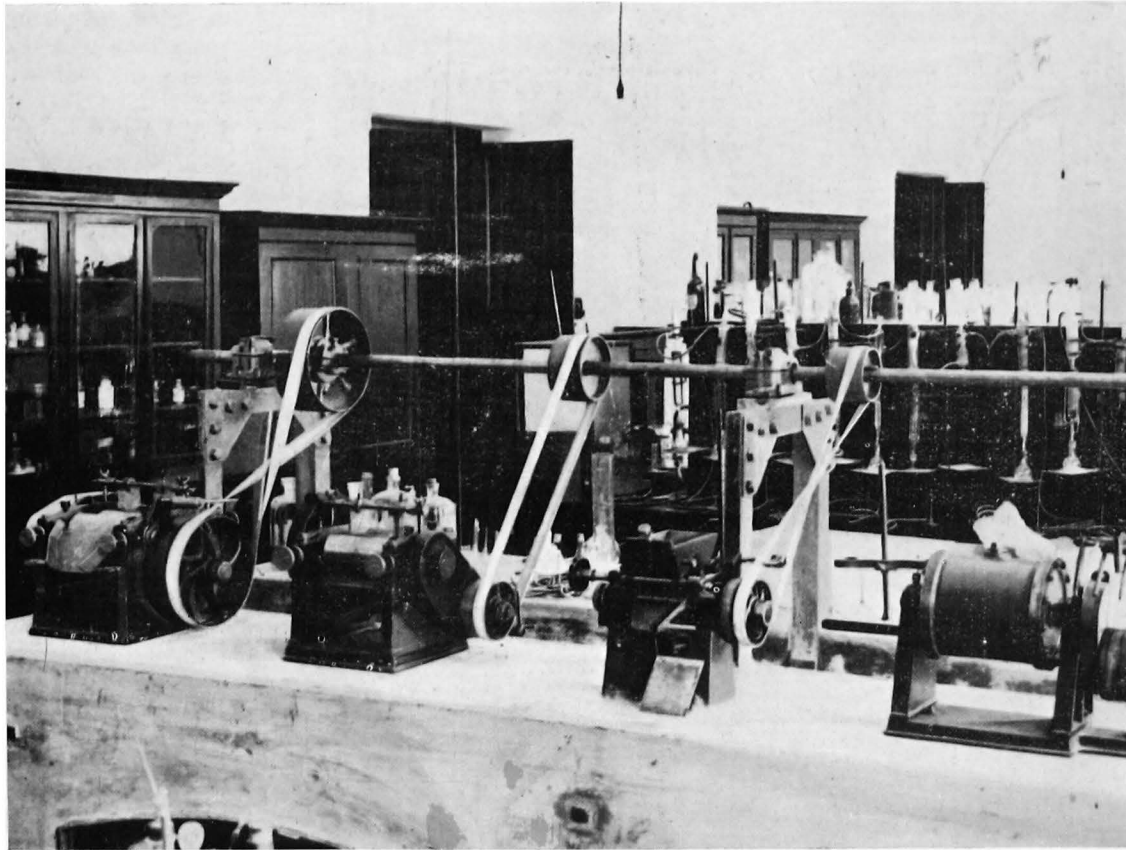
At the suggestion of Prof. P. C. Mahalanobis, the practice has been introduced of exposing four panels for each particular paint in a series, so as to facilitate the examination of test results from the statistical point of view. It has, therefore, become necessary to reduce the size of panels in future tests, and to use 9"×6" panels instead of the old standard 24"×24". In accordance with these plans, a small 20° test rack has already been built and installed, while suitable racks for vertical exposure have been designed and will shortly be built.

*Accelerated Weathering.*—The work on paint exposure tests in the 'Weatherometer' was continued intermittently during the year. A series of sixty red oxide paint panels were exposed, but the expected acceleration of breakdown was not obtained. The search for the causes of this delayed failure led to a considerable amount of investigatory work, as a result of which a number of changes in the apparatus and equipment have been introduced.

The nature of the water to be used in the weatherometer first received attention. Tap water is unsuitable as it contains a substantial amount of dissolved matter, which, on drying, produces a hard protective film on the painted surface. Rain water was considered to be ideal, but it is not available throughout the year and it cannot be conveniently stored in large enough quantities. Dew was found to have a more destructive action than rain water, but its pH value was found to vary from day to day, ranging between 3·6 and 6·9 and giving a bi-nodal distribution with maxima at approximately 4·7 and 5·6 ; moreover the collection of adequate amounts presented practical difficulties.

It was finally decided to use ordinary distilled water, which has an initial pH value of about 4 or more, and to circulate it through the apparatus over and over again. It was found that when repeatedly sprayed on to the panels, it picks up from the atmosphere impurities of the same type as are found in the dew. In addition, it is simultaneously affected by the soluble matter coming off from the paint films. It has been found that during a 22 hours run of the apparatus the pH value of the water increases from a little over 4 to a little over 6. Consequently the water is now renewed after each such run.

Another modification made in the original apparatus consisted in replacing all galvanized iron pipes by lead pipes, so that any acidic ingredients in the



**PLATE I.**

**New Laboratory Paint Mills installed during 1937-38.**



circulating water would not be readily neutralized. The neutralizing action of zinc was actually observed when water of particularly low pH value was employed.

During outdoor exposure tests in summer months the paint films have been found to acquire as high a temperature as 54°C. It was, therefore, considered desirable to instal a radiation heater in the weatherometer to heat the panels up to this temperature. The heater was so arranged that directly after being heated the panels passed under the water spray, thus simulating the sudden cooling, which often takes place during the monsoon season.

*Effect of dew and fungus.*—During the year under review, attention was also directed to the important role paid by dew and fungus in the breakdown of paint films, and interesting observations have been recorded.

*Equipment.*—New equipments added to the laboratory during the year include :—

1. One 20° exposure rack for 9" × 6" panels, facing south.
2. Laboratory paint mills as follows :—
  - i. One triple roll mill.
  - ii. One double roll mill.
  - iii. One single roll mill.
  - iv. One ball mill.

The various mills were installed during the year and put into service. A view of the installation is shown in Plate I.

**DRY CELLS.**—The superior staff engaged on these investigations during the year consisted of one chemical and one physical assistant.

The work has been chiefly concerned with the main heads (b) and (c) of the investigations which were mentioned in last year's report, namely—

(b) Determination of the assembly and maturing processes necessary for the production of high-quality cells.

(c) Comparative tests of raw materials with a view to utilising indigenous materials wherever possible.

*Production of cells.*—More than 450 torch size (B. S. S. size D. U. 2) dry cells were manufactured in batches during the year under closely controlled conditions, and a considerable measure of success has been attained as regards determination of the effects of the following variables :—

1. Different varieties of natural and artificial graphites.
2. Relative proportion of graphite used.
3. Particle size of pyrolusite.
4. Various methods of preparing the electrolyte.
5. Use of acetylene soot in the depolarizer.
6. Different varieties of pyrolusites.
7. Use of artificial manganese dioxide.
8. Proportioning of electrolyte between the depolarizer and the paste.
9. Use of hygroscopic materials in the electrolyte.

10. Use of commercial *versus* pure varieties of chemicals.
11. Variation of tamping conditions in preparing 'dollies'.
12. Variation of temperature and time of 'cooking' the cells.

The technique of manufacture has now been developed to the stage at which cells equivalent in quality, when new, to the best makes available commercially, and satisfying British Standard Specification No. 397 with a satisfactory margin, can be prepared, provided that pyrolusites of good quality are used. The standards of purity required for good performance in the case of the other component materials, *e.g.*, zinc, graphite, ammonium chloride, zinc chloride, magnesium and calcium chlorides, etc., have also been determined.

Repeated manufacture of the same types of cells has confirmed that consistent reproducible results are obtained from batches of cells prepared in accordance with this technique. The question of efficient maintenance of electrical characteristics during long periods of shelf life is now under investigation.

*Use of Indian materials.*—Of all the materials entering into the manufacture of dry cells, manganese ore or pyrolusite is undoubtedly the most important. A great deal of this ore is exported from India for use in steel manufacture in other countries, but very little of it appears so far to have been used in dry cell manufacture.

Eight samples of Indian ores were collected from different parts of the country, and chemically examined to determine the amount and nature of the impurities present. Dry cells prepared with these ores were compared with cells made from imported materials and also with ready-made cells available in the market; tests so far carried out indicate that it is possible to prepare satisfactory cells from some of the Indian ores when a proportion of artificial manganese dioxide is added to them.

Another batch of ten samples of Indian ores has been obtained, and these will be tested in a similar manner. A search for further sources of supply is also in progress. The following is a list of the samples so far collected:—

No.	Designation.						Province.
1	Singhbhum	..	..	..	..	..	Bihar.
2	Keonjhar	..	..	..	..	..	"
3	Type A	..	..	..	..	..	C. P.
4	Type B	..	..	..	..	..	"
5	Type C	..	..	..	..	..	"
6	Shivarajpur No. 6	..	..	..	..	..	Bombay.
7	Shivarajpur No. 10	..	..	..	..	..	"
8	Shivarajpur No. 4S	..	..	..	..	..	"
9	B. C. P. W.	..	..	..	..	..	Madras.
10	Keshapore Lumpy No. 1	..	..	..	..	..	Mysore.
11	Keshapore Lumpy No. 2	..	..	..	..	..	"
12	Keshapore Lumpy Crude	..	..	..	..	..	"
13	Keshapore Concentrate	..	..	..	..	..	"
14	Keshapore Slimes	..	..	..	..	..	"
15	Ore A	..	..	..	..	..	"
16	Ore B	..	..	..	..	..	"
17	Ore A	..	..	..	..	..	Karnatak.
18	Ore B	..	..	..	..	..	"

In addition to the admixture of artificial manganese dioxide, other methods of increasing the utility of Indian ores are being investigated. These involve various types of pre-treatments, such as acid or alkali washing, and activation by catalysts. Magnetic separation was carried out with a view to segregating the weakly and highly magnetic fractions from powdered pyrolusite; the electrical characteristics of the cells made with the two fractions were not found to be substantially different, however, probably due to the fact that whatever small quantity of iron may be present in the ore, is possibly not present in a free state, but forms an integral part of the crystal structure of manganese dioxide.

*Correlation of chemical constitution and electrical performance.*—To determine how a particular impurity in the ore affects the electrical characteristics of a cell made from it, all the ores were analysed. The chemical and electrical data so far obtained point to the following conclusions:—

- (a) In spite of the common belief among investigators in this field, iron-content is beneficial to a certain extent, probably due to catalytic effect.
- (b) The difference between the total manganese, calculated as  $MnO_2$ , (bromine method), and the available  $MnO_2$  (oxalic acid method) is correlated with the voltage and output of the cell. The percentage of available  $MnO_2$  showed, however, no relationship with any of the electrical characteristics.
- (c) Relatively high contents of oxides of manganese other than  $MnO_2$ , (as determined by their solubility in normal sulphuric acid), appear to be advantageous.
- (d) Water of hydration also appears to be advantageous, but this conclusion is tentative.
- (e) Pyrolusites of low specific gravities are definitely superior to ores of higher specific gravities. The specific gravities of Indian ores of which samples have hitherto been obtained are higher than 4.5, whereas foreign ores are available with specific gravities as low as 3.65.

*Experimental dry cell.*—In the last annual report, mention was made of plans for development of an apparatus called the "experimental dry cell", with the aid of which it was anticipated that it would be possible to study, without actually making cells, the effects on the initial characteristics of a number of variables entering into their manufacture. This equipment has been constructed and has confirmed that the data obtained by its use regarding initial voltage, polarization, and recovery characteristics can be directly compared with the values obtainable from actual cells, and a considerable amount of time and work thereby saved.

*Testing equipment.*—Additional dry cell testing equipment has been devised and constructed, and an automatic arrangement for switching on thirty cells under test for a prescribed period at prearranged times daily is nearing completion. This involves two banks of thirty mercury switches, operated by a single solenoid which is energised by clock through relays.

*Machinery for the commercial production of dry cells.*—Information has been collected during the year regarding sources and details of machinery and plant for the manufacture of dry cells on a commercial scale.

**INTERNAL COMBUSTION ENGINES.**—The superior staff engaged on internal combustion engine work during the year consisted of two physical assistants and one chemical assistant.

*Vegetable Oils as lubricants*—The suitability as lubricants of the various vegetable oils under investigation is being determined by the following three test stages :—

- (i) Search for suitable anti-oxidants and development of blends of oils.
- (ii) Practical tests of the blends developed as the result of (i) in small single cylinder engines.
- (iii) Practical tests of the same blends in larger industrial units.

The investigations regarding the efficacy of various anti-oxidants have continued, an Air Ministry Standard Oxidation Equipment being utilised to enable intensive oxidation tests on oils and blends to be carried out.

From among a considerable number tried experimentally, the following substances were found to be promising when used in conjunction with castor oil blends with mineral oils and for other vegetable oils :—

1. *β*-Naphthol.
2. Diphenylamine.
3. *β*-Naphthol and *β*-Naphthylamine mixture.
4. Acetyl phenyl-hydrazine.
5. Tin Naphthenate.

In view of the high viscosity of castor oil, and the fact that the viscosity increases to three times its original value during the oxidation test, it was considered desirable to prepare castor oil blends with mineral oil and also lighter vegetable oil for practical trials in the engines. Castor oil is, however, not directly miscible with mineral oil, which necessitated the development of special processes in order to effect miscibility, reference to which was made in the previous report. The heating of castor oil with certain catalysts under low pressure and in certain cases at atmospheric pressure was found to be satisfactory procedure for this purpose. Two typical blends which were prepared and subjected to engine tests had the following compositions :—

(1) Castor oil	..	..	..	..	40 parts by volume.
Groundnut oil	..	..	..	..	40 parts by volume.
Mobiloil " A "	..	..	..	..	18 parts by volume.
<i>β</i> -Naphthol	..	..	..	..	2 parts by weight on the total oil.

(Note.—Untreated castor oil is miscible in this combination.)

(2) Blown Groundnut oil	..	..	..	60 parts by volume.
Mobiloil "A"	..	..	..	40 parts by volume.
$\beta$ -Naphthol	..	—	..	2 parts by weight.
Tin—Naphthenate	..	..	..	0.2 parts by weight.

Selected blends were each tested for 100 hours in a 1.5 K. W. single cylinder Lister petrol-electric house-lighting set, running at full-load at 700 R. P. M. with the cooling water outlet temperature maintained at 205°F  $\pm 2^\circ$ , small samples of the oil being withdrawn at regular intervals for chemical examination and records of the amount of make-up oil added during the run being kept. The results of tests on the three blends were generally satisfactory, and similar tests were subsequently commenced and are now in progress, using the 16 H. P. Morris petrol engine dynamometer running at 7/8 full load at 1500 R. P. M.

*Vegetable oils as fuel.*—Mention was made in the last report of the 8 H. P. 1200 R. P. M. Lister diesel engine (compression ratio 15 : 1) which had been installed for investigations of the use of vegetable oils as fuels. The various accessories that were added from time to time for operation under controlled conditions were also briefly described.

The selected oils were first subjected to comparative tests against a high-speed diesel mineral oil to determine their respective characteristics as regards starting facility, smoothness or otherwise of running, and power output. The results of these preliminary tests are shown below :—

Oil.	Startability.		Operation.		Maximum H. P. output at 1200 R. P. M.
1. Shell Diesel (mineral)	..	Easy ..	..	Smooth ..	7.85
2. Groundnut	..	Easy ..	..	Smooth ..	7.6
3. Karanja ( <i>Pongamia glabra</i> )	..	Medium ..	..	Smooth ..	7.3
4. Kapok ( <i>Bombax malabaricum</i> ).	..	Medium ..	..	Smooth ...	6.9
5. Mahua ( <i>Bassia latifolia</i> , etc.)	..	Medium ..	..	Smooth ..	7.05
6. Punnal or Polung ( <i>Calophyllum inophyllum</i> ).	..	Difficult ..	..	Smooth ..	7.2
7. Castor	..	Very difficult	..	Unsteady	6.8

From the above it would appear that groundnut oil would give the best results and compare favourably with mineral oil, while Karanja, Kapok and Mahua oils may be regarded as fairly good, and might prove useful as a result of further work.

Prolonged runs of 50 hours' duration on oils which have given promising results are now in progress. The results so far obtained are shown in Appendix "D" of this report.

The test results show that groundnut oil gave practically as good a performance as Shell diesel oil, as, although its consumption was slightly higher, its overall thermal efficiency was the same. On the contrary, polung or punnal oil proved definitely deleterious to the cast-iron cylinder head and exhaust valve seat, where considerable pitting took place.

The work is continuing.

*Engine test equipment.*—Certain additional items of equipment for the experimental engines, for control of test conditions, were devised and fitted during the year. Among these were an improved radiation-proof electrically heated induction pipe for the Morris petrol engine, together with the necessary electrical control apparatus, to regulate the intake mixture temperature, and a similar induction air heater with control accessories for regulating the intake air temperature of the Lister diesel engine.

*C. F. R. anti-knock rating engine unit.*—The routine determination of octane numbers of samples of aviation and motor spirits received at the Test House continues to form a part of the duties of the Research Branch. The number of samples tested showed a steady increase throughout the year, the rate increasing from about 10 samples per month to about 25 per month. The total number of samples dealt with during the period under review amounted to 278.

In continuation of the work mentioned in the previous report, further investigations on petrol-benzol mixtures were carried out on behalf of the Defence Department, to which reports were forwarded.

*Lime, Cement, Surkhi, Sand, etc.*—The superior staff engaged on this work consisted of one physical assistant. The work covered a wide range, and as a result of the smallness of the staff employed on it the progress has been slow.

*Mortar and concrete tests on behalf of the British Standards Institution.*—The new programme of tests has not yet been issued, but information has been received that a considerable measure of success has been achieved as regards standardising vibration methods of preparing and consolidating concrete test blocks, with a view to obtaining reproducible results from a series of laboratories.

*Indian sand substitute for Leighton Buzzard standard sand.*—Investigations have continued on a number of samples obtained from various parts of the country, and up to the present it appears that sand obtained from Hadap Hill and Pir Pahar, near Mangalhat, in Bihar may eventually prove satisfactory. This sand occurs, however, as a mixture with Kaolin, but this substance can be readily and almost completely removed by washing with water, leaving behind in the sand only a small quantity of white particles of an argillaceous nature, which are difficult to remove but have no apparent effect on the strength of mortars prepared with it. In general appearance this sand, when cleaned, is cleaner and more free from colour than Leighton Buzzard sand. The work is still in progress.

*Surkhi.*—The investigations in connection with surkhi prepared from bricks collected from brick-fields and surkhi prepared in the laboratory, on the effect of particle size, and on the strength of surkhi-cement mixtures, are in progress.

*Effect of slaking procedure on the properties of lime.*—Work is in progress to determine the effect of the following different methods of slaking :—

- (i) Slaking with the exact quantity of water required.
- (ii) Slaking with excess water.

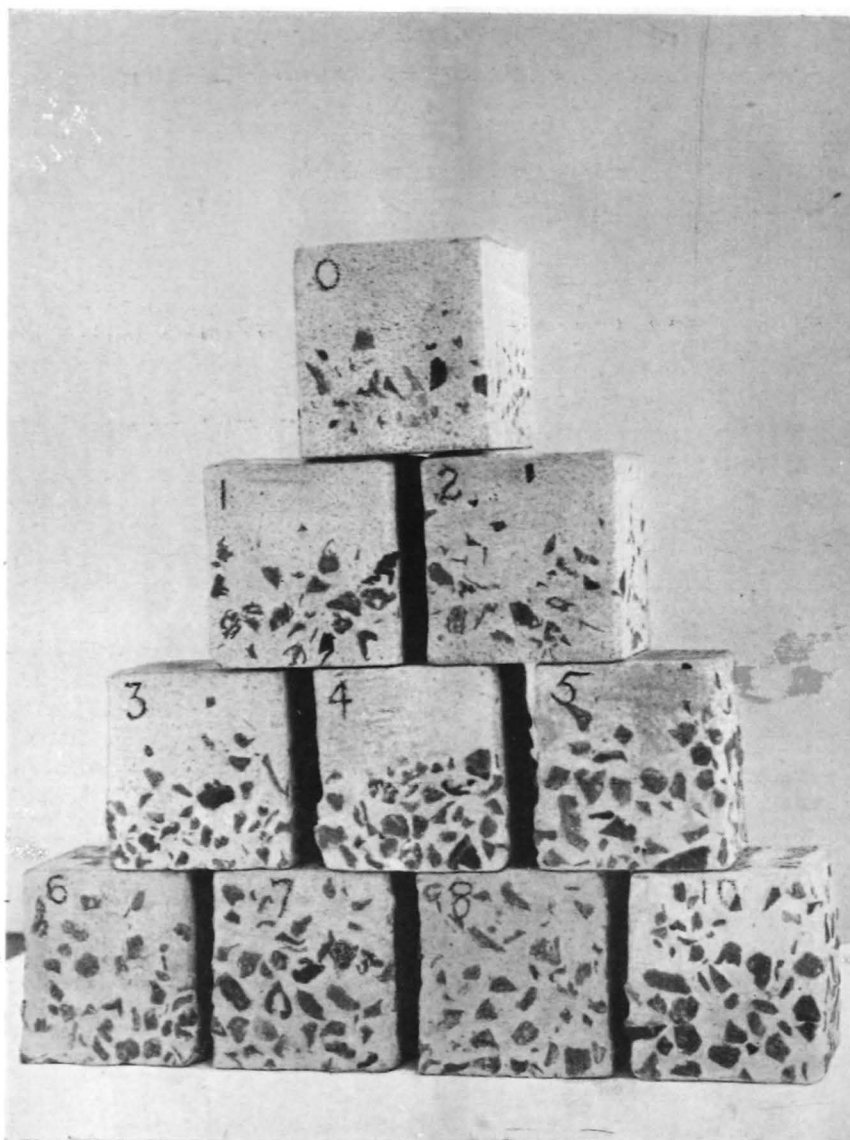


PLATE II.

Concrete cubes showing effects on segregation of aggregates when bentonite is added in varying proportions; figures on the cubes indicate percentages of bentonite.

- (iii) Slaking at controlled temperatures—30°C. and 100°C.
- (iv) Slaking in water vapour.
- (v) Adiabatic slaking with a fixed quantity of water.

*Effects of storage conditions on slaked lime.*—The effects of the following storage conditions on limes are under investigation :—

- (i) Slaked powder stored in open containers.
- (ii) Slaked powder in air-tight containers.
- (iii) Slaked paste stored under water.

*Effects of molasses in lime mortars.*—The effects of different qualities of molasses obtainable from the sulphitation and carbonation sugar processes, new and old, on the strengths of lime mortars, have been studied. The setting times are considerably effected by the use of molasses. Strength tests are in progress.

*Bentonite.*—The sample of bentonite received from Jodhpur State has been tested as regards its effect on the physical properties of cement and concrete, and, following effects have been observed :—

- (i) The setting time of cement is reduced by admixture of bentonite.
- (ii) The strength of cement is slightly increased.
- (iii) The compressive strength of cement appears to be slightly reduced.
- (iv) The fire resistance of cement is increased.
- (v) The imperviousness of concrete to water is improved, and
- (vi) The tendency to segregation of aggregates in concrete is considerably reduced.

As regards the latter effect, attention is drawn to Plate II of this report.

**GLASS.**—The work connected with the glass industry which has been carried out by the Research Branch during the course of the year is described in Chapter IV of this report.

**ELECTRIC LAMPS, MANUFACTURED IN INDIA.**—Assistance continues to be rendered to electric lamp factories operating in India with Indian capital and management by means of periodic tests of groups of their lamps, the tests being carried out by the Government Test House on behalf of the Bureau, upon application to the Bureau through the appropriate Director of Industries.

Electric lamps to the total of 105 were tested on behalf of two Calcutta firms and one Bombay firm in connection with this scheme during the year.

*Shellac cement for bayonet caps.*—Work has been undertaken with a view to developing satisfactory shellac cement for cementing bayonet caps to lamp bulbs. Compositions prepared in accordance with a number of formulæ kindly supplied by the London Shellac Research Bureau and also formulæ developed by the Research Branch are under test.

**ROAD RESEARCH.**—Reference has been already made to this subject in Chapter II of this report. A considerable amount of work devolved upon the staff of the Government Test House in connection with the arrangement of the lease of the site from the Calcutta Port Commissioners, the use of an approach



road belonging to the East Bengal Railway, electric power supply from a near-by sub-station of the Port Commissioners, and other incidental matters. The work is of an unusual and somewhat complex character and it has not been found possible to bring the Track into operation as early as was anticipated in the last report. The work is proceeding satisfactorily, however, and it is planned to bring the Track into operation as soon as the end of the forthcoming rainy season will permit.

#### MISCELLANEOUS.

*Refining of river-clay for use in pencil manufacture.*—Investigations which had been carried out on a sample river-clay used for pencil making, received through the Director of Industries, Madras, were referred to in the previous report. A report thereon was prepared by the Research Branch (R. B. Misc. No. 2), which was subsequently published as Bulletin No. 9 in the series of Bulletins of Indian Industrial Research. During the period under review, however, the factory concerned reported certain difficulties in operating the refining process recommended, and investigation showed that the trouble was chiefly due to the saline nature of the water utilised by the factory. A further report on this work is under preparation.

*Lead-acid storage batteries of Indian manufacture.*—Comparative durability tests on various makes of motor-car lead-acid batteries manufactured in India and on similar batteries of well-known imported makes have been undertaken, and a report will be issued in due course.

*Sealing waxes.*—Two samples of sealing waxes prepared by the Indian Lac Research Institute, Ranchi, were tested at the request of the Director of the Institute in comparison with a number of samples of Indian and foreign made waxes of various grades. A report on this work was issued to the Bureau (R. B. Misc. No. 10), a copy of which was forwarded to the Director of the Institute for information.

*Hurricane lamps.*—The trouble experienced by a manufacturer of hurricane lamps near Calcutta has been referred to in Chapter II of this report. Visits to the factory by members of the staff of the Research Branch revealed a number of contributing causes. Laboratory investigations and also factory tests were conducted, as a result of which a report was drawn up recommending various alterations in the layout of the equipment and in the technique employed.

*Rice bran oil.*—At the request of the Director of Industries, Central Provinces, an investigation of methods of extracting oil from rice bran and of the characteristics of the oil is in progress.

*China clay.*—A sample of china-clay received at the instance of the Director of Industries, Central Provinces, is being examined with a view to eliminating its pinkish tinge, in order to render the material suitable for use in the sizing of textiles.

*Boundary friction tests.*—Preliminary tests have been carried out on a Hardy type of Boundary Friction Testing Apparatus, supplied at the instance of the Railway Board, on behalf of the Central Standards Office, Railway Board.

REPORTS AND PUBLICATIONS.—The various reports which have been issued by the Research Branch to the Bureau up to the end of the period under report are shown in Appendix "C".

The following papers were prepared by members of the staff, and read before the 25th Indian Science Congress held in Calcutta in January of this year.

Section.	Title of the paper.
General and Applied Physics ..	"Some economic considerations in the choice of electric lamps", by D. R. Bhawalkar and G. D. Joglekar.
Do. do. ..	"An experimental dry cell", by G. D. Joglekar and L. C. Verman.
Industrial Chemistry ..	"Use of arsenious oxide as an opacifying agent in lead glasses and the manufacture of china glass in India", by Atma Ram and Lal C. Verman.
Do. ..	"Chemical examination of Indian pyrolusites in relation to their use in dry cell manufacture", by D. S. Naidu and G. D. Joglekar.

BUILDING EXTENSIONS.—The building extensions to which reference was made in the last report, were completed during the year, and the new wing provided thereby has furnished much-needed accommodation for a library, road materials laboratory, internal combustion engine laboratory, and other sections.

## CHAPTER IV.

## WORK IN CONNECTION WITH GLASS.

IMPROVEMENT OF GLASS FURNACES.—The activities of the Bureau as regards this subject during the period under review, have been mainly concerned with the construction and setting to work of an improved pot type furnace in the factory of the Star Glass Works, Ferozabad, United Provinces, in accordance with the arrangements which were described in the previous report.

Briefly repeated, this improved pot type furnace has been constructed to the design on modern lines prepared by the Industrial Research Bureau, which was planned to adhere, however, to the general type of furnace at present in use in Indian glass factories as far as possible.

The chief technical features of this improved furnace are :—

1. It is provided with recuperators.
2. It is fired on the dry-bottom producer principles.
3. It is substantial in construction.
4. It is provided with a suspended roof in order to prevent roof collapse.
5. It provides for comparatively easy change of pots when the technique of this operation has been developed.

The agreement which had been prepared to regulate the question of access of officers of the Bureau, other glass manufacturers, and interested parties to the furnace during construction and subsequently, and also the matter of various experiments to be carried out as convenient when the furnace is in operation, was signed by the proprietor of the Star Glass Works, on the 26th June 1937. The detail drawings of the furnace were thereupon sent to Messrs. Burn & Co., Jubbulpore, with the request to proceed with the manufacture of the refractories and steel-work, and to supply the materials as early as possible.

The excavation of the foundations was commenced in the middle of September 1937, in an existing building at the Star Glass Works, which was barely large enough to permit of the necessary excavations, under the supervision of the Assistant Director of the Bureau, and the foundations were completed on the 8th October, when they were examined by the Director of Industries, United Provinces, and a party of glass manufacturers to whom details were explained by the Assistant Director of the Bureau. Other visits of glass manufacturers were also subsequently arranged from time to time during the progress of construction.

The construction work was completed at the end of January 1938, and a low fire for drying out the masonry was started on the 13th February, the firing rate being gradually increased until the 17th March, when the pots were charged with bangle-glass batch. Glass making was commenced on the 18th March.

A preliminary comparative fuel consumption test between the new furnace and an old type furnace installed near by in the same factory, each furnace being fitted with nine 800 lbs. capacity pots, was carried out under the supervision of the Assistant Director and members of the staff of the Bureau. The

firing rate of the new furnace was arranged so as to maintain a pot temperature of 1350°—1380°C, which is slightly higher than the temperature normally attainable in the usual old type furnace, and under these conditions a considerable economy of fuel consumption per maund of glass produced was recorded. The furnace was also operated for some days at a temperature of 1450°C—1500°C., and the opportunity was taken to prepare and melt a high-lime batch of the composition recommended in the 1932 Report of the Tariff Board on the Glass Industry.

The furnace was inspected by the Chief Controller of Stores, Indian Stores Department, accompanied by the Deputy Director of Purchase (Senior) and the Director of the Bureau, on the 27th March 1938, while in operation. The proprietor, Star Glass Works, subsequently sent letters of appreciation to Mr. B. N. Mukerjee, of Messrs. Martin & Co., Calcutta, who had generously contributed half the total cost of the furnace in accordance with his offer made at the second session of the Industrial Research Council, and to the Director of the Bureau.

The Bureau is continuing to keep in close touch with the operation of the furnace, and monthly visits are being paid to it by an officer of the Bureau. Further experiments will be carried out in due course in accordance with the programme stated in Chapter I of this report, after the furnace has been in operation under normal factory conditions for a sufficient period of time to show whether any of the experimental features of the design are defective.

It is intended to prepare sets of drawings and a detailed report on the construction and operation of the furnace, for issue to Directors of Industries, when it has satisfactorily completed a period of six months of normal factory service.

**WORK OF THE RESEARCH BRANCH CONCERNING GLASS.**—The superior staff of the Research Branch engaged on investigations concerning the glass industry during the year consisted of two chemical assistants. The following subjects, taken up either at the instance of the Industrial Research Council or of the Bureau, have received attention.

*Survey of Glass-making materials.*—The work of collecting, examining, analysis and classification of raw materials available in India to determine their suitability for glass manufacture was continued by the Research Branch throughout the year. A summary of the various materials dealt with up to the end of 1937-38 is presented in the following table. It will be seen that out of a total of 147 samples, 61 have been found to be useable for the manufacture of first quality colourless glass. These latter include 29 sands, 2 sandstones, 10 quartzes and 20 felspars. It is interesting to note that out of these 20 felspars, 15 are of "A" quality. The work is being continued, and the results will be prepared in the form of a Bulletin and published by the Bureau on completion of the investigation.

The statement below includes 37 samples submitted by Dr. Dubey of the Glass Technology Department, Benares Hindu University, in connection with his survey of glass making materials which he is conducting on behalf of the Industrial Research Council. Copies of Dr. Dubey's interim report on his survey, which has hitherto been confined mainly to the United Provinces and Bihar, have been issued to members of the Council.

*Raw Materials for Glass Manufacture.*

No.	Material.	Total No. of samples tested.	Classification.*					Unclassified.
			A	BA	B	CB	C	
1	Sands .. ..	56	..	1	9	19	22	5
2	Sandstones ..	31	..	..	1	1	27	2
3	Quartz .. ..	21	5	..	5	..	11	..
4	Quartzites ..	5	..	..	..	..	5	..
5	Agate .. ..	1	..	..	..	..	1	..
6	Felspars .. ..	26	15	..	5	..	5	1
7	Clays .. ..	5	..	..	..	..	2	3
8	Shell Lime ..	1	..	..	..	..	..	1
9	Marble Powder ..	1	..	..	..	..	..	1
	Totals .. ..	147	20	1	20	20	73	13

\* The classification symbols signify—

A.—First class material useable for making first class colourless glass without decolorizing agents.

B.—Second class material, which may be used with the aid of decolorizing agents to produce first class colourless glass.

C.—Third class materials which may or may not be usable for making second quality glass

BA.—An originally "B" class material which may be converted into "A" class by some simple treatment such as washing or sieving.

CB.—An originally "C" class material which may be converted into "B" class by the above means.

*Unclassified* materials include those which have either been found unsatisfactory on visual examination and hence not analysed, or which do not fit into the general scheme of classification outlined above.

*China Glass.*—The investigation on the possibility of manufacturing China glass in India has been brought to a successful conclusion. The glass composition recommended for the purpose contains a high percentage of lead with arsenious oxide as an opacifier. A semi-commercial scale batch was produced in one of the glass factories in Calcutta, in accordance with the composition and methods devised by the Research Branch, and the product was tested under factory conditions in a glass bangle factory at Ferozabad with satisfactory results. The manufacture of this product in India has been shown to be economically feasible, and a detailed report on the subject has been made (R. B. Glass No. 12), copies of which have been circulated to members of the Council.

*Liquid Gold.*—The investigation on the manufacture of liquid gold reached the stage during the year at which the material could be successfully produced

on a laboratory scale. The quality of the liquid gold prepared in the laboratory is comparable with the best-quality material available in the market, and it now remains to prepare a semi-commercial scale batch and, on the basis of the data collected from this experiment, to make an estimate of the cost of production. It is also considered to be desirable to determine methods of preparation of inferior quality liquid gold, in order to compete with the inferior products which are also being sold.

*Low melting-temperature glasses.*—The general conclusions as regards the improbability of producing satisfactory cheap glasses of low melting-points were indicated in the last report. During the year under review, the work was brought to a conclusion and a report was made to the Bureau (R. B. Glass No. 7).

*Electric lamp glasses.*—A number of electric lamps of reputed foreign makes and also Indian makes were collected, and the glasses used in the outer bulbs analysed. The glasses used for the internal components are also under examination. The thermal endurance properties of the bulb glasses have been determined; for this purpose a new method of determination was developed, the ordinary methods having been found to be too laborious and tedious. Work on the optical transmission properties of the bulb-glasses is also in progress.

*Electric lamp bayonet-cap insulating plate.*—Investigations as to the composition of the vitreous composition often used for the insulating plates in bayonet-caps of electric lamps, with a view to the manufacture of the material in India, are in progress.

*Glasses used for containers of serums and drug tablets.*—An investigation of samples of glass ampoules and containers used by the Indian Medical Service for serums and drug tablets, was undertaken, with a view to ascertaining the possibility of their manufacture from glass made in India, in due course. Analysis shewed that they are of the soda-lime-silica type.

Glasses to be used for these purposes to hold alkaloid or other special preparations are covered by a specification of tests drawn up by a committee of the Pharmacopœia Commission of the British Medical Council. The manufacture of such glass in India, qua glass, would not present great difficulty, but the manufacture of the tubing of the necessary degree of accuracy of dimensions is a much larger problem, and the matter is still under investigation.

*Equipment.*—The following plant and apparatus of interest has been acquired by the Research Branch for work on glass and glass-making materials during the period under review :—

- (1) A gas-fired furnace, designed by the Research Branch for the purpose of preparing a series of glasses simultaneously, to facilitate the study of the effects of planned changes of composition.
- (2) A centrifugal sampling machine, designed by the Research Branch for obtaining a small exactly similar sample from a larger sample for the purpose of analysis or other examination.

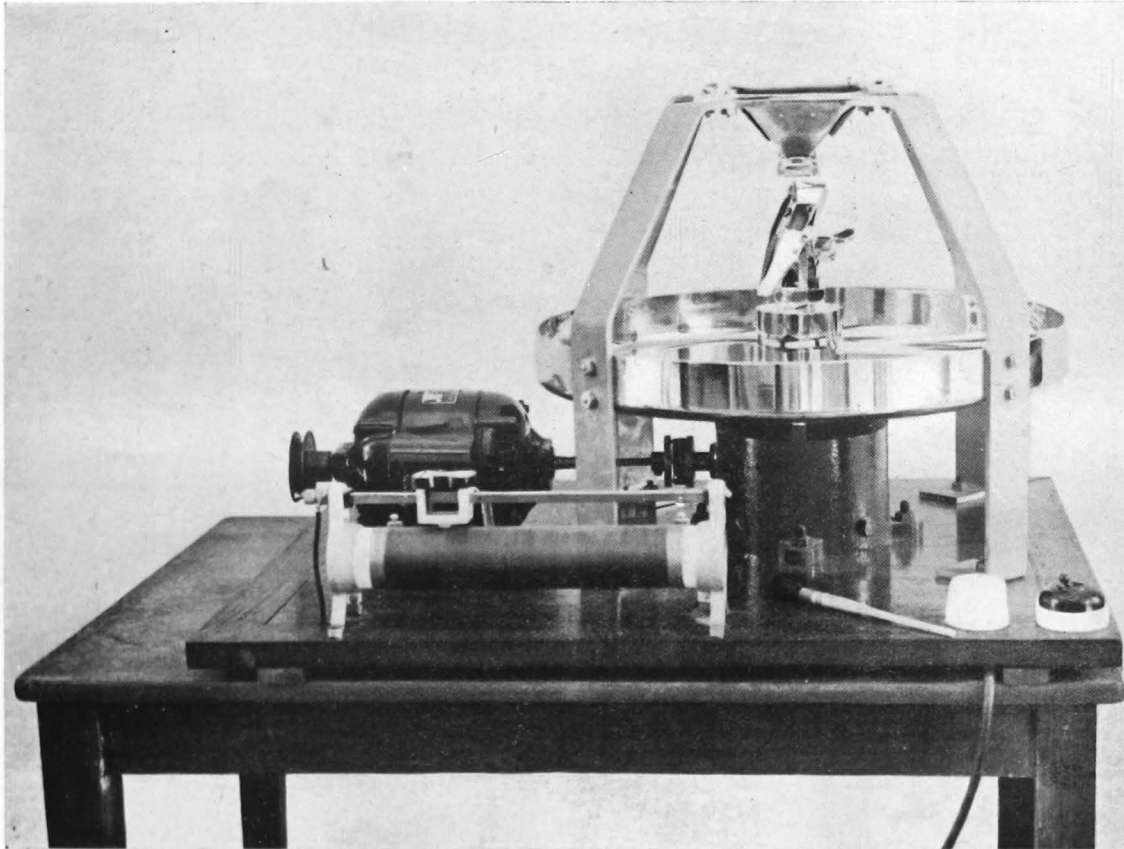
This machine, which is shewn on Plate III, has proved very useful in connection with the examination of sands and other granular materials.

- (3) A mercury vapour lamp. Examination of the fluorescence of glasses of unknown origin or composition enables them to be identified as regards type.

THE MANUFACTURE OF GLASS PRODUCTS OF CONSISTENT DIMENSIONS.—In industrial countries it is now the universal practice to manufacture glass bulbs and other similar shaped articles and also glass tubing for the use of industries engaged in repetition work,—*e.g.*, the bulbs and tubing required for the manufacture of electric lamps, ampoules, etc.,—mainly by machinery. In such repetition work consistent dimensions and wall thickness are essential, and by mechanical methods such glass products can be manufactured to much higher standards of accuracy than is possible by hand methods and without the high percentage of wastage of the latter.

Machines such as the Westlake and the Corning are in use for the production of electric lamp bulbs, the Danner type plant for the production of glass tubing, and the Meyer and Ambeg machines for the manufacture of ampoules and small containers.

Unfortunately such machines produce articles at the rates of upwards of 1000 per hour and are consequently out of the question for the Indian glass industry at present. Nevertheless, if glass bulbs and tubing of the necessary standards are to be produced in India for the growing electric lamp manufacturing industry, and for the manufacture of ampoules and other products of accurate dimensions, the problem of bridging the gap between manual and mechanical methods will require to be considered by all concerned.



**PLATE III.**  
**Sampling Machine.**



## CHAPTER V.

## OILS AND SOAPS.

**ALLOCATION OF RESEARCHES TO LABORATORIES.**—The position at the end of the year 1936-37 regarding the extent to which the Governments of the Provinces and States concerned had accepted the allocation of research and investigations to their laboratories, in accordance with the report of the Oils and Soaps Committee of the Industrial Research Council, was indicated in Chapter V of the Annual Report of the Bureau for 1936-37.

At that time a number of the Governments concerned had not seen their way to agreeing to certain of the allotted items being taken up by their laboratories, and subsequently certain laboratories have intimated that a few of the investigations originally accepted could not for various reasons be undertaken.

The matter was considered by the Industrial Research Council at its third session held in July 1937, and it was decided that the Indian Institute of Science, Bangalore, should be approached to undertake work on the items which had not been taken up, and that thereafter the other laboratories might be addressed.

The Indian Institute of Science was, therefore, addressed by the Bureau and agreed to undertake investigations on the following subjects :—

- (1) Sulphonated fish oils.
- (2) Splitting of oils (Twitchell's process).
- (3) Recovery of glycerine from soap lyes.
- (4) Cinnamon (leaf) oil.

Subsequently, however, the Institute requested the Bureau to arrange for grants to them of stipends for three scholars, to be entertained for a period of one year in order that the work on the first three items might be taken up, as the Institute's scholarships had already been awarded for the conduct of other researches. This, the Bureau was unable to do, as it has no funds at its disposal for grants of this kind, and the matter has remained in abeyance. The other laboratories concerned were addressed regarding the outstanding items, and it was found possible to arrange for certain of these to be taken up, but the following items remain unallocated :—

- (1) The cause and cure of sweating in soaps.
- (2) The cause and cure of rancidity in soap.
- (3) Transparent soaps.
- (4) Sulphonated fish oils.
- (5) The splitting of oils (Twitchell's process).
- (6) The recovery of glycerine from soap lyes.

**ENCOURAGEMENT OF THE CULTIVATION OF ESSENTIAL OIL PLANTS.**—There is nothing to report in connection with this subject.

**BULLETIN ON INDIAN VEGETABLE OILS.**—The draft report prepared by Mr. N. Brodie on Indian vegetable oils and oil seeds was published during the year as Bulletin No. 10 of the series of Bulletins of Indian Industrial Research. There has been a wide demand for this bulletin, and it is apparent that it has filled a real need for an up-to-date and informative publication on this subject.

## APPENDIX 'A'.

*Report of the Prizes Committee, 1937.*

The matters referred to the Prizes Committee by the Industrial Research Council at its meeting held in July 1936 were as under:—

1. (a) to formulate a scheme of prize awards amounting to Rs. 3,000 for next year (1937) for papers dealing with subjects of industrial importance to India ;
- (b) to adjudicate on the papers submitted and recommend the grant of awards.
2. To consider the possibility of—
  - (a) defining the scope of the competition so as to cover papers which deal with the adaptation of known results to Indian conditions :
  - (b) prescribing a subject or subjects for competition :
  - (c) making satisfactory arrangements in respect of rights of publication.

In reference to item 1 (a) above, the individual views of the members of the Committee were invited by the Director of Industrial Research Bureau and after consideration of these views the Government of India decided on the following prizes:—

One prize of Rs. 1,000.

Two prizes of Rs. 500 each.

Two prizes of Rs. 250 each, and

Three prizes of Rs. 150 each.

These prizes were duly advertised, and in response 26 papers were received.

As regards item 1 (b) above, some of the papers received were reported upon by certain officers of the Bureau and the others by expert referees selected by the Director of the Bureau. The Committee considered these reports at its meeting held on 3rd July 1937, and decided to recommend to the Council the following awards:—

Value of prize Rs.	Nom-de-plume.	Title of paper.
1,000	.. Nova Tauri ..	Clock-making in India.
500	.. E. S. F. ..	The chemistry of the manufacture of sulphitation sugar from coloured canes.
250	.. Optiker ..	The manufacture of optical instruments in India.
150	.. Savitri ..	The manufacture of sulphuric acid by the contact process with cheap Vanadium Catalysts.

The number of papers submitted this year is considerably less than last year, and the general technical standard of the papers, is, in the opinion of the Committee, low and again disappointing.

It will be noted that the total value of the prizes recommended for this year is Rs. 1,900, which leaves a surplus of Rs. 1,100. The Committee strongly recommend that this sum should be added to the amount which should ordinarily have been available for prizes next year.

As regards item 2 (a) above, the Committee are of the opinion that the scope of the competition should be widened so as to include papers which deal with the adaptation of known results to Indian conditions. They further consider that prizes should only be awarded for work, whether original or adaptation, embodying results of semi-commercial operations and in cases where such results can be used for the establishment of new industries or for the improvement of existing ones.

In reference to item 2 (b) above, the Committee are of the view that at least two-thirds of the amount that may be available for prizes should be definitely ear-marked for prizes

for set subjects. They are further of the opinion that each prize for a set subject should be of a value of not less than Rs. 2,000, and that the time given for set subjects should be not less than two years from the date of notification of the prize.

As regards the subjects to be set for competition, the Committee recommend that the various Directors of Industries be invited to submit their proposals to the Director of the Bureau, and that the Prizes Committee which the Council may appoint should then select two or three subjects for the purpose. The Committee further suggest that as far as possible the subjects selected should be of a wide character, so that the scope or field of work may not be unduly restricted.

Coming to item 2 (c) above, the Committee are of the opinion that, the value of the prizes being limited, work of outstanding merit is not likely to be submitted if the rights of publication are insisted upon. The purpose of the Council will be served if the author gives for publication a short precis of his paper, to enable financiers and industrialists to get into touch with the author for the purpose of exploitation of the results of the research.

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## APPENDIX 'B'.

*Extract of Enquiries received during 1937-38.*

Enquiry received from	Nature of enquiry.
MADRAS.	
Messrs. Daya Ram & Sons, Madras.	Request information regarding the types of furnace suitable for manufacturing calcium carbide.
The Mettur Chemical and Industrial Corporation, Madras.	Enquire regarding products made from liquid chlorine and bleaching powder, utilisation of chlorine gas from their Electrolytic Caustic Soda plant, and suitable containers for caustic soda, liquid chlorine, and bleaching powder.
Messrs. Massey Ganz Hackethal (India), Ltd., Madras.	Enquire as to the possibility of using vegetable oils (especially groundnut oil) as fuel in Diesel engines.
Mr. B. Govind Prasad Bahadur, Madras.	Requests information regarding a formula for the manufacture of dry cells on a commercial scale, and the methods of manipulation during manufacture.
Director of Industries, Madras	Requests information regarding the import figures of glucose, the sources from which glucose has been manufactured, and whether any work has been done in India in regard to the manufacture of glucose.
Mr. C. Madhavamurti, Madras	Asks for particulars relating to the quantity and value of each of the ferro-alloys imported into India, and also as to India's share of production.
Mr. Lakshmi Ratan, Senior, c/o Lakshmi Rattan, Ltd., Madras.	Requests information regarding the names and addresses of persons, foreign and locally trained, having practical and theoretical experience in the ceramic industry.
Mr. C. Satyanarayana, Rajamundry.	Asks for all necessary information on the manufacture of dry cells, and for a list of publications of the Bureau on the subject.
Director of Industries, Madras	Requests information regarding the imports of table salt into India, Indian manufacturers of table salt, if any, the suitability of using vacuum pans in its manufacture, and machinery necessary for its manufacture.
Messrs. T. V. Rao & Co., Tenali	Request information regarding the capital necessary to start a glass bangle factory, whether sands obtainable in the Kristna river and at Chirala are suitable for glass manufacture, and whether training of apprentices can be arranged in glass factories in Northern India.
Mr. G. Gangaraju, Narsapur	Enquires about the cellulose contents of different cottons with a view to rayon manufacture.
Messrs. S. S. Ramakrishna & Co., Coconada.	Ask regarding researches carried out in connection with the ceramic and glassware industry, information on oil mills, hydrogenation plant and soap-making, and names of machinery suppliers for such industries.
Director of Industries, Madras	Enquires the names of Glass Ampoule blowing factories in India, whether any of them take apprentices, and if so, on what terms.

Enquiry received from	Nature of enquiry.
BOMBAY.	
Mr. Sorab D. Dalal, Bombay	Enquires regarding cheap methods of decolourising China clay.
Secretary, Chamber of Commerce, Bombay.	Requests information as to where and from whom in India sand filtering medium (Quartzsand) is obtainable.
Mr. S. N. Koulichkov, Bombay	Requests information regarding the amount of starch produced in India for the textile industry, the products used in its manufacture, firms in India manufacturing starch, and annual imports of starch.
Messrs. Lever Bros. (India), Ltd., Bombay.	Enquire as to whether Amcoora, Kamala, and Solanum oils are obtainable on a commercial scale, the names of firms which market them, and where samples of these oils may be had.
Messrs. Doshi Bros., Anand ..	Enquire regarding the possibility of casein products being consumed in India, and ask to be informed of literature on this industry.
BENGAL.	
Messrs. Indian Battery Mfg. Co., Calcutta.	Enquire as to the possibility of finding a suitable substitute for cedar wood as wooden separators in the manufacture of car batteries in India.
Messrs. Hance & Co., Ltd., Calcutta.	Ask for the names of firms interested in the purchase of sillimanite, exploited by the enquirer in the Province of Assam and suitable for the manufacture of blocks for glass furnaces.
Dr. S. G. Barker, Indian Jute Mills Association, Calcutta.	Enquires as to where the hydrogenation of vegetable oils is carried out in India. This is in connection with water-proofing of jute.
Ditto.	Asks for any available information on Rosella fibre.
Mr. Baijnath Bajoria, M.L.A., Hony. Secretary, Marwari Association, Calcutta.	Asks for information regarding starting of glass, dry cell, and hurricane lantern industries in Bengal.
Messrs. Carl Ohmes, Calcutta	Suitability of Indian copper for the production in India of copper and brass rod and tubes by the extrusion process.
UNITED PROVINCES.	
The Himalaya Mineral Supply Co., Rikhi-Kesh, U. P.	Ask for the testing of gypsum in order to find its suitability for the manufacture of paints and colours instead of barytes.
Mr. H. S. Agarwal, Fatehgarh	Asks for literature and information regarding the installation of a glass factory in the United Provinces, near Cawnpore.
Research Laboratory, Dyalbagh.	Asks for information regarding modern methods of manufacturing dry cells.
Messrs. Raman Lal Moti Lal, Muttra, U. P.	Ask for the names of manufacturers and producers in India, and the importers from foreign countries, of Sulphate of Ammonia, Superphosphates, Sulphate of Potash and Basic Slag.
Messrs. Tubewell & General Trading Co., Meerut.	Request information regarding the manufacture of buttons from casein, horn, etc.

Enquiry received from	Nature of enquiry.
<b>UNITED PROVINCES—contd.</b>	
Messrs. Tara Chand Raparia, Agra.	Seek advice regarding the capital required and prospects in the manufacture of Caustic Soda and Bleaching Powder and other allied chemicals from salt, the source in India of raw materials such as Kaolin, Quartz, Silicate, etc., for the manufacture of porcelain wall tiles, and whether Agra is a suitable site for these Industries.
Mohd. Imamuddin Siddique, Najibabad.	Requests information regarding the total value of the production and of the imports of finished glass articles in India in 1935 and 1936.
Messrs. Naini Glass Works, Naini.	Request information regarding the method and ingredients of manufacturing Glass-house pots.
Secretary, U. P. and Bihar Joint Power Alcohol Com- mittee.	Requests for information regarding the quality of petrol marketed in India, in connection with the question of the utilisation of molasses for the manufacture of power alcohol.
<b>PUNJAB.</b>	
Mr. C. H. Cotton, Simla ..	Enquiry regarding the possibility of utilising sulphur from pyritiferous schist for sulphuric acid manufacture.
Nath Commercial Co., Simla	Ask for advice regarding plants for manufacturing sulphur and sulphuric acid from Iron pyrite ores found in the Simla Hills, and suitable locality for location of such plants from the economic and commercial point of view.
Rai Bahadur Panna Lall, Ambala.	Asks for a list of books on the manufacture of electric bulbs and Neon signs.
Mr. B. K. Kitchlu, Lahore ..	Asks for the examination of his scheme for a glass factory.
Director, Imperial Veterinary Research Institute, Mukte- sar.	Enquiry as to the comparative merits of petrol and oil gas plants to be installed at the Animal Nutrition Section of the Imperial Veterinary Research Institute, Izzatnagar.
Director of Industries, Punjab	Asks for information with a view to utilising bone-meal in the manufacture of soil fertilisers.
Mr. S. S. Sohi, Lahore ..	Enquires as to the ingredients of the red composition generally used for railway carriage floorings, and the method of mixing the composition.
<b>BIHAR.</b>	
Director of Industries, Bihar	Enquires regarding the manufacture of paper and paper boards from bagasse, and the manufacture of boards such as "Celotex".
<b>CENTRAL PROVINCES AND BERAR.</b>	
Director of Industries, Central Provinces and Berar, Nag- pur.	Request for the Bureau to undertake investigations into the possibility of making fuel briquettes from rice husk.
Ditto.	Request for information regarding the refining of china clay, and for a list of literature on the subject.
Ditto.	Request for information regarding the possibility of developing the Sisal hemp fibre industry in India.

Enquiry received from	Nature of enquiry.
CENTRAL PROVINCES AND BERAR— <i>contd.</i>	
Yeotmal Electric Supply Co., Ltd., Yeotmal, C. P.	Enquiry regarding the installation of an oil-crushing mill.
Director of Industries, Central Provinces and Berar, Nagpur.	Asks for a list of literature on the process of manufacturing double-boiled linseed oil, the method of analysis of oil-cakes, and also a list of technical institutes imparting training in the subjects.
Director of Industries, Central Provinces and Berar, Nagpur.	Request for information regarding the manufacture of spectacles, glass bangles, bakelite, sealing wax, razor blades, artificial silk, type-writer ribbons, buttons and silver thread.
ORISSA.	
Director of Development, Orissa.	Asks regarding the most suitable English or American machinery comparable to certain Japanese make hosiery looms, comparative qualities of sewing machines, and machinery for winding thread balls, for a small hosiery factory to be set up in Cuttack.
DELHI.	
Mr. Thomson of the Agricultural Marketing Office, Imperial Council of Agricultural Research.	Enquires as to the causes of increased consumption of coconut oil in India.
M. L. Poplai & Co., Delhi ..	Ask for names of Indian woods which can be used for manufacturing splints for safety matches, and also where they can be obtained commercially.
Superintendent of Industries, Delhi.	Asks for names and addresses of Indian and foreign dealers in graphite suitable for manufacturing pencils.
Mr. P. K. Ghose, Delhi ..	Enquires about the process of manufacturing starch from potato, gram, and jowar, and the types of machinery required.
L. Shri Ram, Delhi ..	Forwards for scrutiny a scheme for paint and varnish manufacture near Delhi.
Burmah Shell Oil Co., New Delhi.	Ask for information regarding standard grades of cresylic acid sold in India, its estimated consumption, its prices and what duty is levied on imports.
Toyo Shokai, Delhi ..	Enquires as to the technical assistance that may be available from the Bureau in connection with manufacturing sheet glass and plate glass in India, and also asks for a list of glass manufacturers in India.
HYDERABAD (DECCAN).	
Messrs. K. R. Chari & Co., Hyderabad, Deccan.	Request information regarding manufacturers and firms who would be interested in the supply of raw and calcined magnesite, and also the names of manufacturers of machinery for the production of 'dry ice'.
Dr. S. Hussain, Professor of Chemistry, Hyderabad, Deccan.	Enquires regarding firms in India or abroad who could design and supply plant and machinery for the manufacture of iron, steel, and lead.
MYSORE.	
Mr. C. S. Venkateswaran, Indian Institute of Science, Bangalore.	Enquiry regarding the import figures for scientific apparatus for the past five years.

Enquiry received from	Nature of enquiry.
MYSORE— <i>contd.</i>	
The Mysore Lamp Works, Ltd., Bangalore.	Enquires as to whether bakelite cement used for fixing the bayonet caps to the bulbs of electric lamps is available in India ; whether there is any other suitable fixing material available in India.
GWALIOR.	
Mr. Janma Prasad, Agar, Gwalior.	Enquires the names of hydrogenated vegetable oil factories in India.
Secretary, Commerce Department, Gwalior.	Enquires as to where the casein plastic industry has been developed on a satisfactory scale in India, and whether the Bureau could undertake to arrange for the training of apprentices from Gwalior in the casein plastic industry.
• INDORE.	
Deputy Commissioner of Customs, Excise and Commerce, Indore.	Enquiry regarding the use of animal bones available in the State for the manufacture of artificial manures.
TRAVANCORE.	
Mr. J. A. Kallivayalil, Travancore.	Asks for information regarding the manufacture of starch from <i>Cassava</i> roots.
JODHPUR.	
Geologist, Government of Jodhpur.	Requests that researches on the suitability of bentonite and fuller's earth for the refining of vegetable oils may be undertaken.
MISCELLANEOUS.	
American Trade Commissioner, Calcutta.	Asks for information as to the principal places in India where oil seeds are crushed and for information regarding income tax, real estate taxation, import duties and excise tax, in connection with the proposed starting of vegetable oil factories in India by an American firm.
Sir Bryce Burt, Vice-Chairman, Imperial Council of Agricultural Research.	Enquires about the suitability of cotton-seed oil as Diesel engine fuel, the information being required by the Colonial Office, London.
Ceylon Trade Commissioner for India, Bombay.	Asks for the names of firms that manufacture castor oil, and the names of agents of firms that manufacture oil mill machinery, for the information of an officer to be deputed by the Ceylon Government to investigate the manufacture of castor oil in India.
Seth Govind Das, M.L.A., (Through the Department of Industries and Labour)	Asks for information regarding import figures, consumption, cost of a factory, raw materials required, etc., for the straw board industry in India.
Mr. H. Lightfoot of Messrs., Stevenson and Howell, Ltd. London. (Through External Affairs Department).	Enquires about the possibilities of India as a source of supply for essential oils of the citrus type, particularly lemon and lime oils.
Messrs. D. Beenstock, Manchester.	Enquires about the possibilities of manufacturing certain chemicals and materials in India.
Messrs. D. M. Halton & Co., United States of America.	Ask for information on Mowra or Mahua seed oil.



## APPENDIX 'C'.

*List of Reports issued by the Research Branch to the Bureau.*

Report No.	Title.
<i>Miscellaneous.</i>	
R. B. Misc. No. 1	.. 'Polish Cake' for use in the manufacture of Metal Polish.
R. B. Misc. No. 2	.. Purification of Clay.
R. B. Misc. No. 3	.. Lead-Acid Storage Batteries of Indian Manufacture.
R. B. Misc No. 7	.. Petrol-Benzol Mixtures.
R. B. Misc. No. 8	.. Ditto.
R. B. Misc. No. 9	.. Pyritiferous Schist.
R. B. Misc. No. 10	.. Saealing waxes prepared by Indian Lac Research Institute.
R. B. Misc. No. 11	.. Petrol-benzol mixtures.
R. B. Misc. No. 12	.. Filtering Medium.
R. B. Misc. No. 13	.. Tinning of Hurricane Lanterns.
R. B. Misc. No. 14	.. Analysis of Silica.
R. B. Misc No. 16	.. Purification of Clay (continued).
<i>Glass Manufacture.</i>	
R. B. Glass No. 1	.. Samples of Glass Bangles.
R. B. Glass No. 2	.. Miscellaneous glass materials.
R. B. Glass No. 3	.. Analyses of Indian sands, etc., for glass manufacture.
R. B. Glass No. 4	.. Ditto.
R. B. Glass No. 5	.. Ditto.
R. B. Glass No. 6	.. Ditto.
R. B. Glass No. 7	.. Low melting temperature Glasses.
R. B. Glass No. 8	.. Analyses of Indian sands, etc., for glass manufacture.
R. B. Glass No. 9	.. Ditto.
R. B. Glass No. 10	.. Ditto.
R. B. Glass No. 11	.. Ditto.
R. B. Glass No. 12	.. The manufacture of China Glass in India.
R. B. Glass No. 13	.. Analysis of Indian sands, etc., for glass manufacture.
<i>Paints.</i>	
R. B. Paint No. 1	.. Lacquering of Brass.
R. B. Paint No. 2	.. Setting Properties of Indian and imported red leads.
R. B. Paint No. 3	.. White lead paint exposure tests.

APPENDIX 'D'.

Results of a series of runs, each of 50 hours duration, of an 8 H.P., Lister diesel engine running at 1200 R.P.M., and full load, to determine the behaviour of certain vegetable oils when used as fuel oils.

Fuel Oil.	Consumption lbs. per B. H. P. Hour.	Overall Efficiency Brake-Thermal. %.	Deposits.					Corrosion.
			Piston and cylinder heads.	Combustion Chamber.	Inlet valve.	Exhaust valve.	Injector nozzle.	
Shell Diesel Mineral ..	0.629	21	A small amount of soft soot.	A small amount of soft soot.	Thin film of carbon.	None.	Thin film of carbon.	Nil.
Groundnut ..	0.700	21	Small amounts of soft soot and hard carbon.	Small amounts of soft soot and hard carbon.	A very small amount of carbon.	A small amount of carbon.	Thin film of carbon.	Nil.
Punnel or Polung ..	0.692	22	Hard carbon.	Hard carbon.	Thick granulated carbon.	None.	Film of carbon.	Considerable pitting of cylinder head and exhaust valve seat.

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**GOVERNMENT OF INDIA  
INDUSTRIAL RESEARCH BUREAU**

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**REPORT  
FOR THE YEAR  
1938-39**



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## ANNUAL ADMINISTRATION REPORT OF THE INDUSTRIAL RESEARCH BUREAU FOR THE YEAR 1938-39.

### INTRODUCTION.

This report describes the work which has been carried out during the year 1938-39 by the Industrial Research Bureau which was brought into existence on the 1st April 1935, with a view to the development of Indian industrial research and Indian industries. The Research organisation comprises (a) the Industrial Research Council, (b) the Industrial Research Bureau, and (c) the Research Branch of the Government Test House, Calcutta.

The relationships of the three parts of this organisation, one to another, and their respective functions are as follows:—

The Industrial Research Council is an advisory body, consisting of official representatives and non-official scientist and industrial nominees of the Central, Provincial, and leading State Governments, constituted for the purpose of co-ordinating the industrial research and development work of these Governments. This body meets once yearly in various centres for discussion of its agenda, and recommendations are made thereon to authorities concerned.

The Industrial Research Bureau is responsible for carrying out the work entrusted to it by the Government of India, in pursuance of the recommendations of the Council, and for the administrative work of the organisation.

The Research Branch at the Test House undertakes industrial research on the problems suggested by the Council, and also investigations on other technical subjects which are from time to time referred to the Bureau.

The Industrial Research Bureau, together with the Research Branch, was established by the Government of India, four years ago, on a temporary basis in the first instance. The nature of the duties performed by this body as well as the directions in which it may be utilised for the assistance of existing and prospective industries, industrialists, and technical departments of Government, so far as its present limited composition permits, have become clearly defined during this period.

The Bureau was placed on a permanent basis with effect from the 1st March 1938, as recorded in the previous Annual Report, but subsequently a state of considerable financial stringency developed, and owing to the deterioration of the general financial position during the period under review the Government felt compelled to re-examine that decision.

It was decided, however, that the Bureau must remain in being, but this has been accompanied by severe curtailment of plans for the expansion of the Bureau and the Government Test House, and consequently of the range and extent of the work which can be undertaken.

## CHAPTER I.

## THE INDUSTRIAL RESEARCH COUNCIL.

The Council held its fourth session in the Legislative Council Chamber, Fort St. George, Madras, on the 8th and 9th August 1938. As the Secretary to the Government of India, Commerce Department, the *ex-officio* Chairman of the Council, was unable to attend, the chair was taken by Dr. Gilbert J. Fowler, D. Sc., F. I. C., a non-official representative of the Government of India.

The following members and others also attended:—

*Attended by deputation.*

Mr. Y. N. Sukthankar, I.C.S., Deputy Secretary to the Government of India, Commerce Department.

## MEMBERS.

*Government of India.*

Mr. H. R. Stewart, M.Sc., I.A.S., Agricultural Expert, Imperial Council of Agricultural Research.

Rao Bahadur B. Venkatesachar, M.A., F. Inst. P., Director, Indian Institute of Science, Bangalore (Non-official, Government of India).

*Provincial Governments.*

Mr. L. B. Green, M.B.E., Director of Industries and Commerce, Madras.

Mr. G. H. Hodgson, M.L.A. (Non-official, Madras).

Sri D. L. Narasimha Raju (Non-official, Madras).

Mr. P. B. Advani, M.Sc., J. P., Director of Industries, Bombay.

Mr. B. S. Dabke (Non-official, Bombay).

Mr. S. C. Mitter, B Sc. (Eng.) (London), A.M.I.E. (Ind.), Director of Industries, Bengal.

Mr. J. Nigam, I.C.S., Director of Industries and Commerce, United Provinces.

Dr. V. S. Dubey, M.Sc., Ph.D. (Lond.), D.I.C. (Non-official, United Provinces).

Rai Bahadur Lala Ram Lal, M.B.E., Director of Industries, Punjab.

Sheikh Sadiq Hasan, Bar.-at-Law (Non-official, Punjab).

Mr. V. K. B. Pillai, I.C.S., Director of Industries, Bihar.

Mr. C. C. Desai, B.A. (Cantab.), I.C.S., Director of Industries, Central Provinces and Berar.

Mr. S. N. Mazumdar, I.C.S., Director of Development, Orissa.



*Indian States.*

Mr. G. A. Mohammadi, Director of Commerce and Industries, H. E. H. the Nizam's Government, Hyderabad, Deccan.

Mr. M. S. Ramchendra Rao, B.A., Director of Industries and Commerce, Mysore, Bangalore.

Dr. C. A. Mehta, M.A, LL.B. (Bom.), Ph.D., Assistant Director of Commerce, Industries and Labour, Baroda.

Lala Ramji Das Vaishya, Secretary, Commerce Department, Gwalior.

*Secretary.*

Mr. E. F. G. Gilmore, B. Sc. (Hons.), M.I.Mech.E., Offg. Director, Industrial Research Bureau.

*Attended by invitation.*

Dr. Lal C. Verman, M.Sc., Ph.D., F. Inst. P., A.I.R.E., Research Officer, Industrial Research Bureau.

Mr. K. C. Mukharji, M.Sc., A.I.C., Industrial Chemist to the Government of the United Provinces.

Dr. Gilbert J. Fowler, in opening the session, explained the circumstances under which he came to occupy the chair and as a resident of Madras welcomed the Council and members. The Chairman stated that invitations had kindly been extended to the Council to visit the following institutions\* during the session :—

1. The Government Textile Institute, Washermanpet.
2. The Leather Trades Institute, Washermanpet.
3. The Industrial Engineering Workshops, Washermanpet.
4. The Government School of Technology.
5. The School of Arts and Crafts.

The following items formed the agenda which was discussed by the Council :—

- I. Research on Vegetable and Essential Oils and Soaps.
- II. The research programme of the Research Branch.
- III. Accessories for glass bangle manufacture.
- IV. Improvement of glass furnaces.
- V. Improvement of glass products and accessories.
- VI. Survey of glass-making materials.
- VII. Casein plastics.
- VIII. Publications of the Bureau.

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\* These were visited by the Council after the meetings on the 8th and 9th August 1938.

- IX. Allocation of prizes.
- X. Industrial surveys.
- XI. Co-ordination of Universities and research institutions in the development and extension of industrial research.
- XII. Industrial developments.

A brief summary of the discussion on certain of the above items and of the conclusions of the Council arising out of these discussions is given in this Chapter. In the case of items which have since been subjects of investigation by the Bureau office or the Research Branch, however, the corresponding subjects have been dealt with mainly in the subsequent Chapters which describe the work carried out by these establishments.

I. RESEARCH ON VEGETABLE AND ESSENTIAL OILS AND SOAPS.—The Directors of Industries concerned described to the Council the progress made in their respective laboratories, and the Council considered the several items investigation of which had not yet been accepted by laboratories. The Council noted with interest the announcement that the Government of Bengal were considering the establishment of a Soap Research Institute and the statement that if the plan materialised this Institute would undertake work on these unaccepted items.

II. THE RESEARCH PROGRAMME OF THE RESEARCH BRANCH.—The work on which the Research Branch of the Government Test House has been engaged during the year 1937-38 was described by Dr. L. C. Verman, the Research Officer.

The Council approved the Annual Report of the Bureau and expressed its appreciation of the decision of the Government of India to place the Bureau on a permanent basis. It recorded, however, that it considered that the present scale of expenditure on industrial research should be very considerably increased and, moreover, that research work of All-India importance should be financed in the Provinces, States and elsewhere, where conditions and facilities are suitable, on the lines followed by the Imperial Council of Agricultural Research.

The work carried out by the Research Branch and the progress made during the year under review are described in Chapter III of this Report.

III. ACCESSORIES FOR BANGLE MANUFACTURE.—The Council noted the progress of the work connected with the laboratory and semi-commercial scale production of China glass, liquid gold, and selenium red and other coloured glasses. No proposals were forthcoming as regards steps to be taken to develop the local manufacture of China glass. A description of the work carried out in this connection during the past year is given in Chapter IV.

IV. IMPROVEMENT OF GLASS FURNACES.—The Council considered the progress of the work in connection with the construction of the improved experimental glass furnace at Firozabad and the results of the preliminary experiments, details of which are described in Chapter IV,

V. IMPROVEMENTS OF GLASS PRODUCTS AND ACCESSORIES.—It was reported to the Council that considerable trouble had already been experienced as regards the durability of the refractories of the pot chamber, and of the glass melting pots of Japanese manufacture which were in almost universal use in the industry.

As regards the former, it was the intention to reconstruct the pot chamber walls in sillimanite blocks and bricks. The Council recorded that the improvement of the quality of refractories and development of the manufacture of glass melting pots in India are of the greatest importance if adequate advantages are to result from the adoption of improved furnaces. The Council also recommended that the Bureau should get into touch with university and other laboratories with a view to arranging for research work on these problems to be taken up in collaboration with the industries concerned.

The work and tests which have been carried out during the period covered by this Report are described in Chapter IV.

VI. SURVEY OF GLASS-MAKING MATERIALS.—The Council considered the interim report on the first stage of the survey work of Dr. Dubey on deposits of glass-making materials which covers Bihar and a portion of Madras, and also discussed proposals for extension of the work, which are described in Chapter IV.

VII. CASEIN PLASTICS.—The Council considered a note on the Preparation of Casein and its use in Plastics, which has been prepared by the Bureau.

The Council recommended that the Bureau should continue enquiries and investigations as regards the industrial improvement and utilization of milk casein with a view to its use for the production of plastics, as casein is already being made in India. It was considered that the adequate utilisation of the lactose content of the milk used for this purpose should also be investigated, so that this highly nutritive component should not be wasted. Developments in connection with this subject are recorded in Chapter II.

VIII. PUBLICATIONS OF THE BUREAU.—A list of publications issued by the Bureau in the series of Bulletins entitled "Bulletins of Indian Industrial Research" was considered by the Council, and it was recommended that arrangements should be made for preparation of publications on the following subjects by the authors stated in due course—

<i>Title.</i>	<i>Author.</i>
The manufacture of China glass and liquid gold.	The Bureau.
Silk production and weaving in India	Mr. K. T. Acharya, Seri-Culture Expert, Madras.
Workshop training in precision methods	Mr. P. Bence Jones, Principal, Maclagan Engineering College, Lahore.
The washing and purification of Indian glass-making sands.	Mr. B. Jagannath Hegde.
Indian Refractory Clays .. .. .	Mr. H. Crookshank, Superintending Geologist, Geological Survey of India.

The Council considered that steps should be taken to increase the publicity given to the activities and publications of the Bureau and that for this purpose Directors of Industries should arrange to function *ex-officio* as local publicity officers to bring to notice the publications of the Bureau among industrialists, universities and the general public. To effect this, it was proposed that copies of press notes issued by the Principal, Information Officer, Government of India, concerning the Bureau and also copies of publications produced by the Bureau should be supplied to Directors of Industries at the time of publication. It was also decided that up-to-date lists of the publications of the Bureau, giving details and cost of each and details of prize paper schemes and other similar activities, should be issued to public libraries at intervals of not exceeding six months. The position regarding this part of the work of the Bureau is recorded in Chapter II.

IX. ALLOCATION OF PRIZES.—The papers received in connection with the Prize Scheme of the Council having been circulated previously to members of the Prizes Committee, this Committee met on the 6th August 1938 and drew up their Report\* to the Council.

The Council approved the Report of the Committee and the recommendations made therein as regards the allocation of prizes, which were as follows :—

Prize.	Name of author.	Title of paper.
Rs. 500	Mr. S. K. Kulkarni Jatkar, Mr. V. T. Athavale, and Mr. J. G. Kane—Indian Institute of Science, Ban- galore.	Catalytic hydrogenation of Oils.
250	Mr. Sudhir Chandra Chak- ravarty, M.Sc., Calcutta.	Recovery of Titanium Oxide as a by-product in the manufacture of Alumina-Ferric from Bauxite.
250	Professor J. J. Rudra, Col- lege of Engineering, Sai- dapet, Madras.	Conversion of the Standard Poly- phase Squirrel-cage Induction Motor into an Internal Compensat- ing Polyphase Squirrel-cage Induc- tion Motor.
150	Dr. D. Narayanamurti, M.Sc., Assistant Seasoning Officer, Forest Research Institute, Dehra Dun.	Control instruments for the Timber Industry, Electric Mois- ture Meter for Wood.
150	Mr. S. K. Kulkarni Jatkar, and Mr. T. Subramanya, Indian Institute of Science, Bangalore.	Ammonium Alum as Catalyst for the production of Ether.
150	Mr. Sasadhar Roy, M. Sc., Supervisor, Pottery Sec- tion, Industrial Research Laboratory, Calcutta.	Development of metallic lustre (Bronze) on Glazed articles made of Indian plastic clay.

\* The Report of the Prizes Committee, 1938, is given in Appendix 'A'.

The Council decided that the Prizes Committee for 1939 should consist of the Directors of Industries of Madras, Central Provinces and Berar, Orissa and Mysore, and the Director, Industrial Research Bureau. The list of subjects proposed by Directors of Industries as suitable subjects for a set subject prize paper scheme was considered by the Council, and it was recommended that the Prizes Committee should select a subject from the list in consultation with one or more scientists concerned with industrial science, the matter to be arranged through the Director of the Bureau. The Council adhere to the recommendation made at its Third Session that the prize for the set subject paper should be Rs. 2,000, and recommended that the remainder of the fund available annually for prizes should be allocated to papers on open subjects on similar lines to the existing scheme. The present position regarding this subject is recorded in Chapter II.

**X. INDUSTRIAL SURVEYS.**—The Council considered the progress made by Provinces and States concerned in arranging to conduct a co-ordinated survey of the Oil-seed Crushing Industry. Consideration was also given as to the question of when it might be possible to take up similar technical surveys of the Tanning Industry and subsequently of the Potteries and Ceramics Industry, in accordance with the recommendations of the Council at its Third Session. The Council noted the steps which have been taken by the Provinces and States concerned to obtain the necessary staffs to take up the surveys of the Oil-seed Crushing Industry. It was noted that in certain cases the method on which it was proposed to conduct the local survey and the staffs to be provided for this survey differed materially from those contemplated by the common plan to such an extent as to prejudice co-ordination of the work. Moreover, it was unlikely that the Provinces and States could make a simultaneous commencement on the surveys.

The Council recommended that a Vegetable-Oils Technologist should be appointed to the staff of the Bureau to guide and co-ordinate this work of the Provinces and States concerned. As regards the order in which the other major industries under consideration should be surveyed, the Council agreed that the order laid down at the Third Session should be adhered to, but no conclusion was reached as to when it might be possible to take up the work.

**XI. CO-ORDINATION OF UNIVERSITIES AND RESEARCH INSTITUTIONS IN THE DEVELOPMENT AND EXTENSION OF INDUSTRIAL RESEARCH.**—The Council considered what steps could be taken to obtain the co-operation of the scientific staffs of the universities and technical institutions in India and to co-ordinate the work of these establishments with the work of the Industrial Research Council. The Council fully realised the importance and necessity of developing the present inadequate co-ordination and noted with satisfaction that the need for this co-ordination is already recognised by universities and scientific institutions.

It was considered, however, that the object now in view, namely, the acceptance of industrial research work by the universities and technical institutions, would be more effectively attained if such work could be financed by the Council.

The Council also recorded its opinion that co-ordination between the Council and the universities would be facilitated if Directors of Industries were accompanied at the Council sessions by scientific representatives of their local universities interested in industrial research.

The Council also considered the steps to be taken with a view to effect this co-operation and co-ordination, and developments in connection with this subject are recorded in Chapter II.

**XII. INDUSTRIAL DEVELOPMENTS.**—The Council considered the question of the availability of the raw materials required (*a*) for the preparation of cellulose and other materials required for an artificial silk industry, (*b*) for the preparation of synthetic resins of the bakelite type.

The Council took note of the work which is in progress in India in connection with the preparation of cellulose bases suitable for the manufacture of artificial silk and other industrial products. It was recommended that the Director of the Bureau should continue to keep in close touch with these developments and especially with the work in progress in connection with the production of chemical cotton and bamboo pulp of suitable quality.

The Council also noted with interest the work in progress in connection with the raw materials required for the production of synthetic resins of the bakelite type, and recommended that the Director of the Bureau should continue to pursue these investigations and should also keep in touch with work in progress under the Director of Industries, Madras, on formaldehyde cashew nut oil plastics and at the Indian Institute of Science, Bangalore, on vegetable casein. Developments in connection with these subjects are described in Chapter II.

## CHAPTER II.

## WORK OF THE INDUSTRIAL RESEARCH BUREAU.

STAFF.—The sanctioned strength of the Bureau and the actual strength on the 31st March 1939 were as follows:—

Rank.	Sanctioned strength.	Actual strength on 31st March 1939.
Director .. .. .	1	1
Assistant Director .. .. .	1	1
Technical Assistants .. .. .	2	2
Superintendent .. .. .	1	1
Assistants and Clerks .. .. .	12	11
Stenographers .. .. .	2	1
Librarian .. .. .	1	1
Draftsman .. .. .	1	1
Others .. .. .	10	9

One post of assistant and one post of tracer were abolished during the year.

Mr. E. F. G. Gilmore, B.Sc. (Hons.), M.I.Mech.E., was the Director of the Bureau throughout the year under review, and Mr. S. S. Iyengar, B.E., A.M.I.E. (Ind.), A.M.I.Mech.E., officiated as Assistant Director for 8 months during the absence of Mr. E. Dixon, A.M.I.Mech.E., on leave out of India.

PRIZES COMMITTEE.—The Open Subjects Prize Papers competition of the Council was advertised by the Bureau in February 1939, the closing date for the competition being 1st June. The later date was decided upon on this occasion in view of the considerable interval that had hitherto elapsed between the last date allowed for the submission of papers for the competition and the consideration of the report of the Prizes Committee by the Council. Copies of the papers received will be forwarded to members of the Prizes Committee as usual and also the reports thereon of selected expert referees.

The proposals which have been received from Directors of Industries and others in regard to subjects for a Set Subject Prize Papers Competition have been referred to certain scientist scrutineers for their recommendations as to suitable subjects for selection, and these recommendations will be communicated to members of the Prizes Committee.

A meeting of the Prizes Committee will be held in Calcutta prior to the fifth session of the Council, for the preparation of the Committee's report to the Council on these matters.

ROAD RESEARCH.—The road test-track and equipment designed by the Bureau and constructed at Majerhat, Calcutta, under the supervision of the

Superintendent, Government Test House, on behalf of the Consulting Engineer (Roads) to the Government of India was completed and brought into operation during the year. The track was visited by members of the Roads Congress during the meeting of that body in Calcutta in February 1939.

A detailed description of this project is given in Chapter V.

**CASEIN PLASTICS.**—A technical note regarding this subject was prepared by the Bureau and considered by the Council at its fourth session. The note shewed that high grade rennet casein was required and used by industrial countries in the manufacture of casein plastics, whereas the casein which is produced at present in India is the lactic acid type, which is inferior to the rennet type for this purpose.

Subsequent correspondence with several of the larger dairy companies revealed that attempts by them in the past to prepare rennet casein had not been successful, owing to the control of the optimum operating conditions being rendered unduly difficult by the normal atmospheric conditions.

It would appear that a modified technique for the preparation of rennet casein suitable for operation under Indian climatic conditions requires to be developed by laboratory investigations.

**PUBLICATIONS AND REPORTS.**—During the period under review, the following bulletins by the authors stated have been published in the series of Bulletins of Indian Industrial Research :—

- |   |   |
|---|---|
| No. 12. A Study of Indian Mustard and Rape Seeds, and their Oils. | Mr. D. Y. Athawale, M.Sc.*<br>Mr. J. A. Hare-Duke.<br>Mr. P. N. Mathur. |
|---|---|

\*Head of the Oil Technology Department, Harcourt Butler Technological Institute, Cawnpore.

- |                            |   |
|----------------------------|---|
| No. 13. The Soap Industry. | Mr. A. K. Menon, B.A.,<br>F.S.C., Superintendent,<br>Kerala Soap Institute. |
|----------------------------|---|

A list of the bulletins published hitherto in this series is given in Appendix " B " of this Report.

The following papers by the authors named have been received or selected and are under preparation for publication as bulletins :—

- |                        |   |
|------------------------|---|
| Clock-making in India. | Dr. H. Parameswaran,<br>M.A., Ph.D., D.Sc., Pro-<br>fessor of Physics, Presi-<br>dency College, Madras. |
|------------------------|---|

- |   |  |
|---|--|
| Recovery of Titanium Oxide as a by-product in the manufacture of Alumina Ferric from Bauxite. | Mr. Sudhir Chandra Chakravarty, M.Sc., Calcutta. |
|---|--|

- |                          |  |
|--------------------------|--|
| Indian Refractory Clays. | Mr. H. Crookshank, B.A.,<br>B.A. (I.), D.Sc., Geolo-<br>gical Survey of India. |
|--------------------------|--|



The Leather Industry (after revision). Rai Bahadur B. M. Das  
Superintendent, Bengal  
Tanning Institute.

The Handloom Industry. Mr. K. S. Rao, Textile  
Expert, Industries De-  
partment, Bihar.

An invitation to prepare a paper on "Silk products and Weaving in India" has been accepted by Mr. K. T. Acharya, Sericulture Expert, Madras, and on "Workshop training in precision methods" by Mr. P. Bence-Jones, Principal, MacLagan Engineering College, Lahore.

The preparation of bulletins on the following subjects will be taken up by the Bureau when the necessary material for their completion is available :—

The manufacture of china glass and liquid gold.

The electric fan industry.

The electric lamp industry.

The design, construction, and operation of a recuperative type glass pot furnace.

A directory giving information as to the facilities at Universities, technical institutions and colleges in India for researches on industrial subjects, in the case of such establishments as are prepared to undertake investigations on behalf of industrialists, is under preparation.

Cyclostyled copies of technical notes on the following subjects have been circulated to members of the Council :—

Spectacle manufacture.

Phenol-Formaldehyde Resins, moulding types.

Note on the preparation of Casein, and its use in plastics.

COMPILATION OF INFORMATION REGARDING RESEARCHES.—A list of researches and investigations on technical and industrial subjects which have been completed, were in progress in India, or were contemplated, was prepared from information supplied by the Directors of Industries and certain scientific institutions and circulated to all members of the Council.

A copy was also forwarded to the Department of Scientific and Industrial Research, London, in accordance with a reciprocal arrangement.

INDUSTRIAL SURVEYS.—The Industrial Research Council recommended at its third session that steps should be taken to carry out co-ordinated technical surveys of the oil-seed crushing industry, the tanning industry, and the pottery and ceramics industry in succession by the Provinces and States concerned, and that the co-ordination in each case should be effected through the Bureau.

It has not been possible to co-ordinate this work however, as certain of the administrations concerned have already commenced the work, others have decided to conduct the surveys simultaneously as part of a comprehen-

sive industrial survey, while others again have been unable for various reasons to commence the work.

CO-ORDINATION OF UNIVERSITIES AND RESEARCH INSTITUTIONS IN THE DEVELOPMENT AND EXTENSION OF INDUSTRIAL RESEARCH.—Considerable attention was given to this subject by the Council at its Fourth Session, as recorded in Chapter I of this Report. The necessity of developing the co-ordination and co-operation of these establishments with the work of the Council is fully realised by all concerned.

It was considered that preliminary contact might be made with university schools and research institutions by circulating lists of suitable industrial subjects for research and investigation which have been proposed by Directors of Industries and others. These lists have been circulated by the Bureau, and the replies received will be communicated to the Council in due course.

#### INDUSTRIAL INTELLIGENCE.

*Artificial Silk.*—The examination undertaken by the Bureau, at the request of the Indian Central Cotton Committee, regarding the economic and technical possibilities of manufacturing artificial silk (both rayon and staple fibre) in India by the viscose process as well as by the acetate process, has been continued. To assist in this work Dr. L. Thoria, D. Ing. has been loaned on several occasions by the Indian Central Cotton Committee to the Bureau, and a series of notes on various aspects of the subject have been compiled and forwarded to the Committee. These notes have been considered and discussed at various meetings of the Committee, which the Director of the Bureau attended.

The last note to be prepared dealt with the manufacture of chemical cotton from linters and gave information, which had been obtained from America, regarding the grades and market prices of linters in the U. S. A. The note also gives full technical details and an estimate for a pilot plant for the production of chemical cotton which had been obtained from the Chemical Construction Corporation, New York, and recommended the acquisition and installation of such a plant by the Indian Central Cotton Committee.

The co-ordination and co-operation regarding this subject previously arranged between the Indian Central Cotton Committee, the Director of Industries, Bombay, the Forest Research Institute, Dehra Dun, and the Industrial Research Bureau has continued during the period under review.

*Lubricating Oils and Paints.*—The Bureau has continued to co-operate with the Central Standards Office, Railway Board, in connection with matters concerning the lubrication and painting of railway rolling stock. Development work in connection with both these subjects has been actively in progress during the year.

*Starch.*—In the previous Report it was mentioned that information was being collected from various sources regarding available raw materials and manufacturers of appropriate plant for production of starch from these materials. A technical note on this subject is under preparation and will be circulated to members of the Council in due course.

*Cottonised Flax.*—The possibility of recovering and utilising flax fibre from linseed straw, large quantities of which are at present wasted in various Provinces, has been increased by developments in connection with the preparation and use of cottonised flax. Several firms in Europe have developed plant for the preparation, spinning, and weaving of cottonised flax, and particular interest has been taken in this subject by the Department of Agriculture, Central Provinces and Berar.

This matter has been brought to the notice of the Directors of Industries, Bombay, Bengal, the United Provinces, Central Provinces and Berar, and Bihar, with a view to the development, in the first instance, of a retting industry for the preparation of fibre for export.

*The Utilisation of Gypsum in the Manufacture of Sulphuric Acid.*—In answer to enquiries regarding this subject from an industrial firm and also from the Director of Industries, Bihar, a technical note was prepared describing briefly the methods of utilising gypsum for this purpose.

*The Manufacture of Phenol and Formaldehyde.*—With a view to developing the manufacture in India of Phenol and Formaldehyde for use in synthetic resins for moulding powders, disinfectants and other purposes, arrangements have been made for investigations on crude tar acids and phenol-cresol products from a coal distillation plant in Bihar to be carried out by Dr. S. S. Bhatnagar, D.Sc., F.Inst.P., and Mr. Kulkarni Jatkar, M.Sc., who have consented to undertake this work. Contact is being maintained with the Director of Industries, Mysore, regarding the possibilities of producing Formaldehyde from the wood distillation plant of the Mysore Iron and Steel Works, Bhadravati.

*Shellac Moulding Powders.*—The Indian Lac Research Institute, Ranchi, is developing a shellac-urea-formaldehyde moulding powder, and promising results have been obtained. The Bureau is in correspondence with the Director of Industries and Commerce, Mysore, regarding the possibility of production of urea, which might become available in due course as a result of the installation of ammonia producing plant in the State.

*Wood Flour Fillers.*—An important component of many industrial moulding powders is wood flour. A typical sample of imported material has been forwarded to the Forest Research Institute, Dehra Dun, for examination and report as to the possibility of obtaining similar material locally.

*Silk Worm Gut.*—The Bureau drew the attention of the Indian Medical Service Directorate to a paper received in connection with the 1938 Prize Papers Competition of the Council, in which was described the method of preparation of silk worm gut, used as surgical ligatures, which had been developed at the Sericulture Branch, Kollegal, of the Industries Department, Madras. Hitherto, supplies of this article had been imported, and considerable difficulty had been experienced recently in obtaining supplies.

Orders have recently been placed by the Stores Branch of the Indian Medical Service with the Sericulture Branch, Kollegal, for their requirements for six months' supply.

*Paints prepared by Cottage Industries.*—Arrangements were made for examination by the Government Test House of certain samples of paint manufactured by the Sodhana Cottage Industries Association, Tenali, Madras, at the instance of the Director of Industries, Madras.

*Miscellaneous Industries.*—Technical notes on various subjects were prepared by the Bureau in answer to enquiries received from Directors of Industries and other sources. Of these, notes on the following subjects may be mentioned :—

- The manufacture of 1 and 4 gallon tin cans.
- Inside coatings of tin containers for fruit preservation.
- Palmarosa Oil.
- The Manufacture of Carbon Papers.
- The Manufacture of Sealing Wax.
- The Manufacture of Galvanised Ironbuckets.
- Portable Producer Gas Plant for Road Vehicles.

*Requests for information.*—The number of technical enquiries received during the year under review was 186, as against 138 received last year. This shows an increase of about 34 per cent. Of these enquiries, 47 were received from Directors of Industries of Provinces and States, 26 from other Government Departments, 107 from private firms or individuals and 6 from foreign and semi-official bodies. The technical standard of these enquiries was in general satisfactory.

*Scrutiny of specifications.*—To ensure that Indian products are not unnecessarily excluded thereby, specifications drafted by the Indian Stores Department, and the Central Standards Office, Railway Board, continue to be received by the Bureau for scrutiny.

*Membership of Committees.*—During the year under review, officers of the Bureau were members of the following committees and similar bodies :—

#### *The Director.*

- Industries Conference, and Imperial Sericulture and Wool Committees.
- Advisory Board, Imperial Council of Agricultural Research.
- Advisory Board, Imperial Institute of Sugar Technology, Cawnpore.
- Indian Central Cotton Committee, Technological Research Sub-Committee.
- Governing Body and Advisory Board, Indian Lac Cess Committee.
- Indian Roads Congress, Technological Sub-Committee.
- Joint Development Board, Chemical Sub-Committee, Industries Department, Punjab.
- Railway Board, Paints Sub-Committee.

#### *The Assistant Director.*

- Advisory Committee for development of the Glass Industry, Industries Department, United Provinces.

**LIBRARY.**—At the end of the year the library contained the following :—

Text books and works of reference ..	1,762
Publications of Government Departments	2,172
Bound volumes of back numbers of periodicals.	221
	4,155

The number of technical periodicals taken by the library was 51.

**FINANCE.**—The expenditure during the year 1938-39 on the Industrial Research Bureau was as follows :—

		Rs.
Industrial Research Bureau .. ..		1,07,529
Research Branch .. ..		78,101
Total ..		1,85,630

## CHAPTER III.

## WORK OF THE RESEARCH BRANCH, GOVERNMENT TEST HOUSE.

STAFF.—Various changes took place in the composition and numbers of the staff of the Research Branch during the course of the year as the result of new appointments, resignations and transfers. The nett effect has been a gain of two in the number of chemical assistants, of an additional electrical mistri and of a machinist mistri.

The statement below shews the sanctioned strength and also the actual strength of the Research Branch on the 31st March 1939 :—

Rank.	Sanctioned strength.	Actual strength on 31st March 1939.
Research Officer .. .. .	1	1
Assistant Research Officer .. .. .	1	1
Chemical Assistants .. .. .	8	8
Physical Assistants .. .. .	7	7
Clerks .. .. .	5	5
Librarian .. .. .	1	..
Draftsman .. .. .	1	1
Instrument maker .. .. .	1	1
Machinist .. .. .	1	1
Mistris .. .. .	5	5
Others .. .. .	11	11

WORK IN PROGRESS.—The principal subjects of research and investigation on which the staff of the Research Branch was engaged continued to be the following :—

- (1) The improvement of paints, and utilisation of indigenous materials for paint manufacture.
- (2) Development of a technique to guide the manufacture of efficient dry cells.
- (3) Utilisation of Indian vegetable oils as lubricants and fuels in internal combustion engines.
- (4) Investigations with a view to improvement of limes, surkhis and allied building materials.
- (5) Investigations to aid the glass industry.
- (6) Investigations and tests to aid the Indian electric lamp industry
- (7) Road Research.

A number of minor investigations have also been carried out in connection with various industries from time to time at the instance of the Bureau and reported upon. In this connection Appendix "E" of this Report, which is a list of the reports submitted to the Bureau during the period under review, may be seen.

The work carried out and the progress effected in connection with the subjects which have engaged the attention of the staff are described below.

**PAINT INVESTIGATIONS.**—The staff allocated to this work during the year under review consisted of two Chemical Assistants and one Physical Assistant.

Natural Weathering.—The revised technique for determination of the durability of paints, which was outlined in last year's Report was put into full operation during the year. A 20° inclined test rack facing south was built and to this was added a group of six racks built for vertical exposure, the panels facing east and west. The total capacity of the latter racks is 2,880 panels of 6" × 9" size.

Exposure tests on a large number of panels carried out on the 20° rack indicate that, as expected, the breakdown of paints is considerably accelerated on this rack as compared with the rate of breakdown on vertical racks. A complicating factor has been introduced, namely the accumulation of dust and soot on the panels, which becomes rather serious in dry months. The result may be that the breakdown of the paints will be effected somewhat differently from that in the case of vertically exposed panels. The results of exposure tests on the two racks and in the weatherometer, when available in sufficient numbers, will be analysed and compared in due course.

Accelerated Weathering.—Various modifications which have been made in the weatherometer were described in the last Report. During this year the equipment has been in constant operation and has given fairly satisfactory results.

Samples of paints exposed outdoors are being tested also in the weatherometer and the data are being collected with a view to correlation. 123 panels have been dealt with during the year, representing 9 series of paints.

Investigation of Paint Formulae.—Work had been in progress during the year under review in accordance with the comprehensive programme of testing paint formulae drawn up at the inception of the Bureau. The following is a brief summary of the various items on which work is in progress :—

*Black Paints.*—The weathering tests are in progress.

*Red Oxide Paints.*—The series of panels under outdoor exposure tests has begun to show signs of failure. From observations so far made, it appears that natural red oxides are superior to the artificial variety. Among the natural red oxides, the indigenous one gives better results than a certain well-known imported material. Furthermore, paints thinned with linseed-stand oil appear to be more durable than those thinned with double-boiled linseed oil. Besides being exposed outdoors, these paints are also being tested in the weatherometer.

Experiments on the settling of these paints indicate that the addition of a small quantity, say 1 per cent. of stearic acid effectively retards settling. This work is being continued and a report will be issued when complete information has been collected.

*White Paints.*—A comprehensive series of 300 panels prepared from white paint using white lead, antimony oxide, zinc oxide, titanium oxide and various extenders in different combinations has been exposed on vertical and 20° racks.

*Red Lead Paints.*—The number of pigment samples under investigation has been increased from 4 to 13, and investigations have included the study of particle size and the effects of dispersing and suspending agents on setting as well as on weathering properties. The results so far obtained may be stated under separate headings as follows :—

(i) *Setting of Pigment.*—The tendency of pigment to settle to the bottom of the container and subsequently to set hard was observed over long periods of storage, extending up to six months, the degree of settling being estimated by the length of time required to stir up the pigment into suspension in the vehicle again. The results obtained have been communicated to the various manufacturers and suppliers who provided certain of the materials.

(ii) *Dispersion and Suspension.*—If the settling and setting of red lead pigment are ascribable to the chemical reactions taking place at the surface of the pigment particles between them and the medium, it should be possible to inhibit this tendency by introducing certain dispersing agents capable of forming a thin layer of molecular dimensions around the pigment particles and thus reduce the reaction tendency. Furthermore, setting might be reduced by introducing a small quantity of non-reactive pigment or extender which may prevent the red lead particles from coming into close contact with each other and getting 'cemented' by the reaction products. The latter type of materials are termed "suspending" agents for convenience.

Both these theoretical concepts were tested experimentally by using a number of metallic soaps and fatty acids as dispersing agents, and materials such as talc, asbestine, etc., as suspending agents. After a few preliminary experiments had been conducted, seventeen paints were prepared for long-time settling tests, using various dispersing and suspending agents which gave promise of success. The results so far obtained indicate that though the suspending agents do help to retard setting, they cannot prevent it altogether. But certain dispersing agents, such as aluminium stearate, used in as small a proportion as 0.75 per cent. have been found to be very effective as regards inhibiting settlement.

(iii) *Weathering Tests with Dispersing and Suspending Agents.*—In order to determine what effects these dispersing and suspending agents might have on the durability properties of red lead paints, a number of the promising compositions were subjected to natural and also to accelerated weathering. The results so far obtained indicate that the use of aluminium stearate is in no way harmful. The work is still in progress.



(iv) *Particle Size*.—The importance of particle size distribution from the point of view of settling and setting properties and of the effects of the dispersing agents on it was realised at an early stage in this work, but the method now in use in this investigation was developed only during the year under review. All the samples of red lead pigments under test were subjected to particle size distribution analysis under different conditions using this method, and the results so far obtained indicate that the particle size of the pigment in the finished paint, which is normally a function of the amount of grinding to which it has been subjected, is also greatly influenced by the presence of dispersing agents. It has been found that aluminium stearate reduces the particle size of the red lead pigment to a remarkable degree. An attempt is being made to establish a definite correlation between the particle size distribution and the setting properties of the red lead paints.

(v) *Chemical Composition*.—It has been considered hitherto that the chemical composition of the red lead pigment, especially its free lead monoxide content, has an influence on the setting properties. This contention also is being subjected to a critical examination, for though, generally speaking, there does appear to be some truth in it, yet it cannot always be relied upon for the purpose of predicting the behaviour of a given pigment in respect of its setting tendencies.

*Sublimed White Lead and White Lead Paints*.—Outdoor exposure tests on the series of paints in question have been continued, and 20° south exposure and also accelerated weathering tests have been added. From the results so far obtained it appears that though at the early stages the 50—50 mixture of sublimed white lead and white lead gave promising results, the prolonged exposure has indicated the superiority of the white lead paint reduced with 50 per cent. barytes.

*Gypsum as Paint Extender*.—As reported last year, gypsum proved inferior to barytes as an extender, in the accelerated weathering tests. The natural weathering tests, however, are still in progress.

*Magnetite*.—Besides the tests already in progress, additional panels have been exposed on the 20° south exposure rack.

*Titaniferous Bauxite*.—In addition to vertical exposure, tests on 20° south exposure have been commenced. The results so far obtained indicate that calcined and hydrochloric acid treated bauxite gives better results than bauxite which has only been calcined. Furthermore, it has been found that these paints cannot be used in conjunction with a red lead undercoat, for they develop cracks at an early stage.

*Talc*.—Two samples of talc have been received from Jaipur and it is intended to investigate their behaviour as extenders and also as suspending agents (in red lead paints) in comparison with certain other samples of talc, asbestine, and barytes obtained from other sources. Particle size determination has been carried out, which shewed that the grinding of Jaipur talc is not as fine as that of some of the foreign samples.

Heald Varnish.—A Bombay firm enquired from the Industrial Research Bureau whether a suitable quality of Heald Varnish could be prepared in India. The sample received in this connection was subjected to thorough chemical and physical examination. Certain local firms were furnished with the necessary data and invited to manufacture similar varnishes for the purpose. The samples received are now under examination.

Fungus Growth on Paints.—It was mentioned in last year's Report that the growth of fungus on paint films exposed to the weather had been found to play an important part in the breakdown of films. The growth was observed to be particularly extensive on red oxide paints during the monsoon months. Similar paints exposed in Delhi have not developed fungus growth. The fungus is dark, practically black, and appears to produce fine pin-holes in the paint film. In order to inhibit the growth of fungus, it appeared to be necessary to incorporate a suitable toxic substance. A series of paints were therefore prepared containing small quantities of a number of toxic materials and the panels painted with them were exposed outdoors on the 20° rack as well as on the vertical racks. The results so far obtained indicate that certain of the substances which have proved efficacious in western countries for similar purposes, such as sodium silicofluoride, magnesium borate, and tribromophenol, are of very little value in Bengal, but mercuric oxide and mercuric phthalate appear to retard the growth of fungus perceptibly. The optimum concentration of these materials required to inhibit the growth altogether or to reduce it effectively still remains to be determined.

With the kind assistance of Dr. S. R. Bose, Professor of Botany, Carmichael Medical College, Calcutta, it has been possible to propagate the particular fungus in the laboratory and to identify it as being *Ascoidea rubescens*. Further information regarding the life and habits of the fungus requires to be gathered, and also whether this is the only type that grows on paints or whether other fungi are also present.

DRY CELLS.—The superior technical staff engaged on this work consisted of one Physical Assistant and one Chemical Assistant.

Manufacture of Cells.—The study of the different variables affecting the manufacture of cells has been continued. The following are a few of which the effect has been studied this year:—

- (1) Proportion of starch in the electrolyte.
- (2) Water content of depolarizer mixture.
- (3) Use of additional samples of pyrolusite.
- (4) Effect of different varieties of artificial manganese dioxide.

As stated in the last Report, this work was confined to the study of the effects of the different variables on the initial characteristics of the cells.

The results indicate that the starch content could be considerably reduced without any adverse effects, and that a high water content in the depolarizer mixture, consistent with practical considerations of dolly moulding, was beneficial. A certain number of pyrolusites of Indian origin gave promising

results, although most of them indicated that without any pre-treatment or admixture of artificial manganese dioxide they would not function satisfactorily. Artificial manganese dioxides of various origins invariably improved the cell characteristics when added in small proportions.

*Shelf Life.*—In addition to the above work, investigation of the shelf life of cells of promising compositions was commenced. This involves the storage of cells over a period of a year or more and the determination of deterioration in respect of electrical characteristics at intervals during the period of storage. The cells on shelf life are subjected to the same tests as when initial characteristics are determined, after a storage period of 0, 5, 10, 25, 40, 55 and 75 weeks. At present the following batches are under shelf life tests :—

- 2 batches of cells of reputed make.
- 3 batches of low-priced foreign made cells.
- 2 batches of cells made from imported pyrolusites.
- 1 batch of cells made from an indigenous pyrolusite.

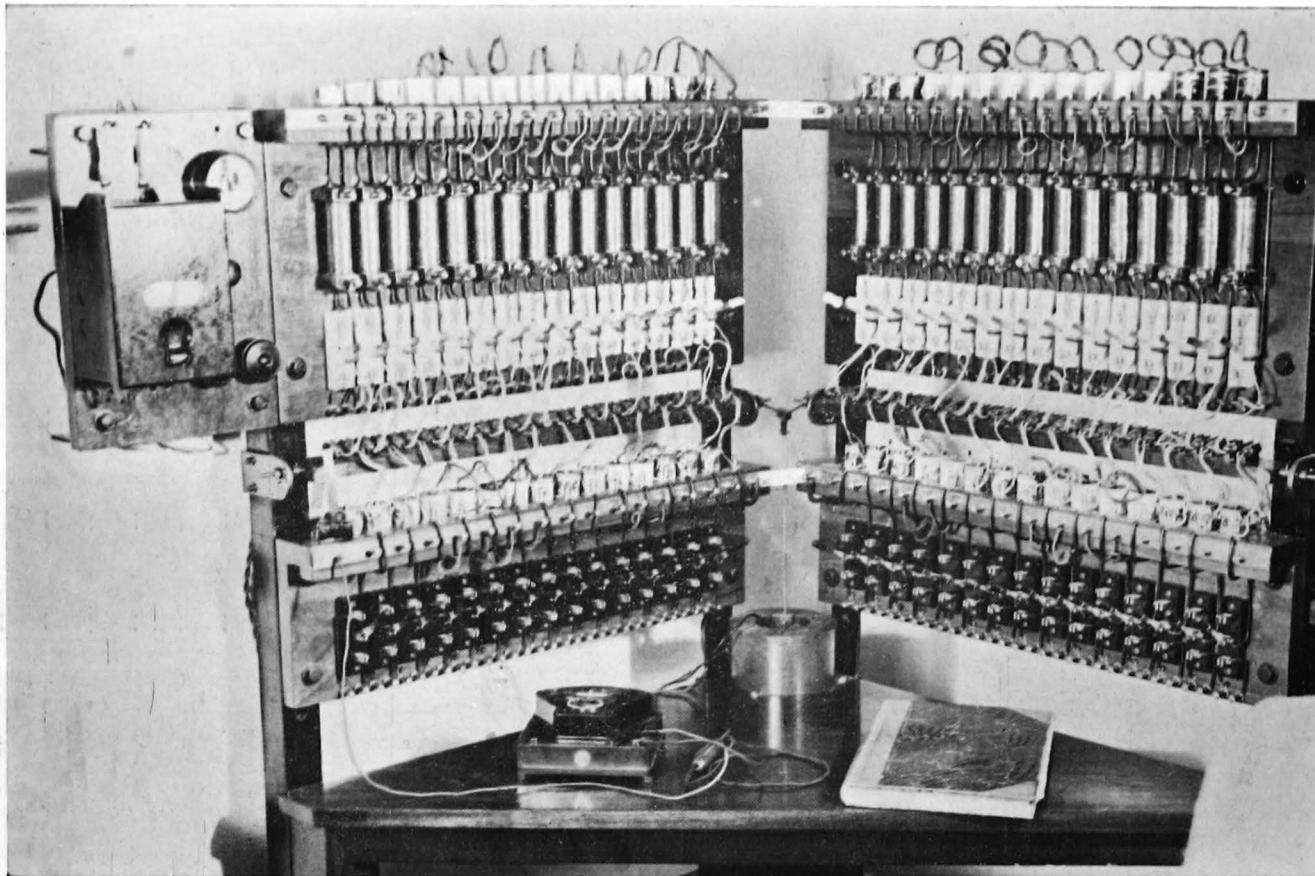
None of these tests have progressed sufficiently far to enable any conclusions to be drawn.

*Indian and Imported Pyrolusites.*—Following up the work described in last year's Report, examination of Indian pyrolusites was continued. Ten additional samples (Nos. 9 to 18, *vide* last year's Report, page 16) were chemically examined and also tested as components of dry cells. In addition, three imported samples of natural ores and two artificial manganese dioxide samples were similarly examined. The results obtained lead to similar conclusions to those stated previously. A few of the Indian pyrolusites appear to be promising raw materials and may safely be used in conjunction with a 10 per cent. addition of artificial manganese dioxide ; most of them, however, require some form of pre-treatment.

*Correlation of Chemical Constitution and Electrical Performance of Ores.*—This work has been continued from last year and has now reached a stage at which a systematic analysis of the data can be undertaken. Generally speaking, the preliminary conclusions reported previously have been confirmed.

*Pre-treatment of Ores.*—Preliminary work in this direction was commenced during the year under review. With the aid of the "Experimental Dry Cell" the effects of the following materials for pre-treatment were tested in the case of a few of the promising local ores available :—

- (1) Water at different temperatures.
- (2) Cold dilute sulphuric acid.
- (3) Dilute potassium hydroxide at different temperatures.
- (4) Dilute sodium carbonate at elevated temperatures.
- (5) Potassium permanganate.
- (6) Manganous chloride.
- (7) Different combinations of (3), (4), (5) and (6).



**PLATE I.**

**Part of the automatic clock-controlled dry cell testing apparatus, showing the test-racks for the cells.**

The work is only in its preliminary stages, and it would be premature to draw any conclusions—general or specific—but it appears that treatment with dilute acids or alkalis may result in improved performance.

*Large Scale Manufacture.*—The work is now approaching a point at which it will be necessary to confirm that the technique of manufacture of dry-cells which has been developed successfully on a laboratory scale will be equally successful when applied to cell production on a commercial scale. The economics of dry-cell manufacture on a commercial scale is also a complicated problem since it involves consideration of many kinds and grades of material, some of which may be indigenous but the remainder of which must for the present be imported. Moreover, the manufacturing process consists of a considerable number of operations, each of which requires to be controlled and supervised. A semi-commercial scale plant equipped with a number of small commercial size units will be required for this stage of the work.

Information has been collected regarding manufacturers and details of factory-scale machinery and also regarding the prices of materials for the production of dry cells on a large scale, and an estimate of the cost of purchasing and installing the necessary machinery is being prepared.

*Testing Equipment.*—The automatic clock-controlled dry cell testing device mentioned in last year's Report has been in operation during the year under review and has given satisfactory service. With the starting of shelf life tests it had become necessary to increase the capacity of the testing equipment. The capacity has therefore been doubled and it is now possible to put 60 cells on test at a time on this apparatus. Plate I shews the test rack part of the apparatus in its present form.

**INTERNAL COMBUSTION ENGINES.**—The superior staff engaged on this work consisted of two Physical Assistants and one Chemical Assistant.

*Vegetable Oils as Lubricants.*—The work was continued in accordance with the plan outlined in the last Report. The progress made during the year is described below :—

*Stabilizers.*—During the search for suitable anti-oxidants and stabilizers for various vegetable oils, considerable discrepancies between the oxidation tests in the modified Air Ministry apparatus and practical tests in the engines often came to notice. Consideration of this matter led to the conclusion that such discrepancy may be due to the contact of the oil with iron surfaces present in the latter case. A series of tests were therefore carried out in the Air Ministry apparatus on oils with and without anti-oxidants and also with and without the presence of iron, one hundred steel balls,  $1/8$ " in diameter, being introduced into the oxidation tubes in the latter case. The results obtained indicated that iron definitely caused increase of viscosity.

It was considered desirable in the light of these experiments, further to modify the laboratory procedure for oxidation tests and to introduce steel balls in all future experiments. The previous work on castor oil was therefore repeated, and the results obtained have led to somewhat different conclusions regarding the efficacy of certain stabilizers. A few of the most effective

stabilizers out of the 54 tested for use with castor oil are listed in Table I below, the ratio of viscosity increase as the result of the modified Air Ministry test being also given.

TABLE I.

*Most Effective Stabilizers for Castor Oil in presence of iron.*

Stabilizers.	Proportion % in the oil.	Ratio of Viscosity Increase.
None .. .. .	..	6.5
P-P-diamino-diphenyl-amine .. .. .	1.0	2.5
Alpha-Naphthol .. .. .	1.0	2.6
Beta-naphthylamine .. .. .	1.0	2.6
Alpha-Naphthol azo-alpha naphthalene .. .. .	1.0	2.6
Hydro-quinone .. .. .	1.0	2.7
Alpha-naphthylamine .. .. .	1.0	2.7

The search for stabilizers was extended to groundnut and cottonseed oils, and a few of the most effective stabilizers found for these oils by the same methods are shewn in Tables II and III below :—

TABLE II.

*Most Effective Stabilizers for Groundnut Oil in presence of iron.*

Stabilizers.	Proportion % in the oil.	Ratio of Viscosity Increase.
None .. .. .	..	9.2
Alpha-Naphthol .. .. .	1.0	4.8
Phloroglucinol .. .. .	1.0	4.9
N-phenyl-alpha-naphthylamine .. .. .	1.0	5.2
Hydro-quinone .. .. .	1.0	5.4
Alpha-naphthylamine.. .. .	1.0	5.5

TABLE III.

*Most Effective Stabilizers for Cottonseed Oil in presence of iron.*

Stabilizers.	Proportion % in the oil.	Ratio of Viscosity Increase.
None .. .. .	..	12
Alpha-naphthylamine .. .. .	1.0	6.4
Alpha-naphthol .. .. .	1.0	6.5
Nos. 2 and 3 .. .. .	0.5 each	7.1

It will be seen that the most effective stabilizers found so far for cottonseed oil are not quite effective enough, and even the best stabilizers for groundnut oil are not as effective as those found for castor oil.

*Blends.*—As a consequence of the results outlined above, it was decided to confine attention for the present to castor oil and groundnut oil blends, and the following two mixtures were found to cover the range of viscosity recommended by the B. E. S. A. specification No. 210-1924 for medium lubricating oils for use in internal combustion engines:—

	Mixture.	
	A	B
Castor oil .. .. .	60%	40%
Groundnut oil .. .. .	40%	60%

Both these mixtures were therefore subjected to a series of modified Air Ministry oxidation tests in conjunction with the most effective stabilizers found for the two oils and it appeared that the most effective combinations of stabilizers gave a viscosity ratio of 3.5 for the mixture A and 4.2 for the mixture B. It was, therefore, decided that attention should be confined to mixture A for the time being. The most effective stabilizers found for this mixture were:—

(1) Alpha-naphthol .. .. .	1%
(2) Alpha-naphthylamine .. .. .	1%
(3) Beta-naphthylamine .. .. .	1%
(4) Beta-naphthylamine .. .. .	0.5%
mixed with Hydro-quinone .. .. .	0.5%

The following blends were then prepared for engine tests:—

(3) Castor Oil .. .. .	60 parts by volume.
Groundnut Oil .. .. .	40 parts by volume.
Alpha-naphthol .. .. .	1% by weight on oil mixture.
(4) Castor Oil .. .. .	60 parts by volume.
Groundnut Oil .. .. .	40 parts by volume.
(No stabilizers).	

The latter of the above two blends was prepared with a view to determining the extent to which the presence or absence of a stabilizer influences engine operation and affects the changes produced in the oil itself under engine test conditions.

The detailed results of modified Air Ministry Oxidation tests on the four\* blends subjected to engine tests are summarised in Table IV below :—

TABLE IV.

*Results of oxidation tests on blends tested subsequently in the engine.*

Blend.	Viscosity Increase Ratio.	Acid Value.		Conradson Residue.	
		Original.	Oxidised.	Original.	Oxidised.
(1)	5.5	..	..	0.35	0.97
(2)	5.3	..	..	0.56	1.27
(3)	3.4	2.5	4.0	0.27	1.29
(4)	6.1	2.5	4.2	0.27	0.97

\*For details of Blends (1) and (2) see the Annual Report for 1937-38, page 18.

*Trials in small Lister petrol engine.*—These blends and also the control mineral oils were then each subjected to a run of 100 hours duration in the 1.5 K. W. Lister House Lighting Set under the controlled conditions specified in the previous Report. The results of the tests were as follows :—

(1) Of all the blends, No. (1) gave the best results.

(2) Blend No. (2) may be regarded as having given fairly good results, but its deposits were rather more than those of blend No. (1). Moreover the viscosity increased by 27 per cent. as compared with 11.4 per cent. in the case of blend No. (1). The difference in the behaviour of the two oils is presumably due to the fact that whereas blend No. (1) contained castor oil, blend No. (2) contained only blown groundnut oil. Blown oil was used instead of raw to obtain the desired viscosity.

(3) Blend No. (3), though it contained no mineral oil, gave as good results as blend No. (2) containing as much as 40 per cent. of the latter.

(4) Blend No. (4) clearly demonstrates, when compared with blend No. (3) the improvement caused by the stabilizer in practically all respects, with the important exception of the final iron content. It would appear that, in the choice of stabilizers, special attention should be paid to the tendency of the oil mixture to attack iron.

*Trials in 16 H. P. Morris Industrial petrol engine.*—No extended period tests on the vegetable oil blends have yet been undertaken in this engine. The results of preliminary tests indicate, however, that the operating conditions



which lubricating oil is required to withstand are much more severe in the case of the larger engine and such as to render the vegetable oil blends comparatively unsatisfactory.

*Vegetable oils as Diesel fuels.*—This work was continued, using the 8 H. P. Lister diesel engine running at 1,200 R. P. M., and preliminary engine tests were made on four additional samples of oils, the results of which are outlined in Table V below :—

TABLE V.

*Preliminary engine tests on Vegetable oils used as Diesel fuels.*

Commercial name of oil.	Botanical name.	Startability.	Operation.	Maximum H. P. output.
Cottonseed	Gossypium	Medium*	Smooth	7·8
Mustard	Brassica juncea	Medium	Smooth	7·7
Til	Sesamum indicum.	Medium	Smooth	7·6
Coconut	Cocos nucifera	Medium	Unsteady	7·4

\*NOTE.—Medium startability implies that the engine could not be started from cold, but starting could be easily effected after heating the fuel pipe leading to the Bosch injector.

These results indicate that all the above oils except coconut oil could be used as Diesel fuels without much difficulty. The starting difficulty may be solved either by preliminary heating of the fuel immediately before its entry to the injector, or else by providing a small duplicate supply tank of mineral oil (*e.g.* kerosene) to be used for the purpose of starting.

Prolonged runs of 50 hours duration have been completed on karanj and cottonseed oils, and a periodic test run on mineral oil was also carried out. The results so far obtained are summarised in Appendix 'C' and shew that the brake thermal efficiency given by vegetable oils is in general higher than that given by mineral oil.

In the case of cotton seed oils it is considerably higher, with the result that the consumption of oil per brake horse-power-hour is actually less than in the case of mineral oil.

The exact explanation of the superior behaviour of cottonseed oil in respect of efficiency cannot be given at this stage of the work. It is, however, proposed to acquire a cathode-ray oscillograph indicator apparatus, when a comparative study of the characteristics of the process of ignition of the various oils will doubtless provide the explanation. It is generally assumed that the ignition time lag of vegetable oils is rather more than that of mineral oils. To compensate for this effect the pressure rise may be much more smooth and uniform,

The superior performance may, on the other hand, be due to a fortunate combination of injection angle, shape of combustion space and other operating conditions, or more efficient dispersion of the injected charge.

*Anti-knock ratings of petrols and aviation fuels.*—The routine tests for octane number determinations of aviation and motor spirits received at the Government Test House from Civil and Military departments and private concerns continued to form a part of the duties of the research staff engaged on internal combustion engine problems. The total number of samples dealt with amounted to 284 during the year. A view of the C. F. R. engine unit installed at the Government Test House for this work is shewn on Plate II.

**LIMES, SURKHIS, SANDS, ETC.**—The superior staff engaged on this work consisted of one Physical Assistant, and the following investigations were in progress :—

(A) *Surkhi as a Pozzolana.*—The work described in the last year's Report was continued during the year under review, and the progress made with the subjects under investigation was as follows :—

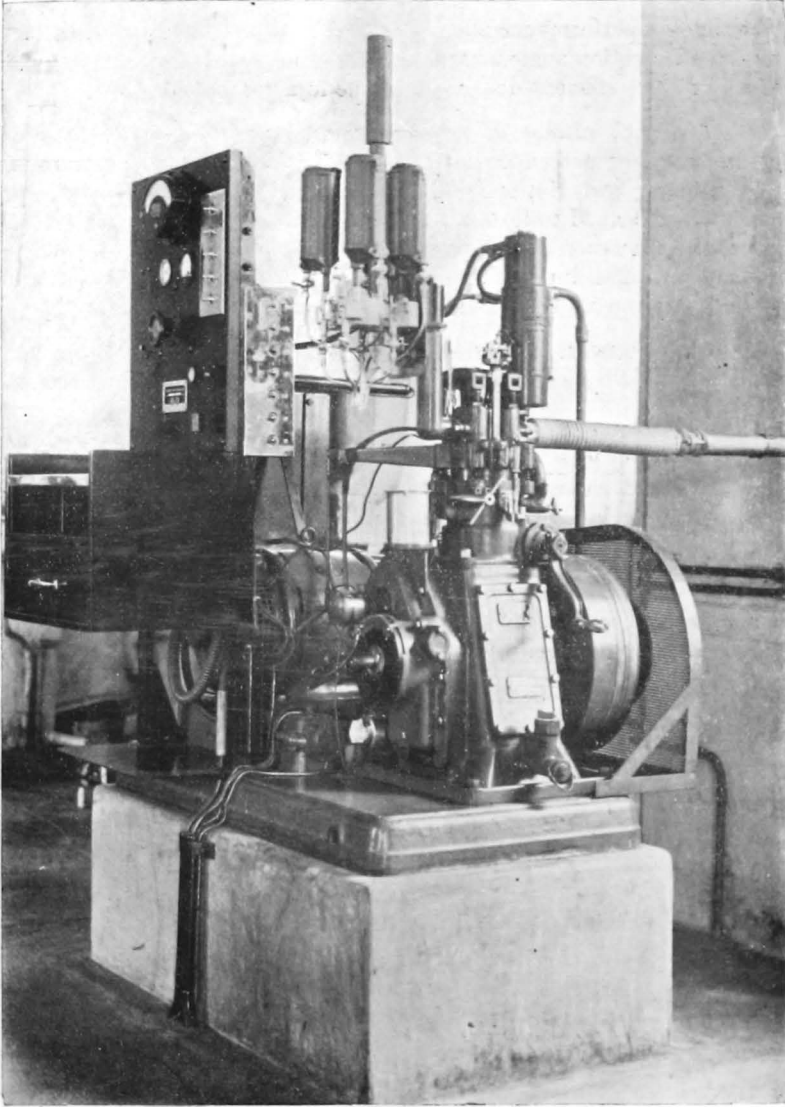
(i) *Surkhi collected from Brickfields.*—The investigation of the behaviour of these surkhis when used in conjunction with high magnesium lime has been concluded. The general conclusions tentatively stated in the Report for the year 1936-37 have been confirmed, these being as follows :—

- (a) Higher ultimate strength of mortar is obtained when using a surkhi prepared from over-burnt bricks than when a surkhi prepared from well-burnt bricks is used.
- (b) Similarly, higher mortar strength is obtained when a surkhi prepared from well-burnt bricks is used than when a surkhi from under-burnt bricks is used.
- (c) The mortar strengths given by dry mixes are generally above those obtained from mixes of a wet consistency.
- (d) The strength of mortar made from coarse surkhi (mesh No. 30) is generally greater than that of a mortar made from more finely ground material (mesh No. 170).

(ii) *Surkhi prepared in the laboratory.*—Investigations were carried out to determine the effect of the temperature of burning and also of the duration of the period of burning on the strength of lime-surkhi mortars made with high calcium and high magnesium lime.

The results obtained indicate that the higher the temperature of burning, the greater is the strength obtained, and also that the longer the period of burning, the greater is the strength of the mortar, with a possible limit at 45 hours for 1,000°C. The results have not yet been fully analysed, and the above conclusions should be regarded as tentative.

A considerable difficulty which had to be overcome in this work was concerned with the necessity of maintaining identical particle size distribution in all the samples. Overburnt surkhis obtained by burning for longer periods and



**PLATE II.**

**C. F. R. variable compression engine unit installed at the Government  
Test House.**

at higher temperatures were found to be difficult to pulverize, and therefore introduced uncertainties in the results. The effect of particle size distribution was separately investigated and this subject is dealt with briefly below.

(iii) *Effect of pugging.*—The surkhis prepared from pugged and unpugged dry clay were compared in respect of the strength of the mortars prepared from them. A preliminary examination of the results indicate that pugging tends to improve the surkhi. Here again, the importance of particle size distribution and the necessity of repeating the tests have been realised.

(iv) *Effect of particle size distribution.*—This investigation was mentioned in last year's Report and has been found to be of considerable importance. Experiments made on surkhis of restricted and also uniform particle sizes indicate that the strengths of mortars increase with a decrease of particle size. Moreover, a surkhi having a reasonably fine particle size distribution (say more than 50 per cent. finer than 300 mesh and all passing 72 mesh) gave results even better than those obtained with extremely fine surkhi (all passing 300 mesh).

These results indicate in a general way the validity of the theoretical expectations. In order, however, finally to establish a standard practice, a considerable amount of work is still required in which the optimum distribution of particle size and optimum lime-surkhi ratio must be determined.

(v) *Surkhi-cement mortars.*—It is well-known that cements, during the course of setting, give rise to the production of free lime, which reduces their resistance to water containing soluble salts such as sea-water. It was presumed that surkhi added to cement might react with this free lime and produce an additional quantity of pozzolanic cement, which would not only increase the resistance to sea-water but also improve the strength.

It was found that an increase in the strength of cement can be produced by an addition of over-burnt surkhi but that this is dependent on the type of cement, the proportion of surkhi added and the age of the mortar. The increase may in certain cases be more than 50 per cent. as compared with cement without surkhi under similar conditions. In fact, an addition of over-burnt surkhi to cement in the proportion of 1 : 2 may be made with advantage, except when early period strength is of greater importance than the ultimate strength. In the latter case an addition of 1 : 4 is considered safe, but this proportion may be increased in the case of certain cements.

(B) *Effect of slaking procedure on the properties of lime.*—The work on the effects of the method of slaking and the mode of storage of high calcium and high magnesium limes on the strength of surkhi mortars was continued throughout the year, and the results obtained are under consideration.

(C) *Substitute for Leighton Buzzard Standard Sand.*—In continuation of the work reported last year, confirmatory tests on Madras sea beach sand were made, and the material was found to be satisfactory. A detailed report, R. B. Building Materials No. 1, has been submitted.

Search for other sources of sand in other parts of the country led to the examination of other samples, but no promising source other than the two already reported [*i.e.*, Mangalhat, (Bihar) and Madras sea coast] has been found.

The sand from Mangalhat, Bihar, appears to be readily obtainable, but the availability of the sand from the Madras sea coast source is still under investigation.

(D) Molasses in lime mortar.—Further work was carried out to determine the effect of molasses on the strength of lime-surkhi and lime-cement mortars. The results obtained are somewhat erratic, due probably to the fact that the reaction between lime and molasses is very rapid and difficult to control, moreover the surface of the mortars appears to harden much more rapidly than the body, due very likely to the effect of the carbon dioxide in the atmosphere.

In general, however, the test-results indicate that the setting time of the mortars are decreased considerably, the tensile strength is generally increased this being more pronounced during early periods. There exists an optimum percentage of molasses at which the strength increases uniformly with time, this lying between 10 to 15 per cent. of molasses calculated on lime. The addition of molasses beyond this optimum point leads to cracking and consequently erratic results.

(E) Bentonite.—The effects of bentonite admixtures on the tensile and compressive strengths of cement mortars, having different water-cement ratios, have been further investigated, and it appears that in plastic mixtures, in which bentonite serves the useful purpose of preventing segregation of the aggregate, the compressive strength is not seriously affected.

A sample of Wyoming bentonite was obtained and gave similar results to those obtained with Jodhpur bentonite (Hathi-Ki-Dhani).

GLASS.—The work carried out by the Research Branch during the year in connection with the glass industry is described in Chapter IV of this Report.

ELECTRIC LAMPS, MANUFACTURED IN INDIA.—Assistance continues to be rendered to electric lamp factories operating in India with Indian capital and management by means of periodic tests of groups of their lamps and advice. The tests are carried out at the Government Test House on behalf of the Bureau, upon application to the Bureau through the appropriate Director of Industries, and one physical assistant of the Research Branch is assigned to the lamp testing section for this purpose.

During the year 192 lamps were tested in this connection. Of these, 72 were manufactured by a factory near Calcutta, 84 were from a factory in the United Provinces, and 36 were imported Japanese lamps of several brands which were obtained for comparative tests.

#### MISCELLANEOUS.

Clay for Pencil Manufacture.—It appears that most of the clay used in the pencil industry in India is now being imported from abroad. It was considered worth while, therefore, to find clays of Indian origin suitable for this purpose. The following four samples of clay were examined in this connection.—

- (1) Clay imported from Germany for use in pencil manufacture.
- (2) Bentonite from Hathi-Ki-Dhani (Jodhpur).

(3) Gachni Clay from the Punjab.

(4) Black Eating Clay from the Punjab.

These clays were subjected to particle size distribution analysis in accordance with a similar technique to that used in the investigations on red lead pigments described under "Paints", but complete analysis was not found to be possible owing to the finer particle size of clays and the lower specific gravities involved. It was, however, found that it was possible to determine the proportion of particles having sizes finer than 0.6 to 0.7  $\mu$ , which, for the clays mentioned above, amounted to (1) 77 per cent. (2) 41 per cent. (3) 39 per cent. and (4) 26 per cent. respectively. It is surprising to find that even bentonite does not compare favourably with the imported German clay. Further work in this connection is in progress.

In addition to carrying out the particle size analyses, samples of the three Indian clays were sent to two pencil factories with a view to carrying out actual tests under factory conditions in order to determine the suitability of these clays. Their reports are not yet available.

*Durability of Lead Acid Storage Batteries.*—Based on the preliminary work mentioned in the previous Report a comprehensive scheme for the comparative testing of lead-acid storage batteries was prepared, and five batteries of Indian manufacture and two of well-known foreign makes were obtained for comparative durability tests. The batteries were practically similar in respect of capacity, number of plates, type of separators, and other characteristics. The initial ampere hour capacity was determined and compared with the rated capacity. Retentivity tests were carried out after 30 days' storage, and thereafter the batteries were placed on regular charge-discharge cycles at a frequency of two cycles per week. The tests are still in progress.

*Boundary Friction of Lubricants.*—On behalf of the Railway Board certain boundary friction tests were carried out on lubricating oils with a view to determining the suitability of a Hardy type testing apparatus. Results were reported to the Industrial Research Bureau.

*Bearing metal deposits on journal surfaces.*—This question was investigated in connection with work on problems concerning the lubrication of railway rolling stock carried out on behalf of the Railway Board, as cases had come to notice of white bearing metals actually being found deposited on the steel journal surfaces.

The possibility of this being due to one or other of the following causes was considered.—

- (i) Electro-chemical reaction.
- (ii) Electrolytic reaction.
- (iii) Cataphoretic migration.
- (iv) Molecular diffusion.
- (v) Mechanical abrasion or fusion.

No theoretically valid grounds could be found for the first four possible causes. As regards the last possibility, however, there are grounds for assuming that momentary breakdown of the film of lubricant may occur, thus introducing boundary lubrication conditions, the result being the production of surface temperatures sufficiently high to melt the white metal of the bearing during contacts with the journal.

*Grinding wheel manufacture.*—An investigation concerning the causes of discoloration of grinding wheels manufactured by a firm in the Punjab has been successfully completed. The defect was found to be due to insufficient firing, and the report to the Bureau on this work made certain recommendations for improvement of the methods of manufacture.

*Rice Bran Oil.*—The problem of extracting rice bran oil and its utilization has been further investigated and the following aspects have been receiving attention :—

- (i) Obtaining oil by expression and extraction.
- (ii) Characteristics of the oil obtained by solvent extraction.
- (iii) Development of rancidity in the oil and in the bran itself and their stabilization.
- (iv) Utilization of bran and oil.

As regards (i), the total oil content of bran obtained from the Central Provinces was found to vary from 14 to 21%, but only about 3·5% of the total oil (*i.e.*, about 5 to 7 %) could be expressed under pressure even as high as 3·7 tons per square inch. The low yield and high pressure required makes expression a very uneconomical proposition. Attempts are being made to devise suitable means to assist expression of oil at lower pressures. Solvent extraction can doubtless be made to give the maximum yield, but the expense involved in plant and operating charges can only be justified if uses of the oil can be found which will enable it to command a sufficiently high price.

As regards (ii), the chemical and physical characteristics of oils obtained by solvent extraction from (a) fresh bran as received, (b) bran which had become highly rancid on storage, and (c) bran stabilized against development of rancidity (see below) were determined. It was found that the acid value of the oil quickly increases, unless the bran or the oil is suitably stabilized before storage.

As regards (iii), bran sent from the Central Provinces was found to be rancid when received in Calcutta, but it could be easily stabilized against further deterioration. Experiments show that stabilization by heat treatment is quite effective up to six months, though longer storage is also possible.

Work on the determination of the vitamin content and food value of the bran and oil cannot be undertaken, but attempts are being made to develop certain possible uses of the product based on information available in the literature on this subject. The work is still in progress.

*Decolorization of China Clay.*—The problem of decolorizing China clay with a view to rendering it suitable for use as sizing material in the textile industry was referred to in the last Report and has been under investigation during the year under review. Several methods and processes have been tried, of which hydrochloric acid treatment appears to give promising results. The work is in progress.

*Soluble Carbonates in the ash of coconut fibre and husk.*—At the request of the Director of Development, Orissa, an investigation was made as to whether soluble carbonates contained in the ash of coconut fibre and husk could be economically utilized in soap manufacture. Laboratory examination indicated that the economic aspects of the proposition were not promising.

*Typewriter Ribbons.*—Various aspects of the subject of the manufacture of typewriter ribbons, such as the types of dyes, physical characteristics of the ribbon material, etc., were investigated.

*Photographic Paper.*—At the request of the Director of Industries, Bengal, photographic papers—bromide and gas light—manufactured by an Indian firm were tested for determination of quality. The results of examination and comparison with foreign made paper of similar grade were reported to the Bureau and to the firm. The report also incorporated suggestions for further improvement of the product.

*Reports and Publications.*—A list of the various reports which have been issued by the Research Branch to the Bureau during the year is given in Appendix 'D' of this Report.

A list of the papers prepared by members of the staff in connection with the Indian Science Congress held at Lahore in 1939, and which were published in the Abstract of Proceedings of the Congress, is shown in Appendix 'E'.



## CHAPTER IV.

## WORK IN CONNECTION WITH THE GLASS INDUSTRY.

**IMPROVEMENT OF GLASS FURNACES AND ACCESSORIES.**—The activities of the Bureau as regards this subject since the last Report have been concerned with the carrying out of comparative fuel consumption tests and observation of the performance of the experimental improved pot type furnace to the Bureau's design which was constructed at the Star Glass Works, Ferozabad, last year, as described in the last Report.

The factory tests which have been carried out, under the supervision of the staff of the Bureau, have demonstrated that the furnace is capable of being operated at temperatures of 1450°-1500°C and of effecting considerable economy of fuel in comparison with the Japanese type of furnace when operating under similar conditions. Comparative test results recorded were as follows :—

- (a) 9/800 lbs. pot Japanese furnace consumed 1·14 maunds of coal per maund of glass produced.
- (b) 9/800 lbs. pot experimental furnace consumed 0·78 maund of coal per maund of glass produced, under similar melting temperature conditions (1350°C).
- (c) The experimental furnace when equipped with 9/1000 lbs. pots consumed 0·66 maund of coal per maund of glass produced (melting temperature 1350°C).

When first started up, the furnace was equipped with 7 pots of Japanese manufacture and 2 pots of Indian manufacture, but the latter broke down completely in a short space of time. In the case of the Japanese pots, also, it soon became apparent that their life would be of the order of a month only in the new furnace, and consequently that the improvement of the quality of glass melting pots of Indian manufacture is essential if adequate advantages are to result from the adoption of improved furnaces. In this connection it may be mentioned that in the case of pot type glass furnaces operating in England the average life of pots is six months, on the other hand enquiries in England showed that the cost of similar pots of British manufacture would be of the order of £20 *plus* freight, as compared with Rs. 80 in the case of Japanese pots.

After two periods of operation under normal factory conditions, it was observed that the refractory blocks of the pot chamber walls and floor had seriously deteriorated, whereas the sillimanite components placed at the eye of the siege had stood up excellently and were practically unmarked. The pot-chamber has therefore been completely reconstructed with wall linings and siege floor in sillimanite blocks, and the furnace will be put into service again shortly.

Meanwhile the factory management have been instructed in the methods employed in Europe for changing pots, which have broken, without necessitating the shutting down of the furnace, and a special truck for transporting and manœuvring hot pots has been constructed at the factory to a design prepared by the Bureau.

Collaboration has also been arranged between Professor P. Carter-Speers and Mr. M. L. Joshi of the Forman Christian College, Lahore, and Messrs. Burn & Co., Calcutta, with a view to improvement of glass-melting pots manufactured by the latter. In this connection contact is also being maintained between the Bureau and Dr. A. Nadel, the glass technological expert of the Government of the United Provinces, who is arranging for the manufacture of improved glass pots at the Ganga Glass Works, Balawali, U. P.

The Industrial Research Council, after consideration of these subjects at their fourth session, recommended :—

(1) That arrangements should be made in due course to encourage the construction of an improved glass furnace of the Bureau's design at a suitable centre in each Province and State concerned.

(2) That the Bureau should arrange to supervise the work of constructing them as in the case of the furnace erected at Ferozabad, U. P.

(3) That arrangements should be made by the Director of Industries concerned to attach a member of his staff to the work for training and experience during the construction and the early stages of operation.

(4) That sets of drawings accompanied by detailed instructions to guide erection and operation of the improved furnace should be made available at a cost of Rs. 25 per set or actual cost of production, whichever is less.

The drawings have been modified in certain minor respects shown in the tests to be desirable, and sets of drawings, together with instructions to guide erection and operation, will be available by the end of July 1939.

*Survey of glass-making materials.*—It was recommended by the Industrial Research Council at the fourth session that arrangements should be made for the survey work of Dr. V. S. Dubey of Benares Hindu University on these materials, reference to which was made in the previous Report, to be continued. It was further recommended that this should next cover the Central Provinces and Central India, Bombay, and the Punjab, subject to the financial provision available.

Sanction was not obtained in time to permit of any of the work being carried out in 1938-39, but arrangements have been made for the survey to be commenced at the beginning of the next cold weather season.

**WORK OF THE RESEARCH BRANCH CONCERNING GLASS.**—The laboratory investigations connected with glass and allied materials have covered the following subjects, taken up either at the instance of the Industrial Research Council or of the Bureau.

*Analysis and grading of glass-making materials.*—In addition to the 147 samples which had been examined and classified up to the end of 1937-38, a further 69 samples have been dealt with up to the end of the period covered

by the present Report. The following table gives a summary of the classification of these 216 samples :—

*Raw Materials for Glass manufacture.*

No.	Material.	No. of samples examined.	Classification.					Unclassified.
			A.	BA.	B.	CB.	C.	
1.	Sands ..	98	..	1	9	19	28	41
2.	Sandstones ..	37	..	..	1	1	32	3
3.	Quartz ..	33	5	..	11	..	15	2
4.	Quartzites ..	6	..	..	..	..	6	..
5.	Agates ..	1	..	..	..	..	1	..
6.	Felspars ..	30	17	..	6	..	6	1
7.	Clays ..	5	..	..	..	..	2	3
8.	Shell Lime ..	1	..	..	..	..	..	1
9.	Marble Powder	1	..	..	..	..	..	1
10.	Pegmatites ..	4	1	..	1	..	2	..
Total ..		216	23	1	28	20	92	52

As in the case of the previous Report, the classification symbols used in the table above signify :—

A.—First class material usable for making first class colourless glass without decolorising agents.

B.—Second class material which may be used with the aid of decolorising agents to produce first class colourless glass.

C.—Third class material which may or may not be usable for making second quality glass.

BA.—An originally " B " class material which may be converted into " A " class by some simple treatment, such as washing or sieving.

CB.—An originally " C " class material which may be converted into " B " class as above.

Unclassified—Such material include those that have either been found unsatisfactory on visual examination and hence not analysed or do not fit into the general scheme of classification outlined above.

The laboratory work on these samples has been completed and examination of the results with a view to preparation of the report is in progress. Modification of the scheme of classification used hitherto and described above is also

under consideration, as it is felt that classification on the basis of the particular type of glass and articles which could be manufactured from a given sample might be helpful to factories and others concerned in the industry.

*Liquid Gold.*—The completion of the preliminary laboratory work on the manufacture of liquid gold was reported in the last Annual Report. During the period under review, a semi-commercial scale batch of liquid gold was prepared with a view to discovering any difficulties that might be encountered when the scale of operation was enlarged and also to study the economic aspects of the manufacture of liquid gold in India.

Twenty tolas of metallic gold yielded about  $43\frac{1}{2}$  ozs. of liquid gold, and the product when tested gave results which compared favourably with the best quality imported liquid gold available on the market as regards brightness, lustre, colour and adhesion. Small samples of this trial batch were distributed to interested users to obtain their comments on the quality and workability of the material. The reports received were disappointing in that the material was stated to lack the lustre normally expected of a fired film of liquid gold. On re-examination of the material stored in the laboratory, it was found that the product had actually deteriorated in this respect during storage. A small quantity of metallic gold had also precipitated at the bottom of each bottle, and microscopic examination under oblique illumination showed that particles of colloidal dimension, which were presumed to be of metallic gold reduced from the resinate originally present, were suspended in the liquid gold.

The causes of these defects are suspected and their investigation is being continued with a view to their removal. When success has been attained, a further batch will be prepared on a semi-commercial scale and samples distributed for trial.

*Electric lamp glasses.*—Investigations to determine the composition, thermal endurance, and optical transmission characteristics of the component glasses of lamps and bulbs of makers of repute have been continued.

It appears that the bulb is generally made of a soda-lime glass whereas the internal parts are normally made of a lead glass, the reasons for the latter apparently being that soda-lime glasses are liable to electrolyse under an electric field, particularly at high temperatures, both of which conditions prevail at the 'pinch'.

The analysis of the bulb samples has been completed and shows that manufacturers adopt a wide variety of compositions; analyses of the lead glass inner components is in progress.

As mentioned in last year's Report, a new method has been developed for determining thermal endurance which is particularly suited for application to electric lamp bulbs. The thermal endurance of the various lamp glasses available was determined, but the wall thickness of the bulb samples was not uniform, and consequently the relationship between thermal endurance and wall thickness could not be found. A batch of bulbs was therefore obtained from Austria, the wall thickness of which was variable, but the variation was within narrow limits. The results obtained on this batch led to the conclusion

that within the limits of the wall thickness of the sample bulbs, the thermal endurance may safely be taken to be proportional to the difference of temperature necessary to cause rupture.

As a result of this work it has been possible to arrange samples of bulbs in order of superiority of thermal endurance, and it has been found that the difference of temperature to cause rupture may vary among different samples from 265° to 360°C. It may, therefore, be stated that bulbs giving thermal endurance less than 265°C may not give satisfactory results in service. Several of the reputable makes of bulbs give figures lying between 310° and 320°C.

The study of the optical transmission of lamp bulbs was taken in hand some time ago, and although a number of transmission spectra have been photographed, it has not been possible to have them measured by microphotometer. University aid is, however, being enlisted for this purpose.

*Electric lamp bayonet-cap insulating plate.*—A sample of glass used for this purpose which had been imported from Belgium was obtained for analysis. It was found to be a soda-lime-lead glass containing appreciable amounts of manganese, alumina, and magnesium, and a report thereon was made to the Bureau (R. B. Glass No. 16).

*Coloured bangle glasses.*—Samples of yellow and red bangles made in Czechoslovakia were analysed at the request of the Bureau. The former was found to be a soda-lime glass containing cadmium-sulphide as the colouring agent, and the latter was a mixed type glass containing considerable proportions of potash and zinc and a small amount of arsenic, the colouring agent being selenium (*vide* Report R. B. Glass No. 18).

## CHAPTER V.

## THE ROAD TEST TRACK.

In 1935, the Consulting Engineer (Roads) to the Government of India proposed that a road test track should be constructed at the Government Test House, Calcutta, and the Industrial Research Council, at its Second Session, approved that the road research work to be carried out by its aid should be supervised by the Bureau, the funds being provided by the Consulting Engineer (Roads).

It was originally proposed that the track should be constructed in the grounds of the Government Test House; it was subsequently found necessary to locate the track outside that establishment, but it has been erected sufficiently close to it to enable adequate control and supervision to be effected. The selection of a site, suitable from the various points of view, proved a matter of considerable difficulty, and it was not till the beginning of 1937 that negotiations were commenced with the Commissioners for the Port of Calcutta with a view to renting a plot of land adjacent to Majerhat Railway Station, which is situated at a distance of about  $1\frac{1}{2}$  miles from the Test House.

*Land forming the track site.*—The total area of the land, which has been leased for five years from the Commissioners for the Port of Calcutta, is about 72 cottahs (1·19 acres). It has been enclosed by a galvanised corrugated steel fencing, 6 feet high  $\times$  1,000 feet long.

*Drainage.*—Uniformity in the bearing capacity of the sub-grade of the test track is of fundamental importance. As a result of observations made on the soil conditions of the land it was decided that such uniformity could not be ensured for all seasons unless an effective system of underground drainage was provided. The system installed consists of two sets of underground sub-soil water drains, one on either side of the test track, a transversal main outlet sewer, a central gully pit situated near the middle of the transversal sewer, and a pump at the outfall end of the sewer for collection of underground water. The water which collects in the sump is pumped out by an electric pump housed close by. Each set of sub-soil drains consists of 4 lengths with their summits near the crowns of the two curved ends of the track and outfalls connecting with the transversal outlet sewer. Each length is made of a 3" radius semi-circular invert of lime concrete finished with polished cement plaster over the invert. The inverts have been provided with  $1\frac{1}{2}$ " thick cast iron cover plates having  $1\frac{1}{8}$ " wide slotted holes to facilitate the percolation of the sub-soil water. The space above the cast iron drain covers up to the ground level has been filled with successive layers of graded brickbats, with a top coat of cinders and a covering of stiff clay. The difference between the depths of the outer and the inner drains is 18 inches.

*Water Supply.*—As the Calcutta Corporation water supply is not available at the site of the test track, a tube well has been sunk to a depth of 185 feet, which supplies sufficient water for the purposes of the track. The tube well has been provided with a hand pump.

*Test Track Construction Details.*—The track consists of two straight sides, each 150 feet long, joined at each end by a semi-circle of 50 feet mean radius, the total length of the track along the middle line being approximately 614 feet. The width of the track is 16 feet, and provision has been made for running one set of electric tractor, trailer and test carts simultaneously on each half width of the track.

The designing of the mono-rail tracks intended for guiding the tractors required for pulling the test carts and of the various items of electrical and mechanical equipment needed for the work was taken in hand in 1936 and completed in 1937. The lease of the Port Commissioners' land was executed in the latter half of 1937, and the constructional work on the land was commenced directly after the monsoon of that year. Owing to the load-bearing capacity of the soil of the land being found to be low during the monsoon, it was considered necessary to pile the ground underneath the 159 reinforced concrete pedestals intended to support the rails of the mono-rail tracks, in addition to installing the drainage system described above to keep the water table underneath the road test track at a safe depth below the formation level. The construction of the test track roadway itself was commenced after the completion of the mono-rail tracks and the underground drainage.

*Electric Supply.*—As facilities are not available in the locality for obtaining a supply of electric current from the Calcutta Electric Supply Corporation direct, it was necessary to arrange with the Calcutta Port Commissioners for the necessary power to be supplied from the transformer house of their silt-pumping station at Majerhat. The power available at that station is 500 volt 50 cycles 3-phase A.C., and a cable connection has been made between the Port Commissioners' transformer house and the power room at the test track. At the latter the A. C. supply is converted by a motor-generator set to a 440 volts D.C. supply which feeds the overhead track circuits. The 440 volts D.C. current is supplied to the electric tractors on the track by means of an overhead trolley wire system. A small transformer has been installed in the power room to provide a 230 volts single-phase A.C. supply for lighting the test track and also for the lights and fans in the office building.

*Buildings.*—A semi-permanent building has been constructed at the eastern end of the site. It comprises an office room with an attached power room, together with a room for the chowkidar and a store room. The position of the power room has been arranged so that the operator stationed at the tractor motor starters which are located close to the window on the front wall of the room, can command a view of the entire track and thus observe the movements of the tractors and test carts.

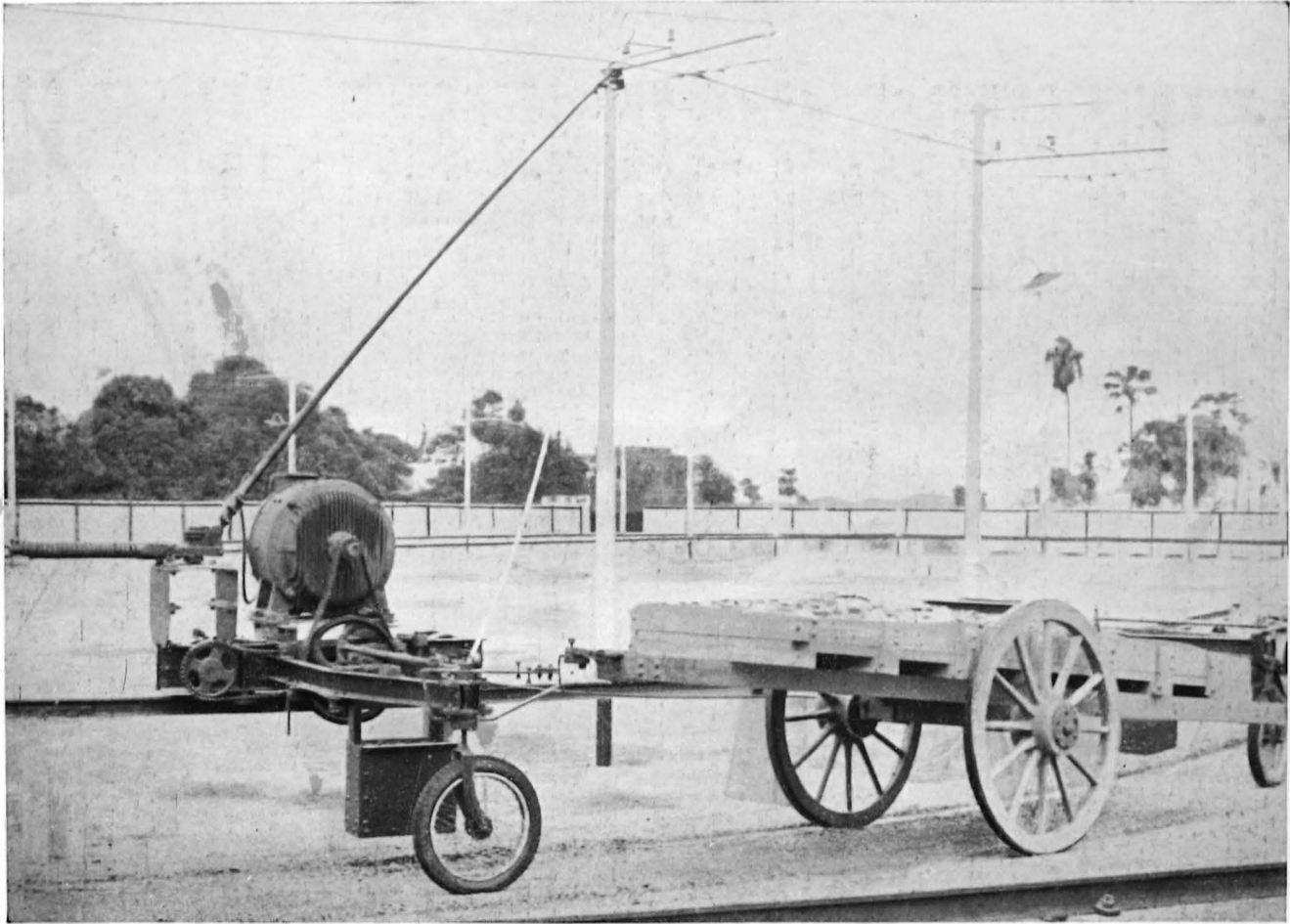
*Mono-Rail Tracks.*—The two mono-rail tracks have been constructed with 50 lbs. flat-footed railway rails, arranged parallel to the two sides of the test track to carry the power tractors along the test track. These rail tracks have been mounted on two series of reinforced concrete pedestals, the position of one of the pedestals on the outer track close to the approach road being taken by a removable built-up steel stanchion so as to enable road rollers and other heavy vehicles to be brought on to the test track from time to time. As already stated, the ground area underneath these 159 concrete pedestals was



**PLATE III.**

**General view of the Road Test Track, showing the tractor monorails and other details.**





**PLATE IV.**

**View showing a power tractor and test cart on the Road Test Track.**

strengthened by three-point piling with salbullah piles. The mounting of the rails has been so arranged as to ensure a uniform level of the rail head at a definite height above the formation level. As the rails are also intended to carry the return current from the tractor motors, the rail joints have been electrically bonded by means of copper rod bonds and suitably earthed to conform to statutory requirements.

A view of the test-track showing the general layout is shown on PLATE III.

*Details of Power Tractors, Trailer Tractors and Test Carts.*—To enable two series of tests to be carried out simultaneously, one assembly consisting of one power tractor, one trailer tractor, and two test carts has been provided for each side of the test track. Each power tractor has been designed to draw a laden test cart of 4,000 lbs. gross weight and at the same time to tow a trailer tractor (of similar design to the power tractor but not provided with a motor) arranged to draw another test cart of the same weight behind the trailer.

Each power tractor consists of a chassis provided with vertical and also horizontal power-driven rollers, by means of which the tractor weight and torque are applied to the rail, and on the chassis is mounted a 10 H. P. motor and the pedestal of the trolley arm which conveys the current from the overhead wire to the motor. A cantilever arm is attached to the chassis and extends partly over the test track, and the outer end of the arm constitutes the towing point for attachment of the towed cart. The end of the cantilever arm is also provided with a steering head with ball-bearing mountings for a fork in which is fixed a pneumatic tyred castor wheel which runs on the track. The balance of the tractor and the towed cart has been so arranged that the load on the pneumatic tyred wheel is approximately 300 lbs.

Each tractor has been provided with rocking gear for the purpose of imposing an oscillating motion on the point of tow and consequently on the test carts during their progress round the track. This has been done with a view to reproducing this not infrequent movement of bullock carts on the road, especially when the roadway has become rutted; the average width of traverse of each wheel due to this oscillation of the cart is 8 inches.

Each test cart has been designed approximately to reproduce normal bullock cart construction and is provided with two wooden wheels which track at 4-6" centres, each wheel being mounted on ball and roller bearings and fitted with a 2 inch wide  $\times$  1/4 inch thick steel tyre, machine-turned after fitting. Connection between the cart and the towing point of the tractor is made by means of a universal ball-and-socket joint.

Provision has been made in the design for drawing the assembly of one trailer tractor and two laden test carts round the track at a speed of 6 miles per hour, but it has also been arranged that the combination can be run at half the above speed by altering the ratio of the sets of chain drive sprocket wheels.

A view of the power-tractor and its towed test cart is shown on PLATE IV.

*Track Surfaces.*—The soling of the track, which was originally specified to be 6 inches thick but which had subsequently to be laid to a greater thickness to ensure thorough consolidation, is composed of broken jhama (overburnt bricks), 2" to 4" gauge, thoroughly consolidated with a 10-ton steam roller. The actual average consolidated thickness of the jhama soling is approximately 14 inches. Upon this soling has been laid an intermediate water-bound macadam coat of Bengal stone (Rajgaon basalt) consisting of a mixture of 75% of 2" gauge stone and 25% of 1-1/2" gauge stone laid hand-packed to a thickness of 4-1/2". This intermediate coat was also consolidated with a 10-ton roller. Over the intermediate coat has been laid, hand-packed to a thickness of 4-1/2 inches, the water-bound macadam top coats of the stone selected for the initial tests.

The following four stones have been used on the four sections of the track for the first series of tests :—

1. Pathankot stone (obtained by breaking boulders which were mainly quartzite).
2. Delhi stone (quartzite).
3. Jhansi stone (granite).
4. Bengal stone (Rajgaon basalt).

The material used in each case was a mixture of 75% of 1 1/2" gauge stone and 25% of 3/4" gauge stone, except in the case of Delhi stone which consisted of a mixture, in equal proportions, of the 1-1/2" and 1/2" sizes.

The consolidation of the top coat was also carried out by means of a 10-ton roller. It was then blinded from above by spreading a mixture of building rubbish and the corresponding chips, and was finally consolidated by rolling with a 10-ton roller with a liberal sprinkling of water. The top coat was allowed to dry for approximately 3 weeks before it was cleaned and dusted preparatory to the laying of the binder coat.

In the binder coat the following four aggregates have been used for the first series of tests, corresponding to the stone laid below :—

1. Pathankot shingle and chips over Pathankot stone.
2. Delhi chips over Delhi stone.
3. Jhansi chips over Jhansi stone.
4. Bengal chips over Bengal stone.

The four aggregates were of 1/2" gauge material, and were spread at the average rate of 5.1 cubic feet per hundred square feet of surface.

The following building materials have been used in conjunction with the aggregates :—

1. Burmah-Shell bitumen, " Mexphalte ", 80—100 penetration.
2. Standard-Vacuum bitumen, " Socony 105 ", 80—100 penetration.
3. Shalimar Tar Products' road tar No. 3.

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The bitumen and tar were applied at the average rate of approximately 48 lbs. per hundred square feet.

In order that the two bitumens and the tar might be represented uniformly along the curves as well as the straight sides, the entire length of the track was divided into 12 single lengths and 6 double lengths. To each of these materials has been allotted 4 single lengths and 2 double lengths, and the disposition of these lengths for the three materials has been such that they have equal shares of the four stones and of the straight sides and curves of the track.

The section contour of the finished track has an average camber of 1 in 60.

*Inspection by the Roads Congress.*—The constructional work was continued practically throughout the whole year under review, and the track was brought into operation at the beginning of 1939. It was visited by the Indian Roads Congress at the meeting held at Calcutta in February 1939, when the track and equipment were inspected successively by the members of the Technical Sub-Committee and the members of the Congress while tests were in progress.

## APPENDIX 'A'.

## REPORT OF THE PRIZES COMMITTEE, 1938.

*Open Subjects Prizes Scheme.*—The conditions of the Open Subjects Prize Papers Scheme for this year were modified by the Director, Industrial Research Bureau, on the lines recommended by the Prizes Committee of 1937 which were endorsed by the Council at its Third Session—*vide* Proceedings of the Third Session, Item VIII of the Agenda, and Appendix "B". The prizes allocated this year were as follows :—

One prize of Rs. 1,000 ;

Two prizes of Rs. 500 each ;

Two prizes of Rs. 250 each ;

Three prizes of Rs. 150 each.

The Prize Paper Scheme detailing the above prizes was duly advertised, and in response 21 papers were received on this occasion. Certain of these papers were reported upon by officers of the Bureau, and eleven of the papers received were submitted to selected expert referees by the Director of the Bureau.

The Prizes Committee met on the morning of the 6th August 1938 for consideration of the reports of the expert referees and agreed as to the relative merits of the papers. It may be mentioned in this connection that two members of the personnel of the Prizes Committee which had been appointed by the Council at its last session were unable to attend. Thus Mr. Dhar, I.C.S., of Bihar recently relinquished his appointment of Director of Industries of Bihar and thereby automatically ceased to be a member of the Council. Dr. Habib Hasan was unable to attend at the last moment owing to indisposition.

The Committee decided to recommend to the Council the following awards :—

Prize.	Nom-de-plume of the Author.	Title of the paper.
Rs. 600	Catalysis ..	Catalytic hydrogenation of Oils.
250	Batu .. ..	Recovery of Titanium Oxide as a by-product in the manufacture of Alumina-Ferric from Bauxite.
250	Kosfi .. ..	Conversion of the Standard Polyphase Squirrel-cage Induction Motor into an internal Compensating Polyphase Squirrel-cage Induction Motor.
150	Dreizehn ..	Control instruments for the Timber Industry, Electric Moisture Meter for Wood.
150	Dehydration ..	Ammonium Alum as Catalyst for the production of Ether.
150	Bronze .. ..	Development of metallic lustre (Bronze) on Glass articles made of Indian plastic clay.

The number of papers submitted this year is again less than in the previous year, and the general technical standard of the papers is considered by the Committee to be again low and disappointing. In certain cases also the anonymity of the author has been destroyed by the disclosure, either in his papers or subsequently in correspondence, of the author's name. Thus in the case of the above paper by the author bearing the nom-de-plume 'Kosfi', a telegram was forwarded to the Bureau by the Principal of his College, giving the name of the author and intimating that he had been granted permission by the Local Government to submit his application. A copy of the Local Government's orders was also subsequently received.

Again, in the case of the paper by the author bearing the nom-de-plume 'Bronze', the author included with his papers a covering letter signed with his name, a certificate from the Director of Industries giving his name, and also Form 'A' completed and signed, instead of enclosing it in a confidential cover bearing his nom-de-plume as instructed in the conditions of the Prize Papers Scheme. The Committee recommends that these failures to maintain anonymity may be condoned, as the disclosures of the authors' names appear to have been due to misunderstandings. Presumably these cases will cease to recur as the conditions of the competition become more widely known. In this connection the Committee are of opinion that there are no other papers worthy of award of prizes.

*Set Subjects Prizes Scheme.*—A list of subjects proposed by the Directors of Industries for the Set Subjects Prize Papers Scheme recommended for introduction by the Industrial Research Council at its last session, was prepared by the Director of the Bureau, and copies circulated to members of the Committee for their consideration. The Committee considered this in the light of Item XI of the agenda to be considered by the Council at this session and are of the opinion that if the proposals made in the memorandum under this item are adopted by the Council, it might necessitate the embodiment of the greater part of this list in the list to be prepared at the instance of the Council for circulation to the Universities and technical institutions likely to be concerned. The Committee therefore recommend that this list should be considered when Item XI of the Agenda is taken up for discussion.

*Personnel of the Prizes Committee.*—It has been assumed that members are appointed by the Council to be members of the Committee in their personal capacity. Acting on this assumption the Director of Industries, Bihar, was not regarded as automatically being a member of the Prizes Committee when Mr. Dhar, I.C.S., who has been appointed a member of the Prizes Committee by the Council at its last session, recently ceased to be the Director of Industries of Bihar and was succeeded by Mr. V. K. B. Pillai, I.C.S. The Committee was therefore reduced in number on this occasion, and was further reduced at the last moment owing to the indisposition of Dr. Habib Hasan. In order to avoid the possibility of the personnel of the members of the Committee becoming so depleted as to become inoperative on any occasion, and assuming that the Council will still prefer that the members of the Committee be appointed by name, it is recommended that the number of members of the Committee be increased to five in future.

## APPENDIX 'B'.

## LIST OF PUBLICATIONS OF THE INDUSTRIAL RESEARCH BUREAU.

- I. R. B. 2·1—No. 1 .. .. Bibliography of Industrial Publications published in India from 1921. (Rs. 4-6-0 or 7s. 3d.).
- I. R. B. 2·2.—No. 2 .. .. A Survey of the Indian Glass Industry by E. Dixon, A.M.I. Mech. E. (As. 14 or 1s. 6d.).
- I. R. B. 2·3.—No. 3 .. .. The Effects of Annealing procedure on the Tensile Properties of Arsenical Copper Bar, by E. F. G. Gilmore, B.Sc., M.I. Mech. E. (As. 8 or 10d.).
- I. R. B. 2·4.—No. 4 .. .. The Manufacture of Photographic Plates in India by N. Kasinathan, M.A., M.Sc. (As. 12 or 1s. 3d.).
- I. R. B. 2·5.—No. 5 .. .. Improved Reflex-Copying by N. Kasinathan, M.A., M.Sc. (As. 4 or 5d.).
- I. R. B. 2·6.—No. 6 .. .. The Preparation of Alumina and Sulphur Dioxide from Bauxite-Gypsum Mixtures by Dr. V. S. Dubey, M.Sc., Ph. D. (London), D.I.C., M.B. Rane, M. Sc., and M. Kanakaratham, M.Sc. (As. 3 or 4d.).
- I. R. B. 2·7.—No. 7 .. .. The Utilization of Nepheline Syenite Rock as a Partial substitute for Soda Ash in the Glass Industry of India by Dr. V. S. Dubey, M.Sc., Ph. D. (London), D.I.C., and P. N. Agrawala, M.Sc. (As. 6 or 8d.).
- I. E. B. 2·8.—No. 8 .. .. Development of Heavy Chemical Industries in India by N. N. Sen Gupta, M.Sc., A. I. C. (Rs. 1-6-0 or 2s 3d.).
- I. R. B. 2·9.—No.9. .. .. Purification of Clay by S. R. Das, M.Sc., and M.A. Saboor, M.Sc. (As. 6 or 8d.).
- I. R. B. 2·10.—No. 10. .. .. Indian Vegetable Oils by N. Brodie, M.Sc., F.C.S., A.I.C. (Rs. 1-14-0 or 3s. 3d.).
- I. R. B. 2·11.—No. 11. .. .. The Manufacture of Sulphitation Sugar from Coloured Canes (Purple Mauritius) by S. Venkata Ramanayya, B.A., M.Sc. (As. 10 or 1s.).
- I. R. B. 2·12.—No. 12. .. .. The Manufacture of Soap in India by A. K. Menon, B.A., F.C.S. (Re. 1 or 1s. 6d.).
- I. R. B. 2·13.—No. 13 .. .. A Study of Indian Mustard and Rape Seeds and Their Oils by D. Y. Athawale, M.Sc., J.A. Hare Duke, and P. N. Mathur, Dip. Tech. (As. 14 or 1s. 3d.).

1. Annual Report for the year 1935-36. (As. 4 or 5d.).

2. Annual Report for the year 1936-37. (As. 14 or 1s. 6d.).

3. Annual Report for the year 1937-38. (Re. 1 or 1s. 6d.).

*N.B.*—Copies of all the above Publications are obtainable from the Manager of Publications, Civil Lines, Delhi, and also from all local depots for the sale of Government of India Publications.

APPENDIX 'C'.

RESULTS OF A SERIES OF RUNS, EACH OF 50 HOURS DURATION, OF AN 8-H. P., LISTER DIESEL ENGINE RUNNING AT 1200 R. P. M. AND ADJUSTED TO GIVE MAXIMUM POWER OUTPUT UNDER THE CONTROLLED CONDITIONS, TO DETERMINE THE BEHAVIOUR OF CERTAIN VEGETABLE OILS WHEN USED AS FUEL OILS.

Name of Oil.	Consumption lbs. per B. H. P. Hour.	Overall Brake Thermal Efficiency %.	Deposits.					Corrosion.
			Piston and cylinder heads.	Combustion Chamber.	Inlet valve.	Exhaust valve.	Injector nozzle.	
High Speed mineral Diesel.	0.629	21	A small amount of soft soot.	A small amount of soft soot.	Thin film of carbon	None	Thin film of carbon	Nil.
Groundnut ..	0.700	21	Small amounts of soft soot and hard carbon.	Small amounts of soft soot and hard carbon.	A very small amount of carbon.	A small amount of carbon.	Thin film of carbon	Nil.
Punnel or Polung ..	0.692	22	Hard carbon	Hard carbon	Thick granulated carbon.	None	Film of carbon	Considerable pitting of cylinder head and exhaust valve seat.
Karanj (Pongamia glabra).	0.674	22.5	Sooty carbon, thick and hard round the periphery.	Fairly thick and hard deposit of carbon.	None on face; thin deposit on shoulder.	Thin film of carbon on face and shoulder.	Thin hard deposit of carbon.	Exhaust valve seat pitted over about $\frac{1}{3}$ the area.
Cotton seed (Gossypium).	0.59	24.9	Sooty carbon; hard around the periphery.	Thin hard film of carbon.	None on face; part of the stem blackened.	Film deposit on face, shoulder and part of stem.	Thin hard film of carbon.	Exhaust valve seat pitted slightly over approximately $\frac{1}{3}$ the area.
High Speed Mineral Diesel (Periodic check test).	0.602	21.8	Soft sooty deposit	Soft sooty deposit	Thin film of carbon	Free from deposit but face and stained black.	Thin film of carbon.	Nil.



## APPENDIX 'D'.

REPORTS SUBMITTED BY THE RESEARCH BRANCH DURING 1938-39.

Report No.	Title.
<i>Dry Cells.</i>	
R. B. Dry Cell No. 1	.. Semi-Automatic Dry Cell Testing Device.
<i>Glass Manufacture.</i>	
R. B. Glass No. 14	.. Analysis of Sands and Felspr for Glass Manufacture (from Baroda).
R. B. Glass No. 15	.. Chemical Examination of Glass used as Containers for Medicines and Drug Tablets.
R. B. Glass No. 16	.. Insulating Glass for Electric Lamp Bayonet Caps.
R. B. Glass No. 17	.. Analysis of Indian Sands, etc., for Glass Manufacture.
R. B. Glass No. 18	.. Analysis of Czechoslovakian Glass Bangles.
<i>Building Materials.</i>	
R. B. Building Materials No. 1.	Indian Substitute for Leighton Buzzard Standard Sand (Interim Report).
R. B. Building Materials No. 2.	Comparative Tests of British and Indian made Cements.
R. B. Building Materials No. 3.	Cement-Surkhi Mortars.
<i>Internal Combustion Engines.</i>	
R. B., I. C. Engines No. 1	Cotton Seed Oil as a Fuel for Diesel Engines.
<i>Miscellaneous.</i>	
R. B. Misc. No. 14	.. Analysis of Silica.
R. B. Misc. No. 15	.. Purification of Clay ( <i>contd.</i> ).
R. B. Misc. No. 16	.. Preliminary Notes on Tests on Hardy Type Boundary Friction Apparatus.
R. B. Misc. No. 17	.. Soluble Carbonate Content in Ashes of Coconut Fibre and Husk.
R. B. Misc. No. 18	.. Typewriter Ribbons.
R. B. Misc. No. 19	.. Testing of Trosen Photographic Paper.
R. B. Misc. No. 20	.. Further Notes on Tests on the Hardy Type Boundary Friction Apparatus.
R. B. Misc. No. 21	.. Bearing Metal Deposits on Journal Surfaces.
R. B. Misc. No. 22	.. Discolouration of Grinding Wheels.

## APPENDIX 'E'.

PAPERS PUBLISHED IN THE PROCEEDINGS OF THE INDIAN SCIENCE CONGRESS, LAHORE, 1939.

No.	Title.	Authors.	Section.	Page No. of proceedings.
1	Use of Vegetable Oils and Fuels for Internal Combustion Engines.	H. D. Chowdhury, S. N. Mukerji, A. N. Kapur and J. S. Aggarwal.	Physics	32
2	Thermal Endurance of Electric Lamp Glass Bulbs.	S. M. Karim, L. C. Verman and S. V. Anantakrishnan.	Physics	32
3	Automatic Cell Testing Device.	G. D. Joglekar and L. C. Verman.	Physics	31
4	Use of Indian Bentonites in Building Materials.	A. D. Banerji, C. A. R. Khan and L. C. Verman.	Physics	31
5	Maximum Efficiency of Tungsten Filament Lamps.	D. R. Bhawalkar	Physics	32
6	Natural Weathering of Paints and some considerations entering the technique of testing their durability.	L. C. Verman, N. Ghatak and H. Trivedi.	Physics	30
7	Accelerated Weathering of Paints and the Development of a Weatherometer suitable for Tropical Climates.	L. C. Verman, H. Trivedi and N. Ghatak.	Physics	31
8	Preparation and Application of Liquid Gold.	Atma Ram, M. A. Saboor and L. C. Verman.	Chemistry	85
9	Setting Properties of Red Lead Paints	N. Ghatak and L. C. Verman.	Chemistry	85
10	Characteristics of Dry Cells made from Indian Pyrolusite Ores.	G. D. Joglekar, K. Subbaramaiah, D. S. Naidu, and L. C. Verman.	Chemistry	86
11	Examination and Classification of Siliceous and Felspathic Materials of Indian Origin for Glass Manufacture.	M. A. Saboor, S. V. Anantakrishnan and L. C. Verman.	Chemistry	87
12	Some Problems in Tinning of articles of Complicated Shapes and Contours.	H. Trivedi, and L. C. Verman.	Chemistry	87
13	Utilization and Properties of Rice Bran and Oil derived from it.	Karimullah, N. Ghatak, J. S. Aggarwal and L. C. Verman.	Chemistry	92

GOVERNMENT OF INDIA  
INDUSTRIAL RESEARCH BUREAU

REPORT  
FOR THE YEAR  
1939-40



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ANNUAL ADMINISTRATION REPORT OF THE INDUSTRIAL  
RESEARCH BUREAU FOR THE YEAR 1939-40.

## INTRODUCTION.

This Report describes the work carried out during the year 1939-40 by the Industrial Research Bureau, which was brought into existence on the 1st April 1935 with a view to assisting in the development of Indian industrial research and Indian industries. The Research organisation comprised (a) the Industrial Research Council, (b) the Industrial Research Bureau, and (c) the Research Branch of the Government Test House, Calcutta.

The relationships of the three parts of this organisation, one to another and their respective functions have been as follows :—

The Industrial Research Council has been an advisory body, consisting of official representatives and non-official scientists and industrial nominees of the Central, Provincial, and leading State Governments, constituted for the purpose of co-ordinating the industrial research and development work of these Governments. This body meets once yearly in various centres for discussion of its agenda, and recommendations are made thereon to authorities concerned.

The Industrial Research Bureau has been responsible for carrying out the work entrusted to it by the Government of India, in pursuance of the recommendations of the Council, and for the administrative work of the organisation.

The Research Branch at the Test House has undertaken industrial research on the problems suggested by the Council, and also investigations on other technical subjects which have been from time to time referred to the Bureau.

The Industrial Research Bureau, together with the Research Branch was established by the Government of India, five years ago, on a temporary basis in the first instance. The nature of the duties performed by this body as well as the directions in which it may be utilised for the assistance of existing and prospective industries, industrialists, and technical departments of Government, so far as its limited composition permitted, have become clearly defined during this period.

The Bureau was placed on a permanent basis with effect from the 1st March 1938, as recorded in the Annual Report for 1937-38, but a state of considerable financial stringency developed in 1938 and owing to the deterioration of the general financial position during 1938 and 1939, Government felt compelled to re-examine that decision. It was decided that the Bureau must remain in being, but this was accompanied by severe curtailment of plans for the expansion of the staff of the Bureau and the Government Test House, and consequently of the range and extent of the work which could be undertaken.

Subsequently, on the outbreak of war, the Bureau was transferred to Calcutta and located at the Government Test House, until such time as decisions could be reached as to the extent to which expansion and modification of the organisation would be necessary to enable it to take an effective part in scientific and industrial research and development, with special reference to war-time requirements.

The decisions finally adopted resulted in the formation of the Board of Scientific and Industrial Research and the office of the Director of Scientific and Industrial Research, and the merging therein of the Industrial Research Bureau and the Research Branch of the Government Test House.

Dr. S. S. Bhatnagar, O.B.E., D.S.C., F.Inst.P., F.I.C. has been appointed as the first Director of Scientific and Industrial Research, and the Board of Scientific and Industrial Research consists of the following members :—

The Honourable Diwan Bahadur Sir A. Ramaswami Mudaliar, B.A., B.L., Member of the Governor General's Executive Council in charge of the Departments of Commerce and Labour.—*Chairman.*

Mr. Ghulam Mohammad, M.A., LL.B., Controller General of Purchase Department of Supply, Government of India.—*Vice-Chairman.*

Dr. S. S. Bhatnagar, O.B.E., D.Sc., F. Inst. P., F.I.C., Director of Scientific and Industrial Research.

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

Dr. Nazir Ahmad, O.B.E., M.Sc., Ph.D., Director, Technological Laboratory, Indian Central Cotton Committee, Matunga, Bombay.

Dr. Meghnad Saha, D.Sc., F.R.S., F.R.A.S.B., Palit Professor of Physics, Calcutta University, 92, Upper Circular Road, Calcutta.

Sir H. P. Mody, K.B.E., M.L.A. (Central) " Bombay House ", Fort, Bombay or New Delhi.

Sir Syed Sultan Ahmad, D.L., Bar-at-law, Patna.

Mr. Kasturbhai Lalbhai, Pankore's Naka, Ahmedabad.

Lala Shri Ram, 22, Curzon Road, New Delhi.

Mr. P. F. S. Warren, B.A. (Cantab.), A.M.I.C.E., M.I.E. (Ind.), Director, Jessop and Company Limited, 93, Clive Street, Calcutta.

Dr. Narendra -Nath Law, M.A., B.L., P.R.S., Ph.D., 96, Amherst Street, Calcutta.

Sir Ardeshir Dalal, Director, Tata Iron and Steel Co., Bombay House, 24, Bruce Street, Fort, Bombay.

*Secretaries.*

Mr. T. S. Pillay, M.A., B.L., (General).

Dr. S. Parthasarathy, D.Sc., F. Inst. P., F.I.C., (Technical).

## CHAPTER I.

## THE INDUSTRIAL RESEARCH COUNCIL.

The Council held its fifth session in the Bengal Legislative Assembly House, Calcutta, on the 7th and 8th August 1939 under the chairmanship of Sir Alan Lloyd, C.S.I., C.I.E., I.C.S., Additional Secretary, Commerce Department, Government of India. The following members of the Council were present :—

*Attended by deputation.*

Mr. Y. N. Sukthankar, I.C.S., Deputy Secretary, Commerce Department  
Government of India.

## MEMBERS.

*Government of India.*

Mr. P. M. Kharegat, C.I.E., I.C.S., Vice-Chairman, Imperial Council of  
Agricultural Research.

Dr. J. Mathai, C.I.E., Director-General, Commercial Intelligence and  
Statistics.

Dr. Gilbert J. Fowler, D.Sc., F.I.C., (Non-official).

*Provincial Governments.*

Mr. L. B. Green, O.B.E., Director of Industries and Commerce, Madras.

Dr. M. Damodaran, M.A., D.Sc. (Lond.), F. I. C., D. I. C., Director,  
University Bio-chemical Laboratory, Madras (University repre-  
sentative, Madras).

Mr. D. C. Gupta, B.Sc., Director of Industries, Bombay.

Mr. D. S. Dabke (Non-official), Bombay.

Mr. S. C. Mitter, B.Sc., A. M. I. E., Director of Industries, Bengal.

Dr. P. N. Ghosh, M.A., Ph.D., D.Sc., F. Inst.P. (University representa-  
tive, Bengal).

Mr. K. C. Mukherkji, M.Sc., A.I.C., Industrial Chemist, U. P. Govern-  
ment.

Dr. A. Nadel, D.Sc., Glass Technologist to U. P. Government.

Rai Bahadur Lala Ram Lal, M.B.E., Director of Industries, Punjab.

Sardar Sahib Sapruran Singh Chawla (Non-official), Punjab.

Rao Bahadur K. S. Rao, L.T.M., A. T. I., Textile Expert to Government,  
Department of Industries, Bihar.

Dr. V. S. Dubey, M.Sc., Ph.D., D.I.C. (Non-official), Bihar.

M. D. V. Rege, I.C.S., Director of Industries, C. P. & Berar.

Mr. S. N. Mozumdar, I.C.S., Director of Development, Orissa.

Sri K. C. Sen (Non-official), Orissa.



*Indian States.*

Dr. C. A. Mehta, M.A., LLB., Ph.D., Director of Commerce, Industries and Labour, Baroda.

Dr. K. G. Naik, D.Sc., F. I. C. (Lond.), D. I. C., C.F.S., Industrial Chemist to the Government of Baroda.

Tajir-ul-mulk Lala Ramji Das Vaishya, Secretary, Commerce Department, Gwalior.

*Secretary.*

Mr. E. F. G. Gilmore, B.Sc. (Hons.), M.I. Mech.E., Offg. Director, Industrial Research Bureau.

*Attended by invitation.*

Dr. Lal C. Verman, M.Sc., Ph.D., F. Inst. P., A.R.I.E., Research Officer, Industrial Research Bureau.

Dr. C. Forrester, Ph.D., F.I.C., F.R.S.E., Principal Indian School of Mines, Dhanbad.

Dr. H. K. Sen, D.Sc., F.I.C., Director, Indian Lac Research Institute, Ranchi.

The Chairman in opening the session, said that the Additional Secretary to Commerce Department, Government of India, had been appointed *ex-officio* Chairman of the Industrial Research Council, and mentioned that the session was the first occasion on which the Council had been presided over by an official chairman since the re-organisation which resulted in the formation of the portfolio of Commerce and Labour.

He trusted that he would be a not unworthy successor to Sir Andrew Clow and Dr. Gilbert Fowler, who had presided over previous sessions of the Council, and that the session would be interesting and successful.

The Council then took up consideration of the following agenda :—

- I. Research on Oils and Soaps.
- II. Research Programme of the Research Branch, Government Test House.
- III. Development of the Glass Industry—
  - (a) Accessories for bangle manufacture.
  - (b) Improvement of glass furnaces.
  - (c) Improvement of glass products and accessories.
  - (d) Survey of glass-making materials.
- IV. Publications of the Bureau.
- V. Allocation of Prizes.
- VI. Industrial Surveys.
- VII. Co-ordination of Universities and Research Institutions in the development and extension of Industrial Research.

### VIII.—Industrial Developments—

- (a) Casein plastics.
- (b) Cellulose and other materials required for an artificial silk industry.
- (c) Synthetic resins of the bakelite type.
- (d) Shellac moulding powders and mouldings.
- (e) The manufacture of sulphur and sulphuric acid from raw materials available in India.
- (f) Utilisation of linseed straw for the production of cottonised flax.
- (g) Low temperature carbonisation of coal.

### IX. Visits to Technical Institutions and Establishments.

The discussion on certain of these items and the conclusions of the Council arising therefrom are briefly summarised and given in this Chapter. Items which have since been under investigation by the Bureau office or the Research Branch have, however, been dealt with in the subsequent chapters which describe the work carried out by these establishments.

**I. RESEARCH ON OILS AND SOAPS.**—The Directors of Industries concerned described to the Council the progress made in their respective laboratories. The Council noted that work was in progress in certain University laboratories on subjects connected with this item which had been included in the list of subjects proposed by Directors of Industries as suitable for industrial research and development and circulated to Universities by the Bureau. It was also noted that the Government of Bengal had deferred consideration of the proposal to establish a Soap Research Institute until the recommendations of their Industrial Survey Committee were available.

The Council recommended that the Industrial Research Bureau should act as a "clearing-house" regarding industrial developments and research, and arrange to circulate information periodically regarding researches and investigations in progress in India, with a view to enabling researchers on the same or allied subjects to exchange information.

**II. RESEARCH PROGRAMME OF THE RESEARCH BRANCH.**—The work on which the Research Branch, Government Test House, had been engaged during the year 1938-39 was described by Dr. L. C. Verman, the Research Officer.

The Council recorded that the Annual Report of the Industrial Research Bureau for the year 1938-39 had been read with interest, and that it had no addition or modification to the programme to suggest so long as its present resources remained unchanged.

The Council again urged that to enable it and the Bureau to work out a more effective programme of industrial research and to further the mission of assistance to industry, the Government of India may be pleased to give effect to the recommendations recorded by the Council at its fourth session.

The work carried out by the Research Branch during the year under review is described in Chapter III of this Report.

III. DEVELOPMENT OF THE GLASS INDUSTRY.—The progress which was being made in regard to improved glass bangle manufacture and the local manufacture of bangle decorating materials such as china glass, liquid gold, and ruby red glass, was noted.

The development of the glass industry of the United Provinces under the guidance of the Glass Technologist to the Government of the United Provinces and especially the production of improved quality electric lamp bulbs, glass-stoppered bottles, tumblers, vacuum flasks, laboratory glass-ware, and glass-melting pots were noted with interest.

The Council was informed of the progress made in the designing and installation of improved glass melting furnaces. It recommended that special attention should be given to bringing about the wider use in factories of furnaces of the Bureau's or other improved designs, and that advantage should also be taken of the improved cottage industry furnace for bangle makers which had been developed by the Department of Industries, Bombay.

The progress of the survey of deposits of glass-making materials was described and it was reported that arrangements had been made for Dr. V. S. Dubey to take up the second stage of his survey scheme, and on this occasion to cover the Central Provinces and Central India, Bombay and the Punjab. The Council recommended that the reports on this work should include data regarding, grading, chemical analysis and also melting characteristics of samples, together with information as to the extent and amount of the deposits sampled, their accessibility, and also the available transport facilities.

The Council also recommended that Directors of Industries should consider the suggestion of Dr. Dubey regarding the formation of a Central Glass Fund, the matter being dealt with in correspondence through the Secretary of the Council.

The work which has been carried out in connection with these subjects is described in greater detail in Chapter IV of this Report.

IV. PUBLICATIONS OF THE BUREAU.—The list of publications of the Bureau in the series entitled "Bulletins of Indian Industrial Research" shown at Appendix 'B' of the Annual Report of the Bureau for 1938-39 was considered by the Council.

As regards the publication to be entitled "Silk production and weaving in India", it appeared that this could best be dealt with by the nomination of a number of joint authors, each a specialist in a different branch of the industry, who might be invited to write a chapter on his special subject for incorporation in the draft bulletin.

At the suggestion of the Director of Industries, Bengal, the Council recommended that the compilation of the proposed Bulletin entitled "Silk production and weaving in India" should be arranged under the general editorship of Mr. C. C. Ghosh, Deputy Director of Sericulture, Bengal, in collaboration with the best selected specialists in the various branches.

The position regarding this part of the work of the Bureau is recorded in Chapter II of this Report.

V. ALLOCATION OF PRIZES.—The series of papers received in connection with the Prize Papers Scheme of the Council consisted of 22 papers, one of which was subsequently withdrawn. They were circulated to members of the Prizes Committee, together with reports by selected experts on certain of them, and the Committee subsequently met at Calcutta on the 5th August 1939 for the preparation of their report\* to the Council.

The Council approved the report of the Committee and the recommendations made therein as regards the allocation of prizes, which were as follows:—

Prize.	Name of author.	Title of paper.
Rs. 500	Mr. S. T. Krishnaswamy Chetty, M.A., Andhra Univeristy, Waltair.	The Tower clock ringing mechanism.
250	Mr. B. J. Hegde, B.A., M.Sc., B.Sc. (Tech.), Benares Hindu University, Benares.	Purification of Indian glass-making sands.
250	Dr. S. S. Joshi, M.Sc., D.Sc. Head of the Department of Chemistry, Benares Hindu University, Benares ; and Mr. L. S. Chandra Kant, B.Sc., Benares Hindu University, Benares.	Contributions to the Chemistry of Permanganate preparation from the Indian standpoint.
150	Dr. H. Parameswaran, M.A., Ph.D., D. Sc., F. Inst. P., Professor of Applied Chemistry, University of Travancore, Trivandrum.	Precision manufacture in India.
150	Dr. B. Dasannacharya, Head of the Department of Physics, Benares Hindu University, and Mr. V. R. Ramanathan, Department of Physics, Benares Hindu University, Benares.	Some critical conditions in silvering on glass.
150	Mr. Arni Chandra Gupta, B.Sc., Harcourt Butler Technological Institute, Cawnpore.	Refining of Nageshwar Oil.

\*The report of the Prizes Committee, 1939, is given at Appendix 'A'

The Council decided that the Prizes Committee for 1940 should consist of the Directors of Industries of Bombay, United Provinces, and Punjab, the Director of Commerce, Industries and Labour, Baroda, and the Director, Industrial Research Bureau.

As regards the selection of a subject for the Set Subject Prize Papers Scheme from among those proposed by the Prizes Committee, it was recommended that this be dealt with and selection arranged by correspondence by the Secretary of the Council. The position at the end of the period under review is recorded in Chapter II.

VI. INDUSTRIAL SURVEYS.—The Council noted the progress which had been made in the survey of the oil-seeds crushing industry, as reported by the Director, Industrial Research Bureau, and amplified by the statements of the various Provincial and State representatives during the discussion.

As regards the proposed survey of the tanning industry it was recommended that the Director, Industrial Research Bureau, be requested (a) to prepare and circulate, after consultation with Directors of Industries and others concerned, a draft questionnaire which might be used to assist in any survey of the tanning industry which had been already undertaken, and (b) to draw up and circulate the outline of a scheme on which the survey of the tanning industry should be conducted, after consultation with the Directors of Industries and others concerned, in order that the scheme may be fully examined before the Provinces and States concerned are invited to take up the work.

The Council further recommended that—

- (a) When an All-India survey is to be undertaken the necessary questionnaires should be drawn up by the Industrial Research Bureau, after consultation with those concerned, and that Directors of Industries should not depart from the questionnaires without prior consultation with the Bureau.
- (b) Any Province or State which wishes to commence the survey of a major industry before the All-India survey thereof has been undertaken or decides to conduct surveys of particular industries before others are ready to do so, should draw up their own questionnaires and forward them to the Bureau for scrutiny and suggestions, especially from the All-India point of view.

VII. CO-ORDINATION OF UNIVERSITIES AND RESEARCH INSTITUTIONS IN THE DEVELOPMENT AND EXTENSION OF INDUSTRIAL RESEARCH.—The Council welcomed the response of the Universities and research institutions to the invitation to co-operate with the work of the Council and the Bureau, and noted with interest the laboratories which had already carried out investigations connected with a number of the subjects in the distributed list.

The Council also noted with appreciation the announcement of a the Chairman that “ the Government of India, as is well known, have recently been passing through a period of severe financial difficulty, and though there are signs of a somewhat more favourable outlook, they are not yet in a position to enter into definite new commitments. They are, however, giving sympathetic

consideration to a plan for placing funds at the disposal of the Director, Industrial Research Bureau, out of which grants can be made to selected institutions for the payment of stipends to workers engaged in research work that falls within the programme arranged ”.

It was agreed that the combined lists of industrial researches completed, in progress, and proposed to be undertaken in Government laboratories and certain of the Universities and research institutions in India, which are compiled and circulated annually by the Bureau, would assume an All-India character of considerable value if similar information from all Universities were included. The Council therefore recommended that the Director, Industrial Research Bureau, should address the Universities and arrange for their co-operation in this matter.

Subsequent developments in connection with this subject are described in Chapter II.

VIII. INDUSTRIAL DEVELOPMENTS.—The Council considered the progress which had been made as regards the production in India of certain materials, and also discussed steps to be taken to encourage their manufacture. The conclusions reached regarding these materials were as follows :—

(1) The Council recommended that before further enquiries were made as regards the utilisation of milk casein for the manufacture of plastics, the Animal Husbandry Commissioner and the Agricultural Marketing Adviser of the Imperial Council of Agricultural Research should be consulted as to whether such an industrial development would affect the available milk supplies of people, either in the natural or the powder form, and whether, owing to inadequate transport facilities in various districts milk is being wasted which might be utilised industrially.

(2) The Council were of the opinion that in spite of the economic attractions of the viscose process of artificial silk manufacture in certain other countries, the large quantities of acetic acid, acetone, and related compounds that are potentially available in India render it desirable to investigate the production of these materials, which would incidentally benefit the sugar industry.

(3) As regards the manufacture of synthetic resins of the bakelite type, the Council recommended that the production of phenol should be specially borne in mind in connection with the subject of coal distillation.

(4) The Council noted with interest the success achieved in the experimental manufacture of household articles of moulded shellac and the prospect that the products could be sold at competitive prices so long as the price of shellac remains low. It recommended that the possibility of manufacturing formaldehyde and urea in India should be examined when the opportunity is favourable.

(5) The Council recommended that the Director, Industrial Research Bureau, in consultation with the Director, Geological Survey, should conduct a detailed investigation of the available sulphur-bearing material deposits in India. It was also recommended that the various Governments in India should, after the enquiry, utilise the information and assist the scheme, particulars of which were available with Dr. Dubey.

(6) The present position regarding the utilisation of linseed straw for the production of cottonised flax was noted.

(7) The Council was of the opinion that the whole question of the more efficient utilisation of coal in India is of such paramount importance to all industries that the Government of India should, at a very early date, critically examine the various proposals that had been advocated in recent years, and if possible, by the aid of funds obtained from the Indian Coal Grading Board, the Indian Soft Coke Cess Committee, and the Sand Stowing Board, when formed, arrange for the early establishment of the nucleus of a Fuel Research Board.

The functions of the Board should include :—

- (a) the immediate compilation of an exhaustive bibliography on all aspects of fuel research with particular reference to India, and
- (b) the co-ordination and systematisation of all work in this connection at present in progress.

VISITS TO TECHNICAL INSTITUTIONS AND ESTABLISHMENTS.—Arrangements were made for members to visit the following institutions and establishments during the session :—

The Government Test House, Alipore.

The Industrial Museum, Department of Industries, Bengal.

The Department of Applied Physics, University College of Science.

The Office of the Director-General, Commercial Intelligence and Statistics.

## CHAPTER II.

## WORK OF THE INDUSTRIAL RESEARCH BUREAU.

The Bureau continued to perform its normal duties during the first five months of the year, but on the outbreak of war the changes which have been briefly described in the Introduction to this Report were carried out. The staff changes resulting from this and other causes are indicated by the following statement, which shows the staff as on 1st September 1939 and also on 31st March 1940.

Rank.	Actual strength on 1st September 1939.	Actual strength on 31st March 1940.
Director .. .. .	1	1
Assistant Director .. .. .	1	..
Technical Assistants .. .. .	2	2
Superintendent .. .. .	1	..
Assistants and clerks .. .. .	11	5
Stenographers .. .. .	1	1
Librarian .. .. .	1	..
Draftsman .. .. .	1	..
Others .. .. .	9	2

Mr. E. F. G. Gilmore, B. Sc. (Hons.), M. I. Mech. E. continued to hold the post of Director during the period under review. Mr. E. Dixon, A. M. I. Mech. E., the Assistant Director, was on medical leave at the opening of the year until the 19th May 1939, and a substitute was not appointed ; he continued as Assistant Director until 10th October 1939, when he was transferred to the Purchase Branch, Indian Stores Department.

**PRIZES COMMITTEE.**—The Open Subjects Prize Papers competition of the Council has been held in abeyance. The question of the early introduction of the Set Subjects Prize Paper competition has been under consideration, in view of the fact that it provides a valuable means of bringing the aid of a large number of scientists and technicians to bear on specific urgent problems connected with the war, industries, and others which may arise.

**ROAD RESEARCH.**—A full description of the lay-out and equipment of the Road Test Track constructed at Majerhat, Calcutta, was given in the Annual Report for 1938-39, in which it was recorded that the track was brought into service in February 1939.

The results obtained during the operation of the track in 1939 and the experience acquired are recorded briefly in Chapter V of this Report.



**PUBLICATIONS AND REPORTS.**—During the year under review the following bulletins by the authors stated have been published in the series of Bulletins of Indian Industrial Research :—

- |  |   |
|--|---|
| No. 14. Indian Refractory Clays  | Mr. H. Crookshank, B.A.,<br>B.A. (I) Geological Survey<br>of India.   |
| No. 15. Recovery of Titanium Oxide as a by-product in the production of Alumina-ferric from Bauxite. | Mr. Sudhir Chandra Chakravarty M. Sc.   |
| No. 16. *The manufacture and application of Liquid Gold.   | Dr. Atma Ram, D. Sc.,<br>Dr. Karimullah, Ph.D., Dr.<br>Phill.<br>Dr. Lal C. Verman, Ph.D.,<br>M.S., F. Inst. P. |

The following papers were under preparation at the end of the year, for publication as bulletins in the same series :—

- |  |   |
|--|---|
| No. 17. *Manufacture of China Glass.   |   |
| No. 18. *Utilisation of Indian Vegetable Oils as lubricants in internal combustion engines—Part I. |   |
| No. 19. *Utilisation of Indian vegetable oils as fuels in internal combustion engines.             |   |
| .. Workshop training in precision methods.   | Mr. P. Bence-Jones, Principal, Maclagan Engineering College.                  |
| The Leather Industry .. ..   | Rai Bahadur B. M. Das, Superintendent, Bengal Tanning Institute.              |
| The Handloom Industry .. ..  | Rao Bahadur K. S. Rao, Textile Expert, Industries Department, Bihar.          |
| *The Manufacture of Dry Cells.<br>Silk production and weaving in India                             | Mr. C. C. Ghosh, Deputy Director of Sericulture, Bengal, (as general editor). |

A list of bulletins published hitherto in the series of Bulletins of Indian Industrial Research is given in Appendix " B " of this Report.

**COMPILATION OF INFORMATION REGARDING RESEARCHES.**—It has been customary for the Bureau to prepare a list of researches and investigations on technical and industrial subjects which have been completed, were in progress, or were to be taken up in India, from information supplied by the Directors of Industries and certain scientific institutions such as the Forest Research Institute, the Indian Lac Research Institute, and the Indian Institute of Science.

\*Papers marked thus were being prepared for publication by the staffs of the Bureau and the Research Branch.

The list was prepared and copies circulated as usual to all members of the Industrial Research Council, to the laboratories and institutions concerned, and also to the Department of Scientific and Industrial Research, London, in accordance with a reciprocal arrangement, during the period under review.

At its Fifth Session, held in August 1939, the Council recorded that these lists would assume an All-India character of considerable value if similar information from all the Universities were included, and it was recommended that the Director, Industrial Research Bureau, should address the Universities in this connection. The Bureau was merged into the organisation of the Director of Scientific and Industrial Research after the close of the year under review, and steps are being taken by the latter to prepare an annual combined list of the form contemplated by the Council.

**INDUSTRIAL SURVEYS.**—The position regarding the industrial surveys of the oil-seeds crushing industry and of the tanning industry by the Provinces and States concerned was reported to the Industrial Research Council for consideration at its Fifth Session. It was pointed out that the survey of the oil-seeds crushing industry could not be regarded as a satisfactory example of co-operation and co-ordination, as the methods and staffs which had been employed differed widely and consequently it was unlikely that the local survey reports, when available, would be sufficiently similar in character to enable them to be amalgamated into an All-India technical report on this industry such as was originally contemplated.

The Council recommended that certain steps should be taken by the Industrial Research Bureau with a view to ensuring that the survey of the tanning industry should be carried out on a common plan, as contemplated by the questionnaires prepared to guide the survey of the oil-seeds crushing industry. These recommendations are recorded in Chapter I in connection with this subject.

Owing to reduction of staff and pressure of other urgent matters since the outbreak of war, it has been necessary to leave the initiative in this connection to the Directors of Industries concerned. Meanwhile no correspondence or draft questionnaires drawn up by a Province or State wishing to commence the survey of a major industry has been received by the Bureau for scrutiny and suggestions.

**COORDINATION OF UNIVERSITIES AND RESEARCH INSTITUTIONS.**—In accordance with the recommendations of the Council after consideration of this subject at its Fourth Session, the Bureau addressed all Universities and research institutions inviting their collaboration and forwarding a list of industrial matters proposed by Directors of Industries and others on which research work was required.

In the memorandum prepared for the consideration of the Council the position was stated to be as follows :—

The replies received showed that the proposals were welcomed generally in all quarters and that a considerable proportion of the heads of the scientific and technical departments of the Universities and research institutions would

willingly co-operate with the Council on the voluntary lines suggested in the covering letter. They also showed that, in the case of a large number of the items on the list distributed, investigations were being or have been already carried out, often at several laboratories.

On the other hand, a considerable body of opinion was also shown to exist which took the view that the Universities and institutions have no surplus funds available to enable them to finance practical industrial research and investigation voluntarily. Their opinion is that financial aid in the form of research scholarships or grants to research workers must be provided in order to effect the required co-operation and co-ordination, otherwise little can be achieved.

It is necessary to appreciate that the number of laboratories in India capable, both as regards staff and equipment, of undertaking research work of an industrial character is not large. A scheme of controlled industrial research work would therefore require to be based at the commencement upon a short list of carefully selected major industries of All-India importance which are either in operation and require scientific aid for their improvement or which are specially suitable for establishment owing to favourable local conditions. The controlled research work and scientific aid would require to be restricted to these listed major industries. Key industries connected with the selected major industries should be included in the list.

It appears that a considerable amount of voluntary research aid is available from University and Institution laboratories, but the following considerations show that such voluntary effort is unlikely to be entirely satisfactory :—

- (1) Only a portion of the listed subjects have been taken up by laboratories, and the voluntary effort has, it can be assumed, been to a great extent exhausted thereby.
- (2) The main centres of research activities are not adequately represented among the offers of collaboration.
- (3) Voluntary work cannot be satisfactorily co-ordinated and controlled. Work might be undertaken in different laboratories on the same subject and overlapping and even duplication could not be prevented, as periodic reports could not be insisted upon.
- (4) The ground-work of the training of a research worker, industrial or otherwise, is advanced instruction and research in "pure" science, and the greater part of the research work conducted in the laboratories of the Universities and teaching institutions in India is, from the industrial stand-point, mainly of this nature.

It would appear unlikely therefore that heads and staffs of departments, whose primary function is teaching and training to the full extent of their available facilities, could be prevailed upon to take up voluntary investigations of industrial problems and industrial research to any greater extent than hitherto. The amount of work of this kind undertaken so far without financial assistance is comparatively small and quite inadequate in its industrial effect.

Considerable attention was again given by the Council to this subject at the Fifth Session ; during the discussion thereon the Chairman announced

that sympathetic consideration was being given by Government to a plan for placing funds at the disposal of the Director, Industrial Research Bureau, out of which grants could be made to selected institutions for the payments of stipends to workers engaged in research work which falls within the programme to be arranged.

This was subsequently superseded by the decision to provide funds to be allocated for similar purposes on the recommendations of the Board of Scientific and Industrial Research, which was formed early in 1940.

#### INDUSTRIAL INTELLIGENCE.

*Requests for information.*—The number of technical enquiries received during the year was 129, as against 186 received in the previous year. The falling off in numbers was more than offset by improvement in technical quality; another noticeable feature was the considerable increase in the number of enquiries received from firms and technical bodies of industrial importance. Typical examples of enquiries dealt with and of the industrial intelligence work connected therewith are described below :—

*Artificial Silk.*—Enquiries regarding manufacture were received from well known firms in Calcutta and Bombay, and one firm's enquiry concerned the possibility of manufacturing " cellophane ". Certain other enquiries were concerned with the question of utilising various available raw materials as cellulose bases. The Chief Controller of Stores, Indian Stores Department, was given information regarding artificial silk pilot plants in connection with an enquiry from the Forest Research Institute, and the Director of Industries, Bombay, was also given similar information.

Close contact was maintained with the Forest Research Institute and the Indian Central Cotton Committee regarding cellulose bases. It is of interest to record that the Committee took steps towards the end of the year to obtain the advice of Messrs. Lockwood, Green, Incorp'd., Consulting Engineers, New York, regarding the chemical cotton pilot plant installation recommended by the Bureau.

*Leclanche' Cells.*—On the outbreak of war urgent enquiries were received from the Supply Department and many of the firms manufacturing dry cells in India as to the availability of Indian sources of raw materials of suitable quality. This information was readily given as a result of the work on this subject which had been carried out by the Research Branch and which was nearing completion.

Information regarding the raw materials and methods used in the production of ' carsac ' elements for wet cells was also given to the Superintendent, Telegraph Workshops.

*Starch.*—Detailed information was given to the Indian Jute Mills Association, Research Department, as to sources of productoin in India of starches and the many other ingredients of the sizing compositions used in the jute mill industry.

*Utilisation of Gypsum in the manufacture of sulphuric acid.*—The Superintendent, Cordite Factory, Aruvankadu, enquired whether the production of

sulphuric acid from gypsum had been established in India. Several firms and individuals also enquired for details of the methods used industrially and the type of plant required.

This subject was discussed by the Industrial Research Council at their Fifth Session held in August 1939 under Item VIII of their agenda, *vide* Chapter I of this Report.

*The manufacture of phenol and formaldehyde.*—The production of phenol in India has been brought nearer by steps taken by the Bararee Coke Co. to utilise their coal by-products for the production of benzene and various classes of disinfectants.

The possibility of formaldehyde being also produced has been advanced by the investigations undertaken in this connection by the Mysore Iron and Steel Works and the Indian Institute of Science.

Close contact has been maintained by the Bureau with these activities. In this connection it is of interest to note that 11 factories are now producing small moulded articles in India, utilising imported bakelite type moulding powders.

*Shellac moulding powders.*—The development of moulding powder compositions containing a considerable percentage of shellac has been continued by the Indian Lac Research Institute, and the Director of the Institute gave a detailed description of the work in progress to the Industrial Research Council at its Fifth Session. Well finished articles can now be produced from shellac-urea-formaldehyde compositions using the same apparatus and procedure as used for the production of bakelite articles, and other shellac compounds for press moulding and also for injection moulding are being developed.

*Silk-worm Gut.*—A copy of the paper referred to in the previous Report in which was described the method of preparation of silk-worm gut, used as surgical ligatures, which had been developed by the Sericulture Branch, Kollegal, of the Industries Department, Madras, was forwarded to the High Commissioner for India, London, for transmission to the Plant and Animal Products Department of the Imperial Institute, South Kensington, at their request.

*Paper manufacture.*—Information was supplied in connection with an enquiry received by Government from a well-known Karachi industrialist as to possible Indian sources of material for the production of mechanical pulp, and suitable localities for a mill to produce news-print paper.

The names of manufacturers of paper-making machinery, including the name of an engineering firm in India which had successfully developed a machine for the preliminary crushing and cutting of bamboo into chips for this industry, were supplied to a company recently floated in Bombay to work bamboo forest leases in the Canara District.

*Manufacture of matches.*—Shortly after the outbreak of war, enquiries were received from a well-known firm of match manufacturers and also from the Marwari Chamber of Commerce, Calcutta, regarding local or alternative sources of supply of chlorate of potash, and amorphous phosphorus, hitherto imported from Germany, Sweden, Japan and France.

*Micaceous iron ore.*—An enquiry was received from the Supply Department regarding the suitability claimed for certain micaceous ore deposits in the Central Provinces as pigments for anti-corrosive and anti-fouling paints for steel-work. Samples were compared with pigments extracted from imported paints prepared with a similar pigment, and a report recommending methods of improving the local material was made.

*The glass industry.*—The work of the Bureau in connection with this industry is recorded in Chapter IV of this Report.

*Miscellaneous enquiries.*—Among other subjects of enquiries received may be mentioned the following:—

<i>Subject.</i>	<i>Source of enquiry.</i>
The hand-loom industry .. ..	The Consul-General for the Netherlands.
Casein .. ..	Bengal Industrial Research Board, U. P. Industrial Research Board, etc.
Lanoline .. ..	The Chief Inspector of Stores and Clothing, Cawnpore.
Malt Vinegar .. ..	The Agricultural Commissioner, I. C. A. R.
Crude Glycerine .. ..	Controller of Stores, N. W. Railway.
Beryllium Nitrate .. ..	Indian Institute of Science.
Soya Beans (industrial utilisation in India).	Messrs. Begg Dunlop & Co.

MEMBERSHIP OF COMMITTEES.—During the year under review officers of the Bureau continued to be members of the following committees and bodies, except where otherwise stated:—

*The Director.*

- Industries Conference, and Imperial Sericulture and Wool Committees.
- Advisory Board, Imperial Council of Agricultural Research.
- Advisory Board, Imperial Institute of Sugar Technology.
- Indian Central Cotton Committee, Technological Research Sub-Committee.
- Indian Lac Cess Committee, Governing Body, also Advisory Board (Chairman).
- Indian Roads Congress, Technical Sub-Committee.
- Paints Sub-Committee, Railway Board.
- Joint Development Board, Chemical Sub-Committee, Industries Department, Punjab.
- Council, Indian Institute of Science.

*The Assistant Director.*

Advisory Committee for the development of the Glass Industry, Industries Department, U. P. (until transfer from the Bureau after the outbreak of war).

**LIBRARY.**—On the transfer of the Bureau to Calcutta the library of the Bureau was amalgamated with that at the Government Test House to form a central general library. Its size and utility have thereby been greatly increased. At the end of the year the combined library contained the following :—

Text-books and works of reference .. ..	3,232
Publications of Government Departments .. ..	2,648
Bound volumes of back numbers of periodicals ..	368
	6,248

The number of scientific and technical periodicals taken by the library at the close of the year was 110.

**FINANCE.**—The expenditure during the year 1939-40 on the Industrial Research Bureau organisation was as follows :—

	Rs.	a.	p.
Industrial Research Bureau .. ..	80,625	9	4
Research Branch .. ..	82,351	13	1
Total ..	1,62,977	6	5

## CHAPTER III.

## WORK OF THE RESEARCH BRANCH, GOVERNMENT TEST HOUSE.

STAFF.—Various changes took place in the composition of the staff during the year under review, mainly as a result of transfers to the General Side of the Government Test House and to the Inspection Branch of the Indian Stores Department for special duties. The nett effect was the temporary loss of the Assistant Research Officer, two Chemical Assistants, two Physical Assistants, one Mistri and two others. A Librarian was appointed during the year.

The statement below shows the sanctioned strength and also the actual strength of the Research Branch on the 31st March, 1940:—

Rank.	Actual strength on 1st Sept. 1939.	Actual strength on 31st March 1940.
1. Research Officer .. ..	1	1
2. Assistant Research Officer .. ..	1	..
3. Chemical Assistants .. ..	8	6
4. Physical Assistants .. ..	7	5
5. Draftsman .. ..	1	1
6. Librarian .. ..	1	1
7. Clerks .. ..	5	5
8. Instrument Maker .. ..	1	1
9. Machinist .. ..	1	1
10. Mistris .. ..	5	4
11. Others .. ..	11	9

PROGRESS OF WORK.—The principal subjects of research and investigations, on which the staff of the Research Branch has been engaged, were the following:—

- (1) Improvement of paints and utilization of indigenous materials for paint manufacture.
- (2) Development of technique for the manufacture of efficient dry cells and utilization of indigenous materials.
- (3) Use of Indian vegetable oils as lubricants and as fuels in internal combustion engines.
- (4) Research on building materials, especially limes and surkhis.
- (5) Investigations to aid the glass industry.
- (6) Investigations and tests to aid the Indian electric lamp industry.
- (7) Road Research.
- (8) Miscellaneous minor investigations arising out of enquiries made by various industries.



Particulars of the reports submitted during the year to the Director, Industrial Research Bureau, and of papers published by members of the staff are shown in Tables I and II respectively of Appendix 'C' of this Report.

In addition to these, a number of papers which were prepared during the year for publication as bulletins or in outside technical and scientific journals have reached different stages towards final publication.

**PAINT INVESTIGATIONS.**—The staff allocated to this work during the year under review consisted of two chemical assistants and one physical assistant.

*Natural Weathering.*—The comparative paint exposure tests described in the previous report, carried out on the 20° inclined south-facing rack, the vertical racks and in the weatherometer, were continued. The results obtained confirm the earlier expectations, but the data collected so far have not enabled any reliable correlation to be established.

*Accelerated Weathering.*—Exposure tests have been continued in the weatherometer under the conditions standardized during the past two years. The rapidity with which results can be obtained with the weatherometer has been fully utilized whenever any necessity for quick comparative testing arose.

Observations on 101 panels, have been recorded representing various series of paints from the original paint programme, and also other paints and finishes received by the Government Test House for routine tests.

An interesting development in the use of the weatherometer has been its application for testing materials other than paints and finishes, which are subject to deterioration during weathering, such as foil-mounted paper and heliographed grained aluminium sheeting used in lithography. Samples of these articles and of enamelled metallic sheets for drawing purposes were received from the Photo-Litho Office of the Survey of India and subjected to the weatherometer cycle of accelerated weathering. The results obtained have proved useful to the Photo-Litho Office in some respects in evaluating the lasting quality of these materials.

The weatherometer has also been utilized by the Eastern Bengal Railway authorities for determining the behaviour of pressed wood panels (Masonite) coated with synthetic enamels.

*Investigation of Paint Formulae.*—Work has been in progress during the year in accordance with the comprehensive programme of testing paint formulae drawn up at the inception of the Bureau. As stated in previous reports, four series of paints, namely, black paints, red oxide paints, white paints, and green paints have been undergoing natural weathering and accelerated weathering tests. The observations recorded on periodic examination of these test-panels confirm in general the tentative conclusions stated in the last report.

*Red Lead Paints.*—Work as outlined in the previous year's report has been in progress on various aspects of these paints, namely settling and setting tendencies, dispersing and suspension, weathering, particle size, chemical composition, etc. The results are being analysed and collated preparatory to the drafting of the report.

*Gypsum as Paint Extender.*—The outdoor weathering tests are still in progress.

*Magnetite.*—The outdoor weathering tests are in progress.

*Titaniferous Bauxite.*—Work on samples of titaniferous bauxite pigments and paints received from a Jubbulpore firm has been practically completed. The results obtained confirm the previous general conclusions and indicate in general that the material has no special feature which would establish that it has advantages over the usual paint pigments. On the contrary it has proved to be inferior to barytes in certain respects, such as oil absorption, development of brownish coloration in contact with linseed oil, and incompatibility with red lead undercoat. Bauxite pigments show improvement, however, on being calcined and treated with hydrochloric acid, but it appears that the extent of the improvement thus effected would not justify the cost of treatment.

*Talc.*—The grades of talc received from Jaipur were investigated in detail to determine their suitability for use as extenders in paints. They were compared with certain imported and indigenous grades of talc, asbestine and barytes in respect of such properties as shape and apparent size of particles, specific gravity, oil absorption, colour, covering power, brushability and nature of paint film. Jaipur talc was found to be similar to other materials of the same type, and it was concluded that it could be used as a paint extender, provided that it was ground sufficiently fine for the purpose. A report embodying the results of these investigations has been forwarded, *vide* Report R. B. Paint No. 5 (Appendix 'C').

*Umber.*—A report (R. B. Paint No. 4) has been issued which records the results of investigations on samples of umber from Jodhpur. The material was not of good quality, but treatment may effect improvement, and further work is proposed.

*Heald Varnish.*—The samples supplied by local firms have not proved satisfactory in service, and further investigations are required.

*Fungus Growth on Paints.*—A number of paint panels prepared with paints containing a series of toxic materials have been under exposure test. It is proposed to prepare and expose another set of similar panels with a view to investigating the anti-fungus action of certain new toxic materials, and also to determine the optimum concentrations required.

*Physical Properties of Paint Films.*—The progress of work in this connection has been as follows:—

- (i) A machine for making controlled and uniform thickness films of paints and varnishes has been built, and this has proved to be useful also in connection with electrical breakdown tests on insulating varnishes.
- (ii) Film thickness equipment is being developed which embodies a precision micrometer screw and an electrical device for indicating contact between the micrometer spindle and paint film, eliminating the necessity of applying a mechanical pressure

which may distort the film. The device promises an accuracy of one micron.

(iii) The manufacture of an accurate automatic drying time determination machine for paints and varnishes is in progress.

**DRY CELLS.**—The superior technical staff engaged on this work consisted of one physical assistant and one chemical assistant throughout the year. A second physical assistant was attached to this section for the last four months of the year.

*Manufacture of Cells.*—The study of the effects of the different variables affecting the properties of cells has been continued. The variables whose effects have been studied during the year under review are as follows :—

- (i) Recently received samples of manganese ores.
- (ii) Artificial manganese dioxide prepared in this laboratory and similar material prepared in the laboratories of the Indian Institute of Science, Bangalore.
- (iii) Treated manganese ores.
- (iv) Different grades of starch.
- (v) Admixture of  $\text{Fe}_2\text{O}_3$  to the depolarizer mixtures.

Except in the case of starches, which are also being studied as regards their effect on shelf life, the above variables have been investigated only in regard to initial characteristics. The results obtained may briefly be summarized as follows :—

Attempts at producing artificial manganese dioxide in these laboratories and at the Indian Institute of Science have not yielded a product comparable with good quality materials. The measure of success obtained may be indicated by the fact that 10 % of certain of the foreign products when added to the ores gives as effective results as 25 % of the laboratory products. Further experiments are in progress, and it is proposed to include in the laboratory trials methods involving electrolysis for the production of artificial manganese dioxide.

A considerable amount of work has been carried out with a view to devising an economical method of treating ores to improve their performance, but no significant progress can be claimed. A certain measure of success may, however, be claimed for a treatment involving the roasting of the ores with potassium or sodium hydroxide at a high temperature in the presence of air. Further work on these lines is in progress.

Substitution of starch for *maida* has been found to improve the output characteristics of the cells, but the use of pre-gelatinized starch shows no advantage over ordinary starch, except that it eliminates the necessity of cooking the cells. Whether this starch can be used successfully depends on to a large extent on economic considerations.

A few preliminary experiments showed that  $\text{Fe}_2\text{O}_3$  added to the depolarizer mixture in any form would not be beneficial, although the  $\text{Fe}_2\text{O}_3$  content of certain ores appears to have a beneficial effect. In order to elucidate the mechanism involved, a great deal more work is required.

*Shelf Life Tests.*—The work on this aspect of the subject was intensified during the year and received the greater part of the attention of the staff. In addition to the eight batches subjected to life tests last year, an additional twenty-three batches were prepared. Tests on all these batches at intervals of ten weeks up to 70 weeks, including one at intervals of 5 weeks, have been in progress.

With a view to collecting information regarding the quality of cells made by Indian manufactures, and hence indicating the progress of the industry in this country, five batches of such cells were also given shelf life tests. The majority of these firms made cells from materials imported from German firms specialising in this line. Such tests should, therefore, also furnish a useful comparison with laboratory-made cells using Indian pyrolusites and other indigenous materials.

A few of the batches on shelf life tests have completed their tests, while most of them are still undergoing the test. The majority of these batches have finished 30 weeks' life tests and the results indicate that British Standard Specifications can now be satisfied by cells made with Indian ores, using the technique developed in this laboratory.

*Correlation of Chemical Constitution and Electrical Performance of Ores.*—The systematic analysis of the data collected on 17 Indian ores and 6 foreign ores has been completed. The results indicate that the iron content of ores has to a certain extent a beneficial effect on the efficiency of the ores in the dry cells, and that in this respect of at least two classes of ores can be recognized, in one of which the iron content is much more effective than in the other. A brief note has been published in "Current Science" on this subject. (Current Science, 9, 64-65, 1940).

With the co-operation of Dr. P. K. Ghosh of the Geological Survey of India, petrological examination of these two ores was undertaken with a view to accelerating whether the two classes of ores could be distinguished petrologically. Though this object has not been achieved by the results obtained by Dr. Ghosh, it has been brought to light that, generally speaking, ores containing a large proportion of the mineral type known as psilomelane appear to be more effective.

In order to elucidate the mechanism of the effect of iron, X-ray analyses has been planned in co-operation with Dr. K. S. Krishnan, F. R. S., of the Indian Association for Cultivation of Science, Calcutta.

*Large Scale Manufacture.*—In continuation of the progress reported last year, an estimate of cost of plant and of manufacturing operations on a semi-commercial scale was prepared. It appeared that the large investment required would only be justified if it were decided to operate the plant continuously as a demonstration factory. Plans in this direction have not matured, due mainly to financial considerations.

The laboratory technique developed for the manufacture of efficient cells is capable of being applied to large scale operations quite simply, for a number of the operations involved are performed on machines which may conveniently

be used in the factory, such as the grinding of ores in ball mills, zinc can making, the pressing of the dolly, and the cooking of cells.

*Supply of Raw Materials and War.*—Since the beginning of the war, almost all the dry cell manufacturers in the country have been experiencing difficulty in obtaining standardized raw materials, which used to be imported by them almost exclusively from Germany. As a result, a number of enquiries have been received direct and through the Supply Department regarding alternative sources of supply for zinc sheeting, carbon rods, manganese ores, artificial manganese dioxide and chemicals.

Several Indian sources of satisfactory manganese ores have been suggested and also, in some cases, those of certain chemicals. Particulars of American sources of zinc sheeting and carbon rods have been obtained and detailed information has been supplied to Indian manufacturers in this respect also. Sources of artificial manganese dioxide seem to be more difficult to find.

As a result of these enquiries, it has appeared that artificial manganese dioxide and carbon rod manufacture should be developed in India. Some preliminary work has already been done, as already mentioned, with a view to the preparation of satisfactory manganese dioxide, and it is hoped to take up work in connection with the production of carbon rods in the near future.

*New Equipment.*—The following items have been added to the laboratory equipment :—

- (i) *Dry Cell Dolly Press.*—Imported, rated capacity 500 cells per hour.
- (ii) *Automatic Cooking Machine.*—Designed and constructed in the laboratory, capacity 250 cells per hour. PLATE I.
- (iii) *Depolarizer Mixer.*—Designed and constructed in the laboratory, capacity 3,000 cells per 8-hour day.

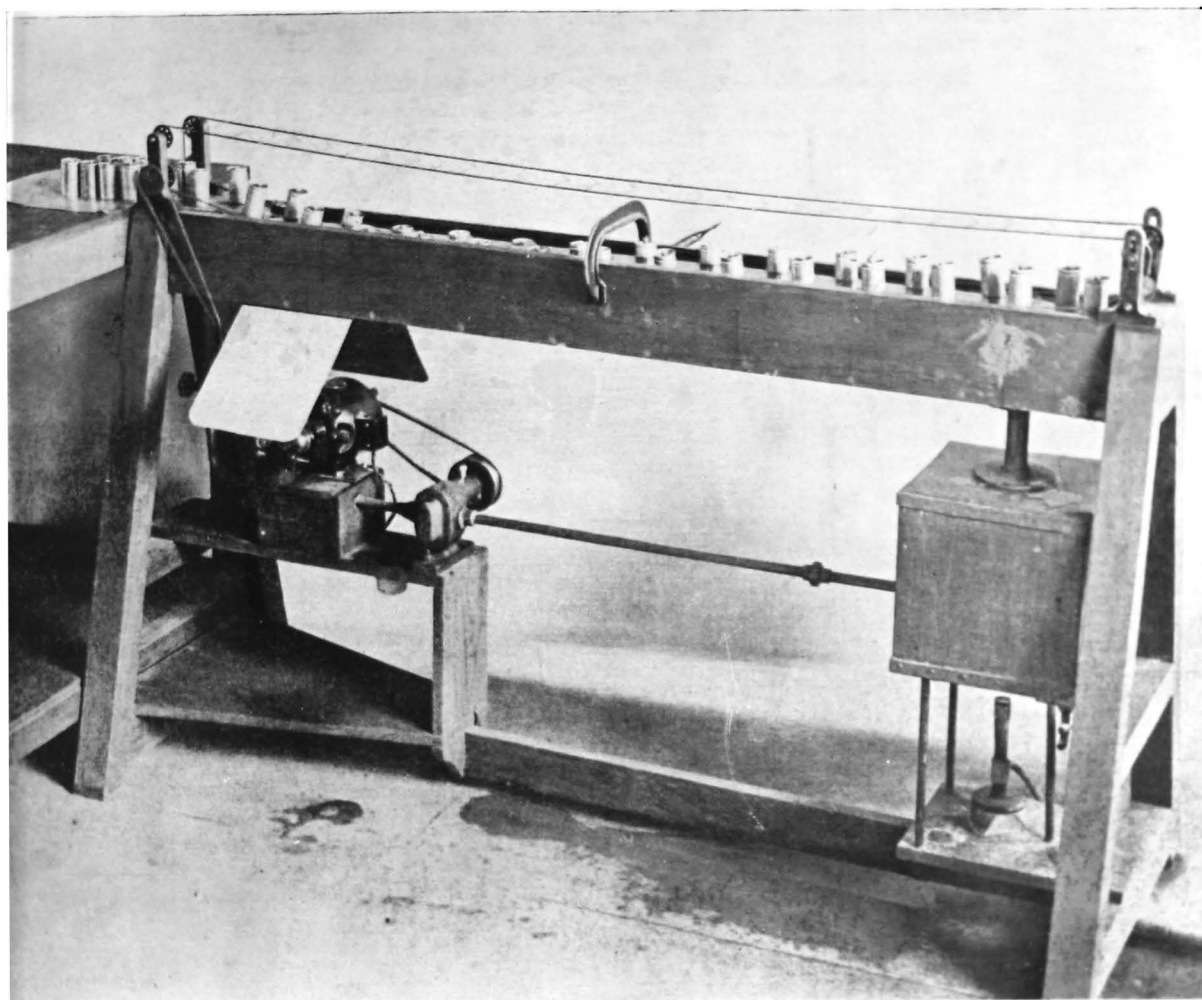
**INTERNAL COMBUSTION ENGINES.**—The superior staff engaged on these investigations consisted of two physical assistants and one chemical assistant.

During the year under review, the internal combustion engine laboratory plant was shifted from its original location in the Workshop to a room on the ground floor of the new north wing building.

*Vegetable Oils as Lubricants.*—The programme of research work under this head was continued in accordance with the plan outlined in previous Annual Reports. The progress made during the year is described below :—

*Stabilizers.*—The modified Air Ministry Oxidation tests on various oils and blends in the presence of stabilizers and steel balls, as described in the last Report, were continued.

From the results of the runs on vegetable oil blends Nos. (3) and (4) in the 1·5 K. W. Lister Petrol House Lighting Set (*vide* the Annual Report for 1938-39, page 24), it was found that the presence of  $\alpha$ -naphthol caused relatively marked wear of the engine parts. It was, therefore, considered desirable to find the effect of adding some film-forming substance, such as colloidal graphite or soaps of the aluminium stearate and iron oleate type, upon the oxidation of



**PLATE I.**

**Automatic Cooking Machine for Dry Cells.**

Hot water is circulated from the heater by the pump to the trough, from which it flows over a weir and is returned to the heater. The cells after assembly are fed at the right hand end and are carried by the chain conveyor against the current of the water. They are gradually dipped in hot water and then delivered at the other end after 12 minutes of cooking, during which the electrolyte gelatinizes leaving no air bubbles occluded in it. Capacity 250 cells per hour.

the oil. A number of modified Air Ministry oxidation tests were therefore carried out, which showed that a mixture of oil-dag (colloidal graphite) and  $\alpha$ -naphthol would be satisfactory as a protective agent for reducing wear.

Several other stabilizers were also tried for castor oil in the oxidation tests. Those listed in the table below were found to be promising, in addition to those mentioned in the previous Report (*vide* Annual Report for 1938-39, Page 23, Table III).

*Most effective stabilizers for castor oil in the presence of iron.*

Stabilizers.	Proportion % in the oil.	Ratio of vis- cosity increase.
N-phenyl naphthylamine .. .. .	1.0	2.8
Assy. diphenyl hydrazine .. . . .	1.0	2.8
p-toluidine .. .. .	1.0	2.7
Phloroglucinol .. .. .	1.0	2.3

Further, in connection with groundnut oil it was found that 1% p-toluidine may also be considered as an effective stabilizer in addition to those already reported; the ratio of viscosity increase in this case was 5.7.

Attention was also directed during the year towards finding suitable stabilizers for rape-seed oil. A few of the most effective stabilizers out of 49 tested are listed below.

*Most effective stabilizers for rape-seed oil in the presence of iron.*

Stabilizers.	Proportion % on oil.	Ratio of vis- cosity increase.
None .. .. .	..	7.5
Phloriglucinol .. .. .	1	3.5
Resorcinol .. .. .	1	3.6
Hydroquinone .. .. .	1	3.6
$\alpha$ -naphthol .. .. .	1	3.6
Nitro- $\alpha$ -naphthol .. .. .	1	3.6
Orcinol .. .. .	1	3.9
$\alpha$ -naphthylamine .. .. .	1	3.6
N-phenyl $\alpha$ -naphthylamine .. .. .	1	3.5
Diphenylamine .. .. .	1	3.1
Assy. diphenyl hydrazine .. .. .	1	2.8

*Blends.*—In preparing the blends described in earlier Reports, factory-refined oils of fairly low acid values were used. It was, however, thought that

a further reduction of acid value might improve engine performance, and consequently the alkali-refining method was used to reduce the acid value to a minimum. Engine trials on blends of oils refined in this way showed definite improvement, but it was suspected that residual alkali soap was liable to cause ring-sticking. Further improvements in the refining method were therefore introduced to reduce the soap content also to a minimum.

In view of the encouraging results obtained with blends containing refined oils in the engine tests, it has been decided that henceforth alkali-refined oils having the least possible acid values and soap content would be used for preparing the lubricant blends.

The following blends were accordingly prepared for engine tests :—

<i>Blend No.</i>	<i>Composition.</i>		
(5)	Castor oil .. ..	..	60 parts by volumes.
	Groundnut oil .. ..	..	40 " " "
	Alpha-naphthol .. ..	..	1 % by weight on oil mixture.
	Acid value .. ..	..	0.86.
	Soap content .. ..	..	0.1117 %
(6)	Castor oil .. ..	..	60 parts by volume.
	Groundnut oil .. ..	..	40 " " "
	Alpha-naphthol .. ..	..	1 % by weight on oil mixture.
	Acid value .. ..	..	0.88.
	Soap content .. ..	..	0.0195 %
(7)	Castor oil .. ..	..	60 % parts by volume.
	Groundnut oil .. ..	..	40 " " "
	Alpha-naphthylamine .. ..	..	1% by weight on oil mixture.
(8)	Castor oil .. ..	..	60 parts by volume.
	Groundnut oil .. ..	..	40 " " "
	Alpha-naphthylamine .. ..	..	1% by weight on oil mixture.
	Chromium oleate .. ..	..	0.1% " " "
(9)	Castor oil .. ..	..	50 parts by volume.
	Rape seed oil .. ..	..	50 " " "
	Alpha-naphthylamine .. ..	..	1% by weight on oil mixture.



The detailed results of modified Air Ministry oxidation tests on the five blends described above are summarized in the Table below :—

*Results of Oxidation Tests on Vegetable Oil Blends, which were subsequently subjected to engine tests.*

Blend No.	Viscosity increased ratio.	Acid value.		Conradson Carbon Residue.	
		Original.	Oxidised.	Original.	Oxidised.
(5)	3·8	0·86	2·6	0·27	1·58
(6)	3·9	0·88	3·5	0·22	1·47
(7)	4·4	1·0	3·1	0·18	1·56
(8)	4·0	1·1	3·4	0·21	1·21
(9)	4·6	1·2	4·4	0·20	0·96

*Trials in Small Lister Petrol Engine.*—Blends Nos. 5, 6, 7 and 8 were each subjected to a run of 100 hours' duration in the 1·5 K. W. Lister House-Lighting Petrol Set under the controlled conditions already described in the earlier Reports. A periodic test run was also carried out using the control mineral oil, in order to take into account the changing condition of the engine. The results of the tests are summarised below :—

(1) Comparison between blends (4) and (5) showed that the reduction of acid value definitely resulted in improvement of the engine performance of the blend in all respects; and comparison between blends (5) and (6) confirmed the desirability of reducing the soap content.

(2) Blend No. (5) behaved satisfactorily except for the sticking of the top piston ring, which might be ascribed to the presence of alkali soap. The total iron removed from the engine after 100 hours' run was much less than that obtained in the case of blends Nos. 3 and 4. The amount of sludge was less than that in the case of the control mineral oil. The colour of the blend remained clear even at the end of the 100 hours' run.

(3) Blend No. (6) gave practically as good results as blend No. (5) and there was no ring-sticking, the amounts of sludge and deposits on the various engine parts were, however, somewhat greater. The total amount of iron removed from the engine was somewhat less than in the case of blend No. (5).

(4) Blend No. (7) gave the best performance of all the blends so far tested. The total quantity of iron removed from the engine was only slightly greater than that in the case of the control machine oil, while in all other respects the blend behaved as well as the mineral oil.

(5) Blend No. (8) behaved in a similar fashion to blend No. (7) except that the carbon deposits were slightly less. The amount of iron removed from the engine was, however, greater. Thus the expectation of less carbon deposit in the presence of chromium oleate has been fulfilled, but that as regards wear has not materialised.

*Trials in 16 H. P. Morris Industrial Engine.*—A standardisation run of 100 hours' duration was carried out using the control mineral oil under new load and speed conditions, namely, three-quarters full-load at 1,200 R. P. M. Vegetable oil blends Nos. (7) and (9) were then tried in this engine under similar controlled conditions. The results of the engine tests were as summarised below :—

(1) Blend No. (7) gave practically as good performance as the control mineral oil in all respects, except that the deposits on various engine parts were slightly greater.

(2) Blend No. (9) gave a superior performance to blend No. (7), especially as regards sludge formation and the total amount of iron removed from the engine. The deposits on various engine parts in the case were, however, more than those in the case of blend No. (7).

It was observed in the case of the above two runs on vegetable oil blends that an appreciable amount of resinous deposits formed on the shoulder of each of the four inlet valves of the engine. The cause of this has since been traced to an inherent feature of the mechanical design of the engine, which causes excessive spray of oil in the valve chamber whence it passes into the valve spaces. The excess oil in the exhaust valve space burns off and leaves no trace, due to high temperature of exhaust gases, while that entering the inlet valve spaces becomes polymerised into a resinous substance which is deposited.

*Vegetable Oils as Diesel Fuels.*—In continuation of the previously reported trials of different vegetable oils in an 8 H. P. Lister Diesel Engine running at 1,200 R. P. M., under controlled conditions, a prolonged run of 50 hours' duration was carried out on rape seed (mustard) oil. The results obtained are summarised below :—

*Results of prolonged run on Rape Seed (Mustard) Oil in the Lister Diesel Engine.*

Average output B. H. P.	Consumption in lbs. per hr.	Over-all Brake Thermal efficiency. %	Deposits.					Corrosion.
			Piston and cyl. head.	Combustion chamber.	Inlet valve.	Exhaust valve.	Injector nozzle.	
7.5	0.638	22.4	Soft sooty.	Thin sooty.	Thin sooty.	Thin sooty.	Thin carbon.	Nil.

Pending the purchase of a high-speed engine indicator, arrangements have been made to carry out cetene ratings of Diesel fuels by the "Throttling Test—Method 2, specified in the Tentative Method of Determining Ignition Quality of Diesel Fuels", marked I. P. T. Serial Designation F. O. 39 (T). The necessary apparatus for this purpose has been designed and constructed, and investigations will be started when opportunity offers.

*Anti-Knock Ratings of Petrols and Aviation Fuels.*—Routine tests for Octane Number determinations of aviation and motor spirits continued to

form a part of the duties of the research staff engaged on internal combustion engine work. The total number of samples dealt with amounted to 282 during the year.

*New Equipment.*—For accurate viscosity determinations, an automatic thermostat has been designed and constructed, with a range from 0° to 55°C and an accuracy of  $\pm 0.01^\circ\text{C}$ . This apparatus is shewn on PLATE II.

**BUILDING MATERIALS.**—The superior staff engaged on this work consisted of one physical assistant for the first nine months of the year, after which the work was brought to a close owing to the staff reductions referred to previously.

*Surkhi as a Pozzolana.*—A detailed report on the subject of “*Burnt Clay or Surkhi as Pozzolana*” has been drafted in a form suitable for publication and includes the description and analysis of the large volume of physical and chemical data so far collected relating to surkhis prepared from bricks obtained from various brickfields. The conclusions arrived at may briefly be summarized as follows :—

- (1) Soluble salts and iron and alumina contents of surkhis decrease with increasing degree of burning, due presumably to the formation by interaction with alkali salts and subsequent volatilization of iron and aluminium chlorides, etc.
- (2) Clays having smaller proportions of water of hydration yield surkhi mortars having higher strengths.
- (3) The strengths of surkhi mortars decrease as the alkali contents of clays and water soluble salt contents of surkhis increase, due presumably to the production of “*Lockerstellen*” during the maturing period by dissolution of soluble salts.
- (4) Certain conclusions regarding correlation between chemical constitution of clays and physical strength of surkhi mortars appear to be much more applicable to underburnt surkhis than to well and overburnt surkhis.
- (5) The strengths of surkhi mortars increase approximately in proportion to the log log of the time of maturing during the early periods, and tend to approach steady asymptotic values after about six months.
- (6) The strengths of overburnt surkhis on the average is about 25% higher, while that of underburnt about 14% lower than those of well burnt surkhis after six months of maturing.
- (7) As regards particle size distribution, the strengths of surkhi mortars depend, within limits, on two factors :—
  - (a) The greater the available surface area, that is the finer the surkhi, the greater the strength.
  - (b) The denser the packing the greater the strength. In the case of overburnt bricks, the correct grading would probably lie between 50 and 200 mesh.

- (8) High magnesium lime gives stronger mortars than high calcium lime.
- (9) Dry consistency mortars give much higher strengths than wet consistency mortars.
- (10) Soaking of mortars for long periods of time prior to gauging weakens them.

*Cement-Surkhi Mortars.*—A paper bearing the title “Cement-Surkhi Mortars” and comprising the data recorded in Report No. R. B. Building Materials No. 3 has been accepted by “*Indian and Eastern Engineer*” for publication.

*Slaking Procedure and Properties of Lime.*—The data collected during investigations on this subject has been partially analysed but the work had to be suspended before completion. From the results so far obtained, it appears doubtful whether any useful conclusions could be drawn, owing to the fact that the atmospheric temperature prevailing at the time of maturing lime-surkhi briquettes has been found to have a profound influence on the strength of the mortars. Since the various lime samples had been treated after different periods of storage, the strength of mortars varied with the season during which the mortar briquettes were gauged and matured.

*Substitute for Leighton Buzzard Standard Sand.*—Since the submission of Report R. B. Building Materials No. 1 on this subject, no extensive laboratory work has been carried out. It was found that certain glass and enamel factories in Madras are making use of the Madras sea coast sand which had been found promising, and arrangements have been made to obtain further samples of this sand. A copy of the above-mentioned Report and small samples of Mangalhat sand were sent to the following organizations for comments :—

- (1) British Standards Institution, through the Institute of Engineers (India).
- (2) Associated Cement Co., Ltd., Bombay.
- (3) Messrs. Martin & Co., Ltd., Calcutta.

As a result of this contact with the British Standards Institution, the Building Research Station has taken up the study of Mangalhat sand in detail, a large consignment of this sand having been forwarded for this purpose.

*Molasses in Lime Mortars.*—As a result of the preliminary investigations mentioned in last year's Report, a comprehensive programme was devised with a view to studying the effect of molasses when added in limited proportions to lime concretes, with special reference to the effect of the water content of the concrete mixes. The laboratory work was, however, suspended after the outbreak of war along with certain other items of work.

*Bentonite.*—The various investigations on the effects of Jodhpur and Wyoming bentonites when added to cement concretes have been concluded and a report is under preparation. Certain additional samples of bentonites from Jodhpur and Kashmir States have been received, but under present conditions it will not be possible to undertake work on them.

*Vibration Compacting of Test Cubes.*—In the draft revised British Standards Specification for cements a vibration compacting machine has been introduced for gauging cement mortar cubes for comparison tests. A machine has been built and installed in accordance with the design drawings forwarded by the British Standards Institution. It has not been found possible to eliminate air holes entirely from test cubes by the use of this machine and correspondence is in progress in this connection with the British Standards Institution.

GLASS.—The work carried out by the Research Branch during the year in connection with the development of glass industry is described in Chapter IV of this Report.

ELECTRIC LAMPS, MANUFACTURED IN INDIA.—Assistance continues to be rendered to the electric lamp factories operating in India by means of periodic tests on batches of their lamps and also the giving of advice. One physical assistant of the Research Branch has been, as before, assigned to the lamp testing section of the Government Test House for this purpose. During the year 262 lamps were tested in this connection.

*Shellac Cement for Bayonet Caps.*—Work on various cement formulæ based on shellac with a view to determining the effect of storage and heating in service on cement strengths has been continued during the year. As a result, two cement formulæ have been found which give satisfactory results up to the end of a storage period of nine months. The experiments are being continued. Certain firms have been supplied with information regarding the technique of manufacture of these cements.

#### MISCELLANEOUS.

*Clays for Pencil Manufacture.*—As mentioned in the last Report, samples of three clays of Indian origin were sent to two pencil factories, with a view to eliciting their opinion regarding the suitability of these clays for pencil manufacture. One of the factories reported that none of the clays was satisfactory, while the other factory found the black clay from the Punjab quite satisfactory. In view of the present difficulty in obtaining foreign clays, this factory and others have been put in touch with the suppliers of this clay.

*Durability of Lead-Acid Storage Batteries.*—Comparative durability tests on five makes of motor-car lead-acid batteries manufactured in India and on two batteries of well-known foreign makes were continued. The tests are nearing completion and a report incorporating the results will be prepared in due course. Meanwhile the firms concerned have been informed regarding the performances of their units and advised regarding necessary improvements.

*Decoloration of China Clay.*—The opinion of the Director of Industries, C. P., regarding the whiteness of the decolorized material produced in the laboratory and the cost of decolorizing which would be considered economical, were obtained. The cost of the processes developed in the laboratory have been worked out and information on this aspect given.

*Pyritiferous Schist.*—Samples of schist quarried from the Simla hills were subjected to chemical analysis and were found to be free from objectionable impurities such as arsenic, and to have a sulphur content of 40.6%. Report R. B. Misc. No. 23 deals with the details of this work.

## CHAPTER IV.

## WORK IN CONNECTION WITH THE GLASS INDUSTRY.

**IMPROVEMENT OF GLASS FURNACES AND ACCESSORIES.**—The improved glass melting furnace designed by the Bureau and installed at the Star Glass Works, Ferozabad, was brought back into service after reconstruction of the pot chamber, which on this occasion was lined and floored with sillimanite. This had been necessary owing to the inability of the best ordinary fire-bricks to withstand the higher temperatures and more severe operating conditions of this furnace. The reduction of the staff of the Bureau connected with this work and the removal to Calcutta has resulted, however, in loss of the necessary close contact of the Bureau with the furnace and its operation.

Information continues to be given to those concerned with the design and installation of improved glass-melting furnaces, as and when required, and collaboration has been maintained with the activities of the Glass Technologist to the Government of the United Provinces in this connection.

In accordance with the recommendations of the Industrial Research Council regarding supply of drawings of the improved furnace, sets of the drawings, together with instructions to guide erection and operation, have been supplied to all Directors of Industries and also to the following firms :—

- Messrs. Reliance Firebrick & Pottery Co., Ltd.
- „ Imperial Chemical Industries (India), Ltd.
- „ Bengal Electric Lamp Works, Ltd.
- „ Govan Bros., Ltd.
- „ Bharat Glass Works.

The Director of Industries, Bengal, forwarded an enquiry from a local firm regarding the difficulty they were experiencing in connection with a tank furnace of their own design and make, which was yielding streaky and milky glass. The trouble was traced to the inferior and unsuitable quality of fire-bricks used in the construction of the furnace. Report R. B. Glass No. 20 of the Research Branch deals with this investigation.

Close contact has continued with the Glass Technologist to the United Provinces Government in connection with the improvement of glass melting pots of local manufacture. Collaboration for the same purpose has been maintained between Messrs. Burn & Co., Calcutta, and Mr. M. L. Joshi, M.Sc., of the Foreman Christian College, Lahore. Enquiries in this connection were received from the Director of Industries, Bengal, and also from the Director of Industries, Bombay.

The Bureau has continued to maintain touch with developments in connection with the production and improvement of glass tubing, bottles and other blown containers, and electric lamp bulbs. It is of interest to note that neutral glass tubing suitable for the manufacture of serum ampoules and other containers required by the medical services and greatly improved bottles and similar blown ware are now being manufactured. An electric lamp factory has developed the production of electric lamp bulb glasses at the rate of 1,500

daily, and was given information by the Bureau regarding the compositions of a series of glasses for this purpose, and also that of a Belgian glass used for the insulation plates of electric lamp bayonet caps.

**SURVEY OF GLASS-MAKING MATERIALS.**—At the last session of the Industrial Research Council it was recommended that, in addition to the laboratory work so far carried out by the Research Branch on the chemical composition and grading of raw materials collected from various parts of the country by Directors of Industries and others concerned, the fusion characteristics of the sands should also be determined.

Owing to the limited quantity of each sample available, it was only possible to carry out small-scale experiments of a comparative character ; moreover, the literature available on the subject of fusibility of sands is scanty and a large number of preliminary tests was necessary before the final procedure was evolved. That finally adopted consisted in heating standard glass batches of the following composition for 7 hours in an automatically controlled electric furnace at  $1,390^{\circ} \pm 5^{\circ}\text{C}$  ;

	%
Sand (30 to 60 mesh) .. .. .	75
Lime .. .. .	7
Soda .. .. .	18

The criterion for fusibility was that no unreacted particles of the original batch should be present in the glass so produced when observed through a magnifying glass. Other criteria, such as determining the size and number of seed, blowing of small bulbs, drawing of wires, etc., were also considered, but were not found to be satisfactory for the object in view. The results showed that there was little difference between the samples tested, so far as fusibility was concerned.

In addition to the data on chemical analysis, grading, classification and fusibility, information regarding the following points for each sample is being recorded :—

- (a) source of supply,
- (b) geographical location of the deposit,
- (c) nearest Railway Station and its distance from the deposit,
- (d) means of transport available,
- (e) nature and extent of deposit.

The survey work which was being conducted by Dr. V. S. Dubey was brought to a close on the outbreak of war.

**GLASS PRODUCTS AND ACCESSORIES.**—Laboratory work has been continued by the Research Branch on china glass, liquid gold, electric lamp glasses, and neutral glasses. The progress effected during the period under review is described below.

*China Glass.*—From the information obtained through the provincial Directors of Industries, it appears that a number of firms have begun to manufacture and market china glass in India.

In view of the war-time conditions, the position regarding the prices and availability of raw materials and of the final product has altered considerably. Up-to-date information in this connection has been obtained, and the original report on the manufacture of china glass suitably revised with a view to its publication as a bulletin in the series of Bulletins of Indian Industrial Research.

*Liquid Gold.*—It was recorded in the last Report that the product obtained from the semi-commercial batch which had been prepared was observed to develop signs of deterioration on storage. During the period under review the investigation of the causes of this deterioration, which was begun last year, was completed. It appeared that the deterioration was probably caused by decomposition of the gold resinate, owing to the presence of minute traces of impurities which remained absorbed during its preparation. For a successful and good quality preparation it is also essential that the gold resinate should be free from dust particles and be thoroughly washed with pure methy alcohol before drying. Once the dried resinate has been freed from impurities it keeps well, and the liquid gold prepared from it does not show signs of deterioration.

In the light of the experience gained during this investigation, another semi-commercial scale batch of liquid gold was prepared, starting with 13 tolas of gold, the result being a yield of 33.5 ounces of liquid gold of 12.1% metallic content, equivalent to an overall yield of 75%. This yield was higher than that obtained in the original batch (66.2%), and it is anticipated that further improvement in yield is likely in larger commercial operations.

The quality of the second batch of liquid gold was found to be quite satisfactory, and it compared favourably with a well-known high grade foreign product which has been much used in this country. The material has been kept in storage under normal conditions and has been practically tested every month over a period of eight months. So far there has been no serious deposit of metallic gold in the containers nor any sign of deterioration in the film-producing qualities.

On the completion of the above practical work, investigation of the economic aspect indicated that the manufacture of liquid gold in India on an industrial scale would be commercially sound. Due to the outbreak of war, the prices of chemicals and apparatus required in its manufacture had increased, however, but so also had the price of imported liquid gold. Moreover, the stocks of a German product, which was the best in the market, were nearing exhaustion.

The report on this subject, covering also the question of the commercial production of this material, has been prepared for publication as Bulletin No. 16 of the series of Bulletins of Indian Industrial Research.

*Electric Lamp Glasses.*—The chemical analysis of glasses used to form the internal parts of electric lamps has been conducted intermittently as opportunity permitted. The work is nearing completion.

The investigations regarding the thermal endurance of lamp bulbs, described briefly in last year's Report, have been completed and the results incorporated in Report R. B. Glass No. 19 submitted to the Bureau.



In connection with the work on the optical transmission characteristics of lamp bulb glasses, the authorities of the Andhra University very kindly made their microphotometer available for the measurements of spectographs prepared by the Research Branch. The results obtained have made it possible to ascertain the range of the spectrum in which the transmission of light through various makes of lamp bulb glasses changes from 100% to 0%. This range in most cases lies below the short wave end of the visible spectrum.

*Neutral Glasses.*—In the Annual Report for the year 1937-38 mention was made of work carried out on neutral glasses for use in making containers for sera and drugs. Since the outbreak of war, the demand for such glasses by pharmaceutical manufacturers and the medical services in the country has induced several glass factories to produce neutral glass tubing and bottles. Samples of neutral glass made in India were collected and compared with foreign products in respect of neutrality, and the results show that Indian glass factories give promise of being able to meet the requirements of the pharmaceutical industry and the medical services.

## CHAPTER V.

## THE ROAD TEST TRACK.

In the last Annual Report it was recorded that the Road Test Track at Majerhat, Calcutta, had been brought into operation in February 1939. The formation of ruts in the region of the cart-wheel tracks soon developed, and it became clear that certain parts of the tractors subjected to heavy shocks when the surfaces traversed by the cart-wheels became worn and uneven, as a result of the rutting, required considerable strengthening.

The tests were therefore stopped and structural alterations of the tractors undertaken by the makers, but owing to labour troubles in their works, these were not completed before the arrival of the rainy season. Up till the 27th July 1939, the number of trips of the test carts after recommencing operation was small, and though the rutting was considerable the painted surfaces in the rutting were still in good condition. Heavy rainfall occurred between the 27th July and the 2nd August, however, the total rainfall during this period being approximately 13 inches.

As a result of the continuous heavy rainfall the track was often submerged, but operation was continued and under these conditions the test surfaces broke down rapidly. It appeared that the following causes were contributory to this rapid break-down :—

- (1) Unduly heavy loading per inch width of bullock-cart wheel. (At this time the loading was 1000 lbs. per inch width, or 4,000 lbs. per cart).
- (2) Action of water from above and also below while the operations were continued between 27th July 1939 and 2nd August 1939.
- (3) Incorporation of silt, dirt, etc., with the painted surfaces in the ruts due to the accumulation of water and these extraneous materials in the wheel ruts.

This rapid and practically simultaneous breakdown of the surfaces prevented any useful conclusions being formed regarding the comparative merits of the various specifications to which the test surfaces had been prepared. Although the results of the initial tests were negative, valuable experience had, however, been gained during this period which has been necessary to guide the evolution of a technique of test-track operation. As a result it was concluded, *inter alia*, that to complete tests satisfactorily in future the following modifications in the test-conditions should be tried :—

- (i) The load per inch width of car-wheel tyre should be reduced, in order to reduce the local rutting.
- (ii) Operation should be suspended while the track is wet or submerged. It was realised that this would probably entail suspension of testing practically throughout the monsoon season in future.

Consequent upon the rapid break-down of the test surfaces, further work was perforce stopped pending discussion with the Consulting Engineer (Roads) to the Government of India. This took place in September 1939, when the

question of closing down the test-track during the period of the war owing to the possibility of financial retrenchment was considered. Decision on this question was deferred till the end of October, however, when the Consulting Engineer (Roads) examined the test-track and it was agreed that the operation of the track should be continued.

Various schemes with a view to enabling the original programme to be repeated without tearing up the whole road surface and re-making were examined. The one finally adopted involved the stripping of the paint coat, off the entire road surface, the digging out of four wheel track ruts and subsequent re-packing, followed by local consolidation prior to re-covering the entire road surface in accordance with the original specifications.

The work of reconstruction was commenced at the beginning of January 1940 and the road-way was again examined by the Consulting Engineer (Roads) in the middle of the month, together with members of the Technical Sub-Committee, when the work of surface stripping and digging back the wheel ruts had been completed. Further instructions as to the manner in which the work should be continued and the region of the ruts consolidated were then given, and it was also decided that the inner set of tractors should be modified so as to lengthen the pitch of oscillation of the test-carts operating on the inner track to 48 feet that of the carts on the outer track being left at 16 feet for the time being.

This preparatory work was nearing completion at the end of the period under review.

## APPENDIX A.

CAMP CALCUTTA,

*The 5th August 1939.*

## INDUSTRIAL RESEARCH COUNCIL.

## REPORT OF THE PRIZES COMMITTEE, 1939.

*Open subjects prize papers scheme.*—This competition of the Council was advertised in February 1939, the closing date for the competition being 1st June, the latter date being decided upon on this occasion in view of the considerable interval that had hitherto elapsed between the last date allowed for submission of papers and the consideration of the report of the Prizes Committee by the Council. The prizes allotted this year were as follows :—

- 1 prize of Rs. 1,000,
- 2 prizes of Rs. 500 each,
- 2 prizes of Rs. 250 each, and
- 3 prizes of Rs. 150 each.

Twenty-two papers were received on this occasion, but one was subsequently withdrawn by the candidate. Certain of these papers were reported upon by officers of the Bureau and 16 were sent to selected expert referees.

The Prizes Committee met on the morning of the 5th August 1939, for consideration of the reports of the scrutineers and agreed as to the relative merits of the papers. Two members of the personnel of the Prizes Committee which had been appointed by the Council at its last session were unable to attend, these being Mr. L. B. Green, Director of Industries, Madras, and Mr. M. S. Ramchandra Rao, Director of Industries and Commerce, Mysore.

The Committee decided to recommend to the Council the following awards :—

Prize.	Nom de plume.	Title of the paper.
Rs. 500	" Bells " ..	The Tower-clock ringing mechanism.
250	" Pursand " ..	Purification of Indian glass-making sands.
250	" J. C." .. ..	Contribution to the chemistry of Permanganate preparation from the Indian standpoint.
150	" Precision " ..	Precision manufacture in India.
150	" Plantain Grove ..	Some critical conditions in silvering on glass.
150	" Nageshwar " ..	Refining of Nageshwar Oil.

The numbers of papers received is approximately the same as that received last year, but the Committee regrets to say that the general technical standard remains low and disappointing. In certain cases also the anonymity of the author has been destroyed by the disclosure of the author's name either on papers received with the prize paper or on the wrapping of the papers. The Committee recommends, however, that these failures to

maintain anonymity be condoned, as these cases continue to appear annually and seem to be due to misunderstandings. As it happens, this matter only concerns one of the papers recommended for the awards of prizes.

*Set subjects prizes scheme.*—The list of subjects proposed by the Directors of Industries for the Set Subject Prize Paper Scheme, recommended for introduction by the Industrial Research Council at its Third Session, was amplified by proposals received from other sources, and copies circulated to selected scientist advisers, viz., Professor S. S. Bhatnagar, Lahore University, Professor P. N. Ghosh, University College of Science, Calcutta, and Professor N. R. Dhar, Allahabad University. The list was also circulated to heads of Departments of the Universities and research institutions in India to elicit information as to the extent of the work which had been already done or was in progress on the various items in this list. The views of the scientist advisers and the information obtained from the Universities and technical institutions were considered by the Committee, and as a result the following abridged list of subjects is recommended to the Council for consideration and selection of a subject suitable for this scheme.

Serial No. of item on the list.	Title of Item (amended where necessary).
3	Utilisation of indigenous materials in the manufacture of insecticides, fungicides and weed killers.
5	Manufacture of patent foods from indigenous products.
24	Warping and sizing in hand-weaving.
26	Utilisation of paddy husk and saw dust,
46	A simple mechanical method suitable for Indian glass factories for the industrial production of glass tubing on a small scale.
47	The preparation and manufacture of sillimanite or other highly refractory glass melting pots for use in pot type glass furnaces.
48	The preparation of pure tungsten suitable for use in the manufacture of electric lamp filaments from Burmese tin-tungsten ores.
49	Utilisation of molasses or products from molasses on a large industrial scale other than for the production of alcohol.
50	The production of high-grade alpha-cellulose suitable for use in an artificial silk industry from an agricultural waste material widely available in India.
52	A process for the commercial recovery of vanadium from vanadium bearing ores in the Singhbhum district.

Item 11 'Manufacture of Enamel Wares' and Item 18 'Manufacture of Toy Enamels with bright colour and rapid drying properties' might also be worthy of consideration, and it is recommended that the Directors of Industries concerned might explain the purpose of their inclusion to the Council.

The Committee recommend that the above list should be considered when Item V of the Agenda is under consideration.

## APPENDIX B.

## LIST OF PUBLICATIONS OF THE INDUSTRIAL RESEARCH BUREAU IN THE SERIES OF BULLETINS OF INDIAN INDUSTRIAL RESEARCH.

- I. R. B. 2. 1.—No. 1 .. .. Bibliography of Industrial Publications published in India from 1921. (Rs. 4-6-0 or 7s. 3d.).
- I. R. B. 2. 2.—No. 2 .. .. A survey of the Indian Glass Industry, by E. Dixon A. M. I. Mech. E. (As. 14 or 1s. 6d.).
- I. R. B. 2. 3.—No. 3 .. .. The Effects of Annealing Procedure on the Tensile Properties of Arsenical Copper Bar, by E. F. G. Gilmore, B.Sc., M. I. Mech. E. (As. 8 or 10d.).
- I. R. B. 2. 4.—No. 4 .. .. The Manufacture of Photographic Plates in India, by N. Kasinathan, M.A., M.Sc. (As. 12 or 1s. 3d.).
- I. R. B. 2. 5.—No. 5 .. .. Improved Reflex Copying, by N. Kasinathan, M.A., M.Sc. (As. 4 or 5d.).
- I. R. B. 2. 6.—No. 6 .. .. The Preparation of Alumina and Sulphur Dioxide from Bauxite-Gypsum Mixture, by Dr. V. S. Dubey, M.Sc., Ph.D. (London), D.I.C., M.B. Rane, M.Sc., and M. Kanakaratham, M.Sc. (As. 3 or 4d.).
- I. R. B. 2. 7.—No. 7 .. .. The Utilization of Nepheline Syenite Rock as a Partial Substitute for Soda Ash in the Glass Industry of India, by Dr. V. S. Dubey, M.Sc., Ph. D. (London), D. I. C., and P. N. Agarwala, M.Sc. (As. 6 or 8d.).
- I. R. B. 2. 8.—No. 8 .. .. Development of Heavy Chemical Industries in India, by N. N. Sen Gupta, M.Sc., A.I.C. (Rs. 1-6-0 or 2s. 3d.).
- I. R. B. 2. 9.—No. 9 .. .. Purification of Clay, by S. R. Das, M.Sc., and M. A. Saboor, M.Sc. (As. 6 or 8d.).
- I. R. B. 2. 10.—No. 10 .. .. Indian Vegetable Oils, by N. Brodie, M.Sc., F.C.S., A.I.C. (Rs. 1-14-0 or 3s. 3d.).
- I. R. B. 2. 11.—No. 11 .. .. The Manufacture of Sulphitation Sugar from Coloured Canes (Purple Mauritius), by S. Venkata Ramanayya B.A., M.Sc. (As. 10 or 1s.).
- I. R. B. 2. 12.—No. 12 .. .. The Manufacture of Soap in India, by A. K. Menon B.A., F.C.S. (Re. 1 or 1s. 6d.).
- I. R. B. 2. 13.—No. 13 .. .. A study of Indian Mustard and Rape Seeds and their oils, by D. Y. Athawale, M.Sc., J. A. Hare-Duke and P. N. Mathur, Dip. Tech. (As. 14 or 1s. 3d.).
- I. R. B. 2. 14.—No. 14 .. .. Indian Refractory Clays, by H. Crookshank, B.A., B.A.I. (Rs. 1-6-0 or 2s.).
- I. R. B. 2. 15.—No. 15 .. .. Recovery of Titanium Oxide as a by-product in the Manufacture of Alumina-Ferric from Bauxite, by Sudhir Chandra Chakravarty, M.Sc. (As. 4 or 5d.).
- I. R. B. 2. 16.—No. 16 .. .. The Manufacture and Application of Liquid Gold, by Atma Ram, D.Sc., Karimullah, Ph.D., Dr. Phil, and Lal C. Verman, Ph.D., M.S., F. Inst. P. (As. 6 or 7d.).

*N.B.*—Copies of all above publications are obtainable from the Manager of Publications, Civil Lines, Delhi, and also from all local sale depots for the sale of Government of India Publications.

## APPENDIX C.

TABLE I.

*Reports submitted by the Research Branch during 1939-40.*

Report No.	Title.
<i>Paints.</i>	
R. B. Paint No. 4 .. ..	Use of Indigenous Umber in Paints.
R. B. Paint No. 5 .. ..	Use of Talc and Asbestine in Paints.
<i>Dry Cells.</i>	
R. B. Dry Cells No. 2 .. ..	Brief Note on " Carsac " type cells.
<i>Oils for Internal Combustion Engines.</i>	
R. B. I. C. Eng. No. 2 .. ..	Utilisation of Indian Vegetable Oils as Lubricants in Internal Combustion Engines, Part I.
<i>Glass.</i>	
R. B. Glass No. 19 .. ..	Thermal Endurance of Electric Lamp Glass Bulbs.
R. B. Glass No. 20 .. ..	Glass Tank Furnace at the Lucky Glass and Calcutta Silicate Works, Calcutta.
R. B. Glass No. 21 .. ..	The Manufacture and Application of Liquid Gold.
<i>Miscellaneous.</i>	
R. B. Misc. No. 23 .. ..	Pyritiferous Schist.

TABLE II.

*Papers published by members of the staff of the Research Branch during 1939-40.*

No.	Title.	Authors.	Reference.
1	Indian Substitute for Leighton Buzzard Standard Sand.	C. A. R. Khan and Lal C. Verman.	<i>Proc. Ind. Sc. Cong.</i> p. 44, 1940.
	Cement-Surkhi Mortars ..	C. A. R. Khan and Lal C. Verman.	<i>Ibid.</i> p. 44, 1940.
3	Jute Cloth Testing at different temperatures but constant humidity.	Lal C. Verman and A. N. Chowdhuri.	<i>Ibid.</i> p. 43, 1940.
4	Bearing Metal Deposits on Journal Surfaces.	Lal C. Verman ..	<i>Ibid.</i> p. 42, 1940.
5	Particle Size Distribution of Red Lead Pigments.	A. Jogarao and Lal C. Verman.	<i>Ibid.</i> p. 56, 1940.
6	Semi-Automatic Cell Testing Device for Dry Cells.	Lal C. Verman ..	<i>Current Science</i> , 8, pp. 332-335, 1939.
7	Effect of Iron Content of Manganese Ores on Dry Cell Characteristics.	Lal C. Verman, K. Subba Ramaiah and G. D. Joglekar.	<i>Ibid.</i> 9, pp. 64-65, 1940.