# NATIONAL METALLURGICAL LABORATORY OF INDIA

## JAMSHEDPUR

1954

Council of Scientific and Industrial Research

NEW DELHI

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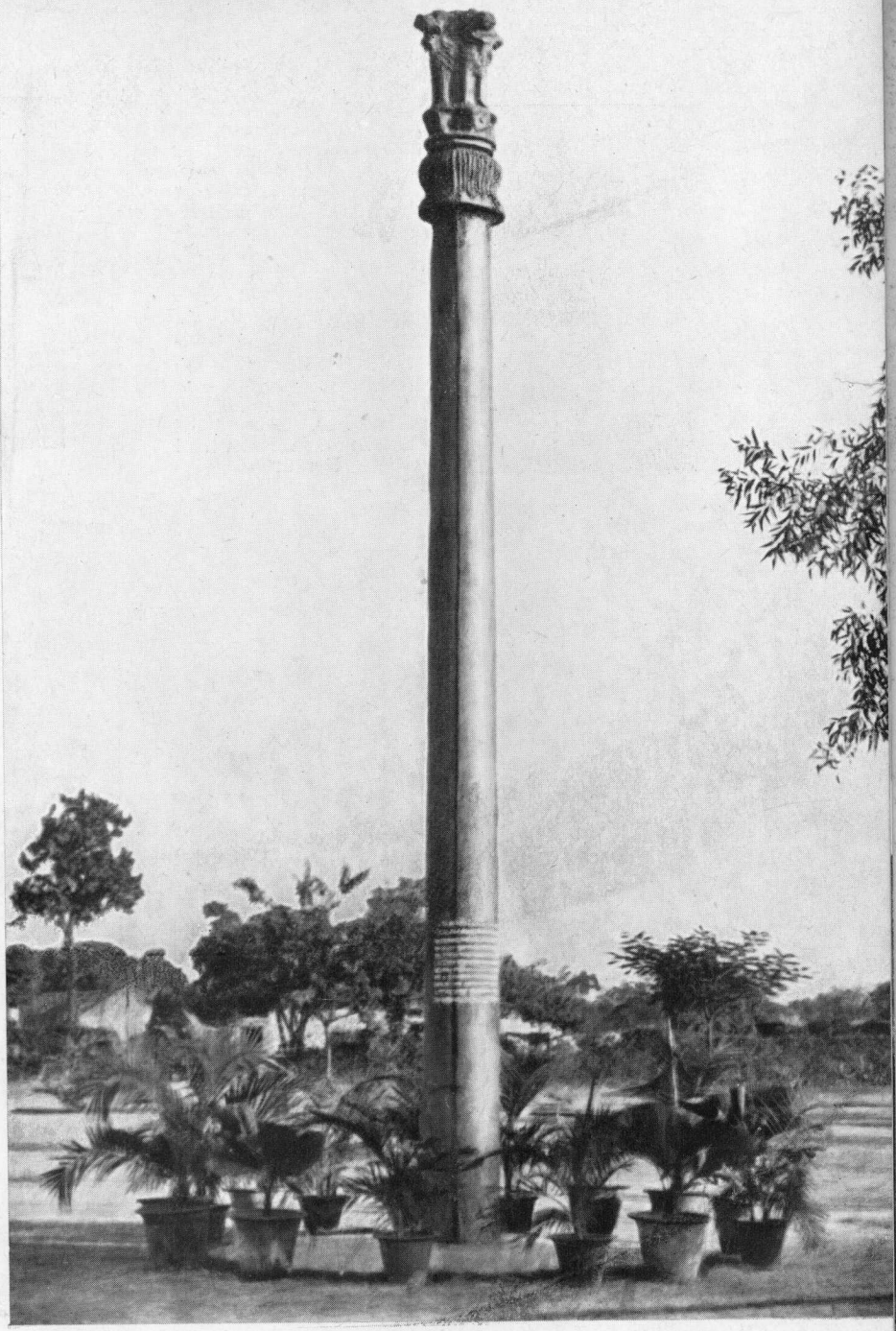
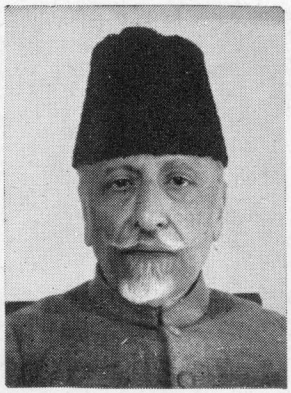


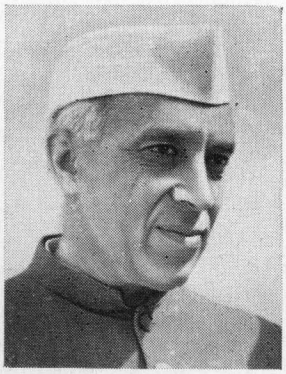
**Ashoka Pillar**

"This Replica of the Ashoka Pillar was installed at the National Metallurgical Laboratory on the 26th November 1950, on the opening of the Laboratory, by Shri Jawaharlal Nehru, Prime Minister, as a Symbol of the Science and Industry of India in the past, a token of the present, and as an inspiration for the future."

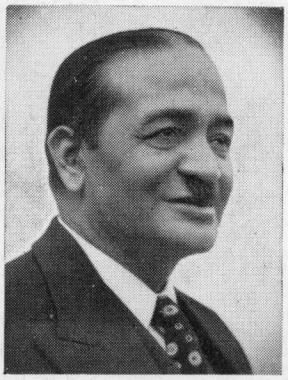


Maulana ABUL KALAM AZAD, Minister for Natural Resources & Scientific Research and Education and Vice-President, Council of Scientific & Industrial Research

Mr. J. R. D. TATA, Chairman, Tata Industries Ltd., whose interest in the establishment of the Laboratory is well known

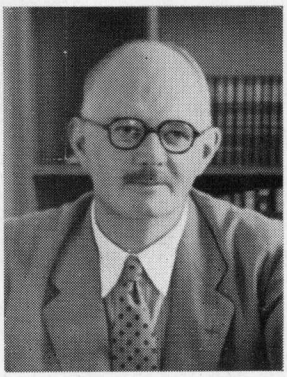


Shri JAWAHARLAL NEHRU, Prime Minister and President, Council of Scientific & Industrial Research, opened the Laboratory



Dr. S. S. BHATNAGAR, Secretary, Ministry of Natural Resources & Scientific Research and Director, Scientific & Industrial Research

Mr. E. H. BUCKNALL, Director of the Laboratory



# Brief History

Soon after Dr. Bhatnagar assumed charge of Government-inspired research in India, as the Director of Scientific and Industrial Research in 1940, he suggested to the Board of Scientific and Industrial Research the setting up of a Metals Research Committee in order to ensure the progress and expansion of India's metallurgical industries. At its first meeting held in December 1940 the Committee came to the considered decision that a central organisation in the form of a National Metallurgical Research Laboratory was essential. A Laboratory Planning Sub-committee of the Metals Committee was later constituted with Sir J. J. Ghandy as chairman to formulate a concrete scheme for submission to the Board of Scientific and Industrial Research. The preliminary report of the Committee was ready in May 1942. The layout and architectural plans were drawn up by Messrs. Ballardie Thompson & Matthews in September 1942. The final report of the Committee, including approximate estimates of both capital and recurring expenditure, was submitted to the Board in November 1942. The Board accepted the Sub-committee's recommendations and in October 1944 the Board appointed the National Metallurgical Laboratory Planning Committee with Sir J. J. Ghandy as chairman and Dr. G. P. Contractor (Assistant Director) as secretary. Tentative proposals for the establishment of the National Metallurgical Laboratory were published in 1946.

Out of a total sum of Rs. 50.75 lakhs made available for the establishment of this Laboratory, the grant from the Government of India

was about Rs. 38.0 lakhs, and the balance of about Rs. 13.0 lakhs was from donations, the most important of which were the magnificent contribution of Rs. 12.0 lakhs from the Sir Ratan Tata Trust, and Rs. 1.0 lakh from Sardar Bahadur Sir Indra Singh. The Council also received a donation of Rs. 10,000 from the Indian Metallurgical Association towards the establishment of this Laboratory.

The Tata Industries, Ltd., generously placed at the disposal of the Council a plot of land measuring about eight acres for the site of the Laboratory, together with about 18 acres of land for staff quarters.

The foundation-stone of the National Metallurgical Laboratory was laid by Shri Chakravarti Rajagopalachari, then Minister for Education and Arts in the Interim National Government, on November 21, 1946. The actual construction work was taken in hand in January 1948. In order to advise and plan the day-to-day constructional work, the Council of Scientific and Industrial Research constituted a Local Planning Committee under the chairmanship of Sir J. J. Ghandy, the other members being Sardar Ajaib Singh, Major W. H. Ames, Mr. B. R. Kagal and Mr. A. K. Aga. The Laboratory was opened by the Prime Minister, Shri Jawaharlal Nehru on 26th November 1950. A few excerpts from the speeches made on that occasion are reproduced below :

Shri JAWAHARLAL NEHRU—"Opening this great Laboratory I think of the combination of this Laboratory with the great steel works in this city, of the marriage of science with industry for the progress of both."

Professor CHARLES CRUSSARD—"India is one of the few countries to build a National Metallurgical Laboratory . . . . This laboratory is exactly of the right size for a self-contained unit."

Sir J. J. GHANDY—"If the Prime Minister has been the inspiration behind this string of laboratories, it has fallen to Dr. Bhatnagar, the great dean of scientific research, to give them concrete form. I am sure a better choice could not have been made, as Dr. Bhatnagar is not only a scientist of great repute, but is also an indefatigable worker and can be more than fitly compared to that beryllium-copper alloy commonly known as 'Tireless Alloy,' which does not fail or even show signs of fatigue under severe stresses."

Sir C. V. RAMAN in his speech compared democracies with metals and said "she (democracy) stoops to conquer, she yields to conquer. The more she yields, the stronger she becomes and that is the true secret why metals have conquered the world—why the civilization from the very beginning of time has been built on metals."

National Metallurgical Laboratory of India : Main Building

## The Buildings

THE location of the Laboratory is very appropriate, as Jamshedpur is the main centre of the steel and allied industries and is near to the only copper producing plant in the country and to the engineering industries in the Calcutta area, and also to two other national laboratories of the Council, the Central Glass & Ceramic Research Institute, and the Fuel Research Institute. The possibilities of close collaboration with the Government Metallurgical Inspectorate situated at Jamshedpur and with the Research and Control Laboratories of the Tata Iron & Steel Co. Ltd., are additional advantages.

The Laboratory is situated on a site to the east of and adjoining the Tata Laboratories, while opposite are the laboratories of the Government Metallurgical Inspectorate. The problems of power, water and gas supply and sewage and effluent disposal had already been successfully solved by the Tata Laboratories, and all services were available close to the site.

The Laboratory consists of a Main Building containing administrative offices, conference room, research laboratories, dark rooms, studio, stores,

**The Library**

library, reading room, refectory etc., and a separate Technological Laboratory comprising large bays with north light roofing, associated control rooms, and an electric sub-station.

The Main Building is three-storyed with a floor area of about 50,000 sq. ft. It is arranged to trap the maximum of north light, the lighting being mainly of north and south fenestration. An eight-foot wide corridor has been provided on both the ground and first floors, running east to west, dividing the building into two rows of rooms. Efficiency and convenience of operation coupled with the required degree of flexibility and adaptation to future needs were borne in mind in designing this building. The size of the rooms was carefully planned in relation to the requirements for benches and aisles and natural illumination. The location of the laboratories for different types of work was carefully considered. The administrative offices and the conference room are centrally located on the second floor, where facilities are to be provided also for statistical investigations, compilation of metallurgical trade figures and practical production and operational problems. The first floor, part of the ground floor and the conference room on the second floor of the Main Building are air-conditioned.

The Sir Ratan Tata Technological Laboratory, named after Sir Ratan

Tata in view of the generosity of the Sir Ratan Tata Trust, is situated about 135 ft. to the south of the Main Building. The total area of the building is about 38,000 sq. ft. It consists of five 100 ft.×40 ft. bays, with rooms for the operating staff, for specialised apparatus in connection with pilot plant work, inspection and control, as well as workshops and other service facilities. A part of the central bay houses the electrical sub-station and the remaining part is used for mechanical testing. The Refractories laboratories are located in another bay, while a third is occupied by the Ore-dressing and Mineral-beneficiation laboratories. The Technological Laboratory also houses the machine shop, the pattern shop, the instrument making shop, an experimental foundry, the foundry testing laboratory, the electrical repair shop, melting and heat-treatment furnaces and mechanical working equipment.

## Functions

THE laboratory deals with all aspects of metallurgical research. The main functions of the laboratory include :

1. Application of research results to commercial operating conditions.

**The Conference Room**

Sir Ratan Tata Technological Laboratory

Verandah of the Technological Laboratory

2. Close collaboration with other research institutes and organisations of the Council, particularly on long term research of a fundamental nature.

3. Testing and standardization of manufactured products, and tendering advice on the preparation of specifications appropriate to Indian conditions.

4. Collection of data and technical information so as to function as a clearing house for information.

5. Providing facilities for solution of problems of industries through a system of industrial fellowships.

The laboratory is administered by a Director and the Advisory Board of the National Metallurgical Laboratory reviews the progress of work, recommends the programme of research and advises in the framing of the budget of the laboratory.

Dr. George Sachs was the first Director. Professor Charles Crussard succeeded him for a time in 1950-51. After Professor Crussard's departure from India, Dr. G. P. Contractor took over charge as Acting Director for a period of nearly two years up to February 1953, when Mr. E. H. Bucknall joined the Laboratory as Director. In May 1953, Dr. B. R. Nijhawan became Deputy Director.

The research work of the Laboratory is carried out in the following six main Divisions.

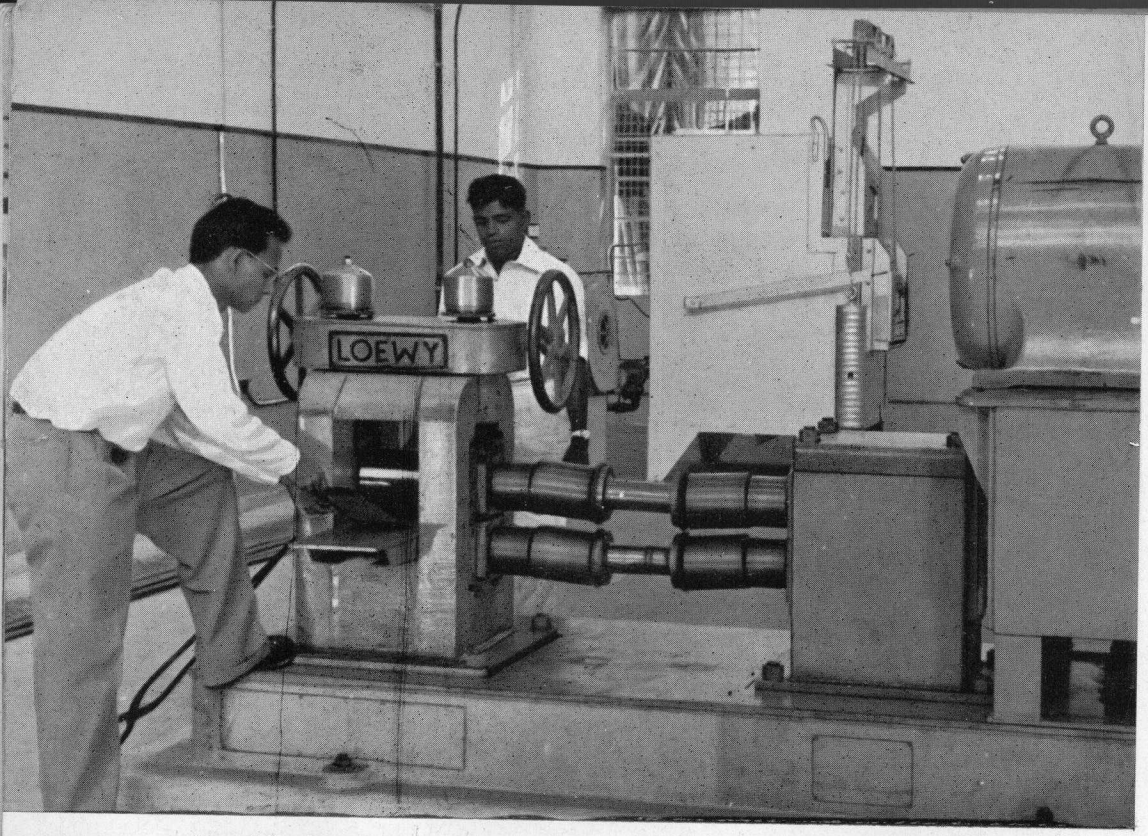
1. *General Metallurgy* (*under the Deputy Director*)—Metallographic studies, macroscopy, inclusions study, experimental foundry, sand testing, heat-treatment of metals and alloys, dilatometric and allied thermal studies, welding, study of structure and properties of metals, etc.

2. *Chemistry* (*Asst. Director: Dr. T. Banerjee*)—General analysis of metals, alloys, ores, refractories, etc., micro-analysis, electro-metallurgy, corrosion and protection of metals, electro-plating, spectrographic and polarographic studies, physical chemistry of slag, metal, etc.

3. *Ore-Dressing and Mineral-Beneficiation* (*Asst. Director: Shri P. I. A. Narayanan*)—Extraction and refining of metals from their ores and similar materials, flotation studies, pilot plant experiments on enrichment of ores and minerals, etc.

4. *Refractories* (*Asst. Director: Shri Rabinder Singh*)—Study of the thermal and physical characteristics of refractories, binders, etc. of metallurgical importance, petrographical studies of minerals and refractories, development of refractories from indigenous raw materials, routine tests such as Pyrometric Cone Equivalent.

5. *Mechanical Metallurgy & Testing* (*S.S.O. in charge: Dr. M. S. Mitra*)—Mechanical working of metals and alloys, such as rolling,




**Experimental Rolling Mill**

forging, pressing, drawing, etc., study of elasticity, plasticity, etc. in metals, stress-strain determinations, strain-gauge measurements, photo-elastic method for stress distribution studies, determination of tensile strength, ductility and other physical characteristics.

6. *Physical Metallurgy* (*S.S.O. in charge*: *Dr. A. A. Krishnan*)—Electrical and magnetic testing, pyrometry, X-ray studies, radiography, optical properties, application of ultrasonics to metallurgical problems, etc.

Besides the above divisions and apart from the Administration Branch there are the following important sections: (1) Chemical Engineering section for setting up pilot plants and for allied work; (2) Purchase section, which attends to the purchase of scientific equipment, apparatus, machinery, etc., for use of the workshop and various divisions of the Laboratory; (3) Liaison and Information section which provides technical information service, and attends to scientific liaison work, publicity and publications, compilaton of technical reports, photostats and prints, and organizes lectures, film shows, etc.; and (4) Maintenance.

## General Metallurgy

THE Division has been carrying out experiments on production of nodular cast iron, using an addition alloy of 75 per cent copper and 25 per

cent magnesium and studying the mechanism of graphite formation in nodular cast iron with a view to applying the process to Indian pig irons.

Study of the properties of moulding sands from a large number of foundries in India is being made in order to determine their suitability for various types of casting of ferrous and non-ferrous metals and alloys.

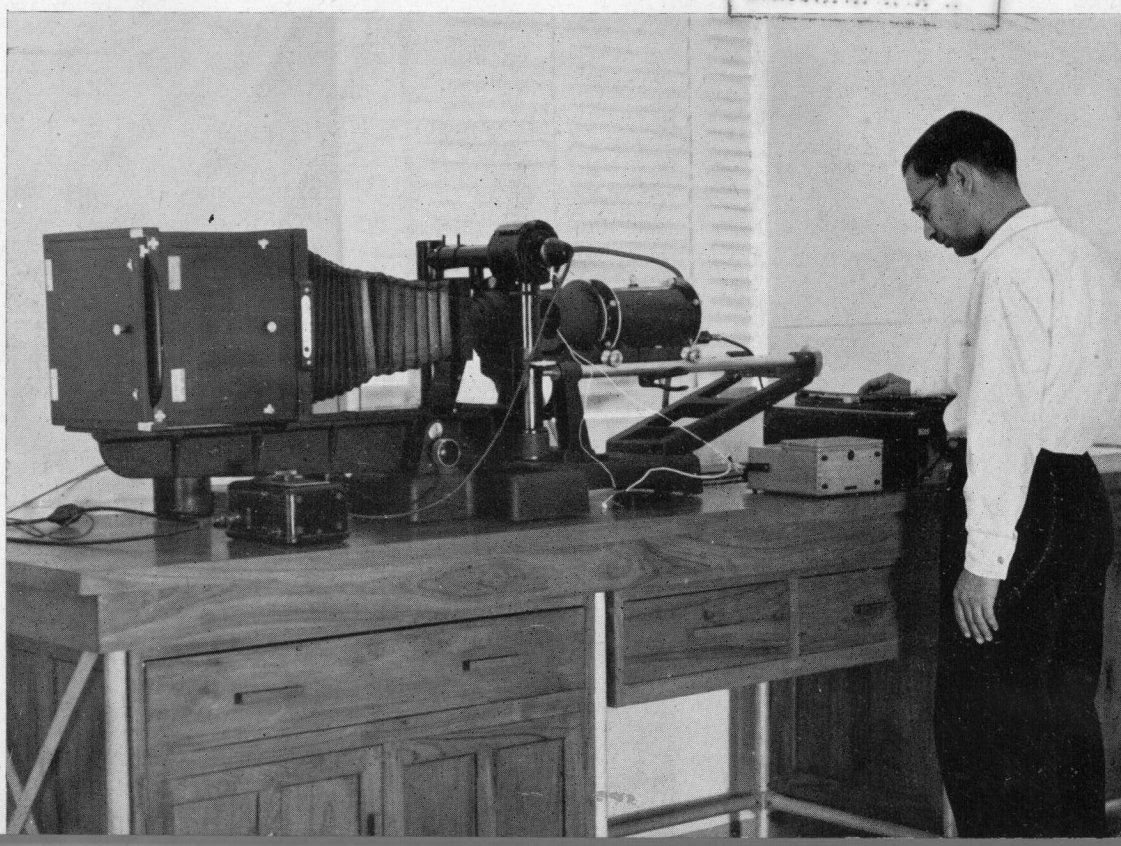
The possibility of replacing other forms of plated steel and other materials by aluminized steels to conserve nickel, chromium and tin is being investigated. The process of dip-coating and heating mild steel with a packing of aluminium, alumina and ammonium chloride has been studied.

Production of aluminium-silicon alloys by thermal reduction of silica by aluminium is being experimented upon.

Response of alloy steels to aluminium addition and heat treatment is being studied from two aspects, viz., the problem of grain growth inhibition and abnormality, and of hardening behaviour, particularly the isothermal transformation characteristics in the bainite range. The amount of aluminium which has to be added to produce the maximum inhibition to growth in plain carbon as well as nickel chrome steels has been found out. Grain-size control by such addition improves the mechanical properties of steels.



**Leitz Dilatometer for Thermal Analysis of Metals and Alloys**



Investigations carried out at the instance of Messrs. *Tata Iron & Steel Co. Ltd.* on manufacture of low carbon ferro-chrome by reducing chromite with ferro-silicon have indicated the feasibility of this process being used in India.

Beneficiation experiments by thermal treatment of low grade manganese ore (36%) have resulted in the recovery of a 50 per cent concentrate from the slag.

## Physical Metallurgy

THE established alloys for permanent magnets contain nickel and cobalt. An attempt is being made to develop permanent magnet alloys of iron, manganese and aluminium. Alloys of Fe-Mn-Al (80:10:10; 75:15:10) prepared both by the powder method and by melting, casting and annealing have been shown to retain magnetism. Incidentally, it has been found that some Fe-Mn-Al alloys show resistance to corrosion and to high temperature oxidation.

Equipment to measure the internal friction of materials in wire form has been designed and constructed.

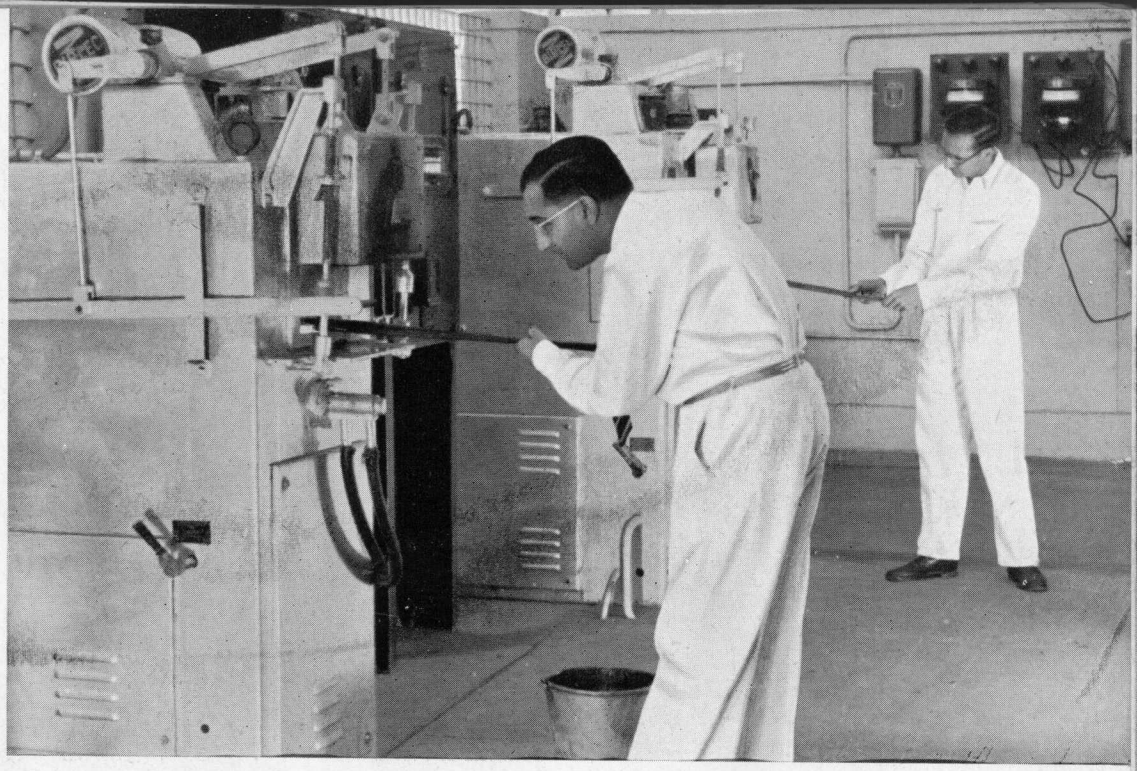
## Chemistry

MANUFACTURE of electrolytic manganese, beryllia and titanium are three important investigations pursued in this Division. Laboratory-scale work on manganese has been completed and pilot plant experiments have been planned. Production of beryllia by chemical, electrolytical and chlorination processes is being investigated. A pilot plant scheme for the chemical production of 2,400 lb. of beryllia per annum has been prepared after considering the economics of the process. The electrolytic process has also made some headway.

Among investigations on electroplating, the substitution of cyanide by non-cyanide baths for the electroplating of brass, technique of plating metals on non-metals like glass, wood, paper and porcelain, chromium plating on aluminium are some of the achievements.

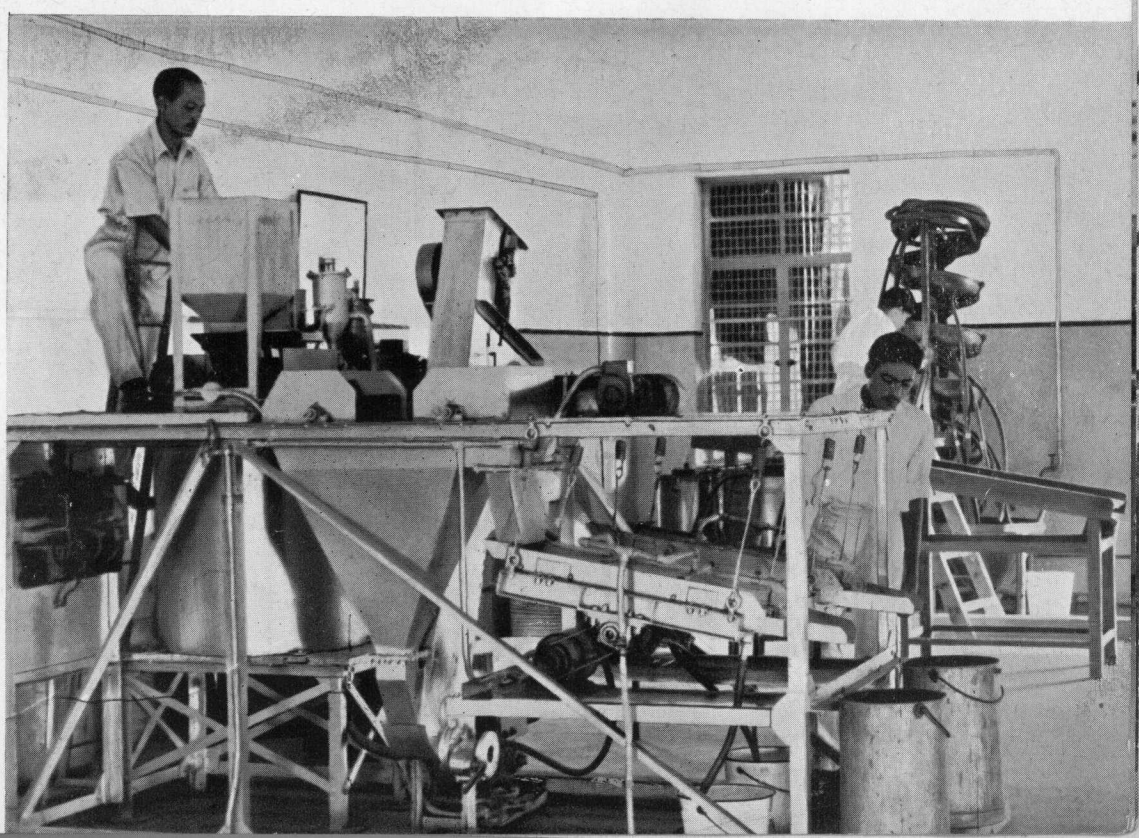
The Government of India Mint at Bombay referred to the Laboratory the problem of recovery of nickel from silver-refinery waste liquors. A method of separating the zinc as sulphide and the nickel electrolytically has been worked out.

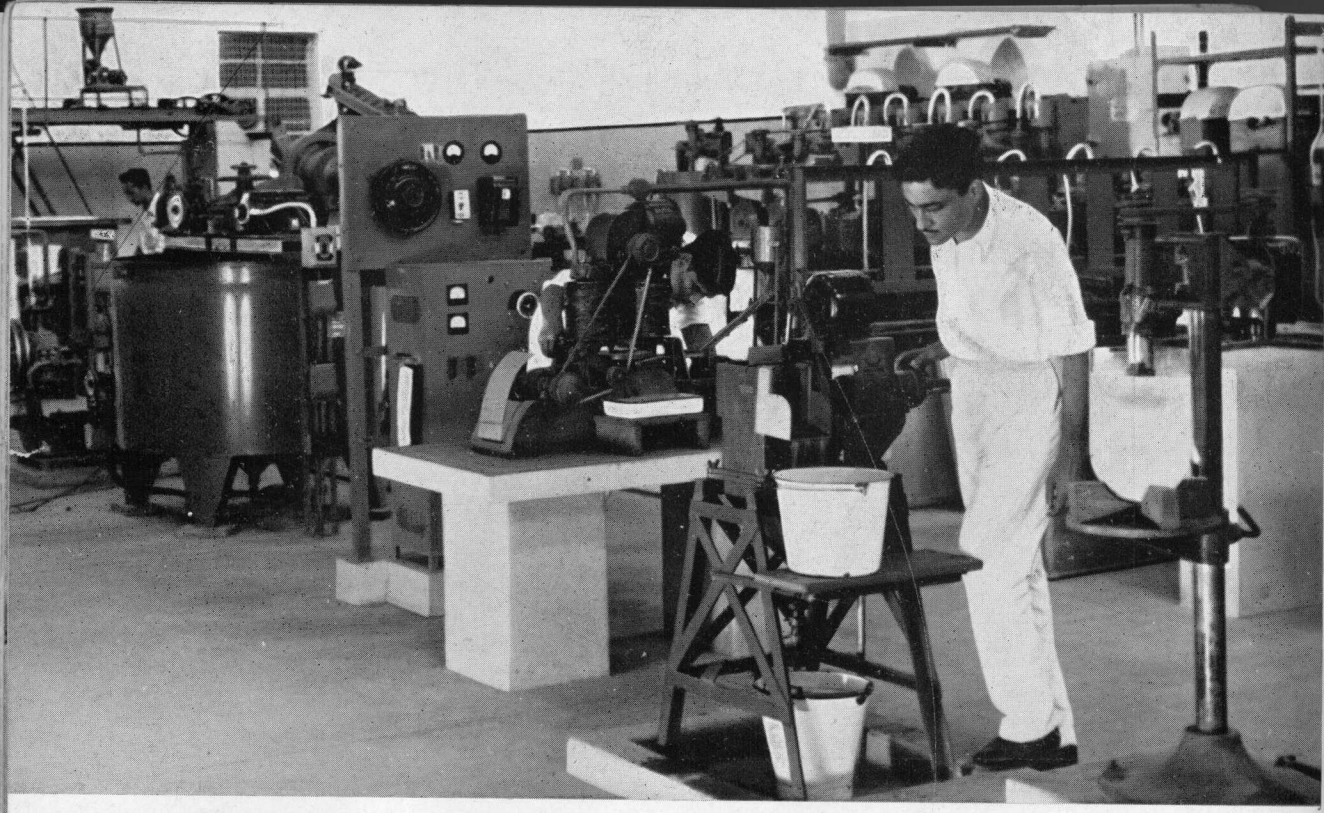
A process has been evolved for the regeneration of the waste liquid from electrolytic manganese or manganese dioxide cells.



Corner of Heat Treatment Laboratory

Sink and Float Plant—Capacity 200 lb. per hour





Corner of Ore Dressing and Mineral Beneficiation Laboratories

## Ore Dressing and Mineral Beneficiation

ORES, as found in nature, are not always suitable for direct processing and some improvement in the grade has to be brought about by ore-dressing methods. The Laboratory has undertaken study of several low-grade chromium ores. Work on ores from Dodkanya (Mysore) and Kittaburu (Bihar) has been completed and samples from Talur, Arsekere and Dodkatur (all in Mysore) are being studied.

Concentration of low grade pyrites from Chitaldrug (Mysore), Wynaad (Nilgiris) and Karwar (Bombay) is being attempted. From the preliminary investigations it has been calculated that ores from Chitaldrug may yield about 150,000 tons of sulphur after proper beneficiation.

## Refractories

THE furnaces and heat treating equipment for metallurgical operations require satisfactory refractory materials. Hence, research on the production of high quality refractories is also a part of the activity of the Laboratory. India has one of the largest workable deposits of sillimanite in the world. It is obtained as a by-product in the extraction of monazite and ilmenite from Travancore beach sands. As a result of preliminary

investigations and tests of the products made therefrom, suitable sillimanite refractory compositions and method of processing are being evolved. Work on the manufacture of graphite, silicon carbide and super-basic refractories is in progress. It is anticipated that the products will compare favourably with standard imported goods.

Petrographic studies on raw materials for refractories are also being made.

## Mechanical Metallurgy and Testing

USERS of metal products are naturally interested in determining the specific performance of the products they purchase and here comes the field of testing. Considerable work has been done in this connection on the wear of railway wheels, tyres and axles. The role of wear products in accelerating wear has been determined. The work is being continued to correlate wear resistance with the physical properties and structure of the materials.

Other aspects of performance in service are also receiving attention at the Laboratory. Study of impact fatigue resistance of structural steels and of the fatigue properties and notch sensitivity of structural steels

**Corner of Workshop**

and aircraft alloys in particular are being made. Research of a more fundamental nature on the elastic and plastic properties of metals and on the upper and lower yield points of steels has also been undertaken.

## Technical Aid to Industry

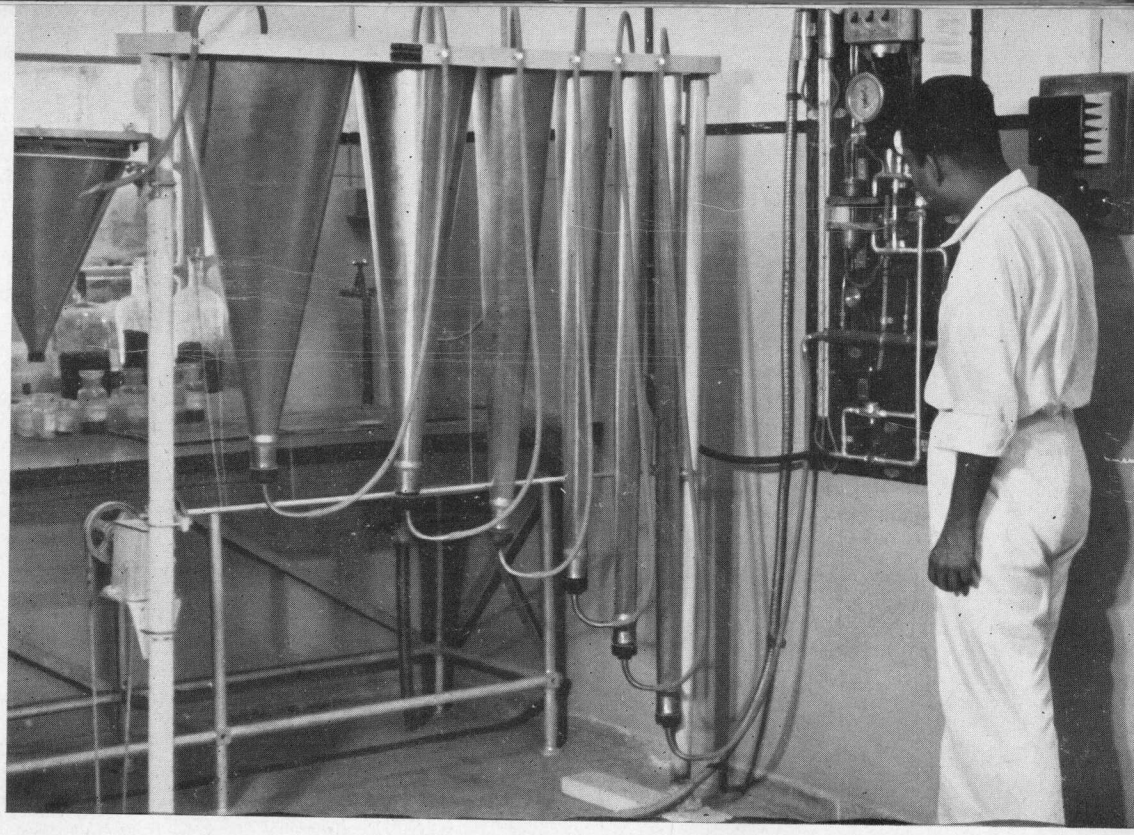
Two types of research problems have been referred to the Laboratory. One type involves a fairly extensive investigation of an industrial process or scheme of development, the other comprises the examination of operational difficulties or service failures. As an example of the first type, may be mentioned work done for the aluminium industry on the disintegration of Soderberg electrodes and on the separation of cryolite from the carbon dust produced in the reduction furnaces. Problems in plating due to bad colour or burnt deposits or to non-deposition, experienced by the Surat Jari Plating Industry, have been successfully solved and the industry has increased its output. The successful work of recovery of nickel and zinc from waste liquor left after recovering silver and copper from old silver coins is an instance of work done for a Government Department, the Mint.

Failure of four droppers of the overhead traction equipment on the Bombay-Calcutta mail was referred to the Laboratory. The Laboratory has suggested several remedial measures to prevent failures. The failure of a gear box assembly in the gypsum grinding plant at Sindri is being investigated. Testing of brick samples for refractory properties, ore-dressing tests, heat-treatment and testing of coiled spring used in railway wagons, the cause of excessive dross formation in a galvanizing plant are some examples of work carried out for industry.

Besides their scientific implications, examinations of service failures are valued as supplying an important link in the development of contacts with industrial concerns in the country.

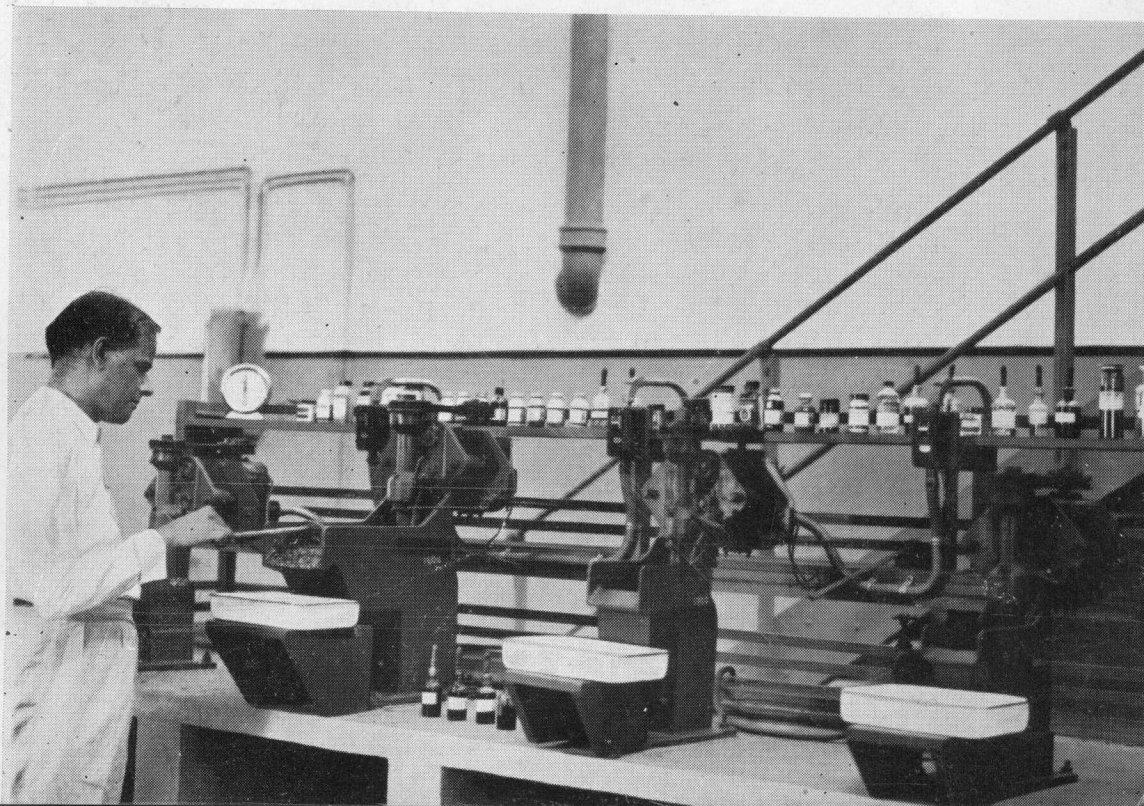
The Liaison and Information Section of the Laboratory maintains contact with the public by arranging for talks and articles on the scope and functions of the Laboratory, as well as through the fortnightly issues of the CSIR News, published by the Council of Scientific and Industrial Research. Technical information is supplied on enquiry and special tests and investigations of short duration are undertaken.

Further contacts between the industry, research workers and trade interests are brought about by arranging symposia on various aspects of metallurgical industries. Two symposia, one on 'Electroplating and Metal Finishing' and another on 'Industrial Failures of Engineering Metals and Alloys' have been held so far and the proceedings of the first symposium have been published.



Infra-Sizer for separation of sub-sieve particles

Flotation Cells in Ore dressing Laboratory



# Some Appreciations and Messages

"A National Metallurgical Laboratory in India should be of great help and value to her rapidly expanding metallurgical industry. I wish you every success in your present undertaking."—Dr. RALPH BROWN, Director of Research, Bell Telephone Laboratories, New York.

"I am confident that it will prove to be an important factor in the industrial development of India."—S. R. ZIMMERLY, Chief, Salt Lake City Division, Metallurgical Branch.

"The Institution of Metallurgists expresses its cordial good wishes for the success and future well-being of the National Metallurgical Laboratory, Jamshedpur, on the occasion of the opening ceremony."—Dr. HAROLD MOORE, First President of the Institution of Metallurgists, London.

"My best wishes go to the scientists of India who can no longer complain of want of facilities for research. May they prove that India has once again taken up the great search for truth after a few centuries of neglect."—Shri C. RAJAGOPALACHARI.