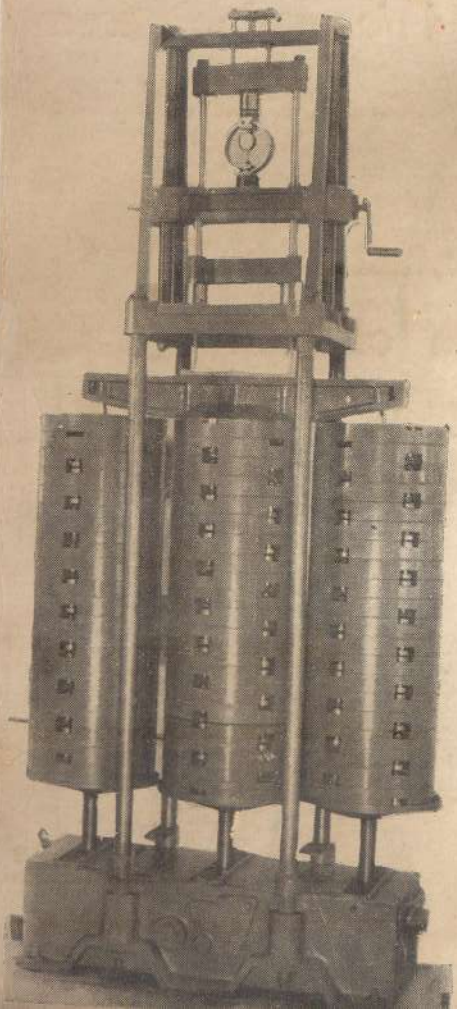
National Physical Laboratory
New Delhi



ANNUAL REPORT 1966-67

The Laboratory welcomes requests for advice or information from Institutions and Industries on subjects dealt with by N. P. L. You are requested to contact the Scientist Incharge, Division of Planning and Liaison, N.P.L., New Delhi - 12.

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REPORT OF THE DIRECTOR FOR THE YEAR 1966–67

To The Executive Council of the National Physical Laboratory, New Delhi-12

During the period under report, two meetings of the Executive Council were held: one on the 26th August, 1966 and the other on the 18th March, 1967. These were preceded by the meetings of the following sub-committees: (1) Scientific Sub-committee; (2) Building and Finance Sub-committee; and (3) Development-cum-Production of Electronics Components Sub-committee.

According to the recommendations of the Executive Council, the number of Divisions of the Laboratory has been reduced from 22 to 14, as given below:

RE-ORGANISED DIVISIONS

(1) Acoustics; (2) Basic Physics (including Theoretical Physics and Low Temperature Physics); (3) Electricity; (4) Electronics; (5) Heat; (6) Mechanics; (7) Materials; (8) Materials Analysis (Chemical Analysis group and Physical Analysis group, X-ray, Infrared Spectroscopy, Electron Microscopy, etc.); (9) Solid State Physics; (10) Optics; (11) Radio Science; (12) Weights & Mearsures; (13) Planning & Liaison; (14) Rain & Clouds Physics (to be transferred to Meteorological Department.)

This has led to better coordination of work of the Laboratory, which is project orientated requiring inter-divisional activity.

The Planning & Liaison Division has started working during the year.

Steps have been taken for the transfer of Rain & Clouds Physics Division.

NEW SCHEDULE OF TEST FEES

The test fees being charged by the National Physical Laboratory for various test jobs which are being carried out in different divisions of the Laboratory had been fixed at a fairly low level. These fees were not revised during the past 15 years in spite of similar organisations in other countries having raised their test fees. This was with a view to enabling various

new research institutions to equip themselves with standard equipment for research work as well as to enabling the developing industries in the country to derive maximum benefit from the facilities available at the National Physical Laboratory. Particularly low fees were being charged for several items. Chief amongst these were graduated laboratory glassware, sets of weights and balances for scientific work and items which find an application in the inspection of engineering products. Very often the Test Reports issued by the Laboratory are accompanied with suggestions to the manufacturers, on how to improve the quality of their products. The policy of charging low fees has gone a long way in encouraging the newly started undertakings to send their products for the purpose of "Developmental Testing".

These fees have now been raised and those relating to the work of different divisions have been brought to a more or less common basis. The new schedule of testing fees has been put into effect from 1-3-1967.

PANEL OF CONSULTANTS FOR THE VARIOUS DIVISIONS OF THE LABORATORY

The panels for the various divisions gave their comments. Their suggestions have been found useful. It was possible during the year to convene the meetings of the three panels mentioned below:

(1) Panel for Carbon Products

(2) Panel for Weights and Measures Division, and

(3) Panel for the Heat Division.

Meeting to Co-ordinate the Work on Ferrites in Different Laboratories

Work on ferrites is being carried out in various laboratories in the country. To maintain proper liaison and avoid unnecessary duplication, a meeting of workers in this field was held on 12-9-1966. The conclusions arrived at are given below:

(1) At present there is no unnecessary duplication in the CSIR laboratories engaged on the development of ferrites,

(2) Each institution should be allowed to work on ferrites on a laboratory scale and take up problems suiting the talent, material and resources available locally, and

(3) When the work has come to a stage where it requires processing it on to a pilot-plant scale, it should be considered whether it could be done at the pilot-plant in NPL.

Public Relations Activities At The NPL

I. THERMOMETRY GET-TOGETHER

13th to 17th February 1967

The Get-Together enabled the scientists and the manufacturers to understand each other's problems. It was inauguarated by Mr. J.A. Hall of the Bureau International des Poids et Measures, Paris. An exhibition of Temperature Measuring Instruments and books on this specialised subject was organised for the benefit of the delegates Fig (1)

During the Get-Together, 57 papers and 58 problems on the specialised field of thermometry were discussed. The papers have been published in the following sections:

1. Concepts and Temperature Scale
2. Glass Thermometry
3. Meteorological and Biological Thermometry
4. Instruments and Sensors; and
5. Applications, Gadgets and Recipes.

II. KRISHAN MEMORIAL LECTURE

30th January 1967

Dr. S. Bhagvantam, Scientific Adviser to the Minister of Defence, delivered the Third Krishnan Memorial Lecture on "Magnetic Effects in Crystals" before a select gathering of scientists of Educational and Scientific Organisations in Delhi, Fig. (2)

III. OPEN-DAYS AT THE NPL

30th and 31st January 1967

Open-days were organised for the second time, to afford an opportunity to the general public, industrialists and students to see the achievements of the Laboratory.

Press Conference: The objectives of the Laboratory and its achievements were explained to the representatives of the Press on the first day. They were taken round the Laboratory and the exhibition which was specially organised for this occasion. The visitors were shown 3,000 kgf dead weight testing machine, abrasion testing machine, hydraulic extrusion and workshop processes, pilot plant for carbon products, ionosonde room, radio services and ionospheric studies, radio noise from sun, use of galactic radio noise, determination of solar flares and nuclear explosions, solar energy compound, development and production of electronic

components, testing of refrigerators, liquid air plant, planetarium and a large number of other exhibits. The Planetarium was a favourite with the students.

Press Reports: It was gratifying to note that the important achievements of the Laboratory were brought to the notice of the public by the Press. The Press also publicised the important work done in the three *pilot plants* of the Laboratory, which had been responsible for a considerable saving of foreign exchange.

Visitors: Over 5000 students from the educational institutions, over 500 persons from the industries and about 1000 from the general public visited the Laboratory on "Open Days". (Fig. 3)

Brochure: In order to acquaint the public with the scientific activities of the Laboratory carried out during the last two years, a brochure in English was brought out and distributed to the visitors.

Enquiries: As a result of the "Open Days", the Laboratory has begun receiving a number of enquiries regarding the problems as well as the developmental testing to be undertaken by the Laboratory for the industries. The enquiries received during the year have been shown under service (p. 14)

NPL Technical Bulletin

The Laboratory has started a new activity in January 1966, by bringing out a Quarterly Technical Bulletin, which may be considered as a great landmark in its history. This has enabled the Laboratory to maintain proper liaison with the Universities, research organisations, Government departments and general public. As a result of this publication, a good number of enquiries are being received from interested parties, and calibration and testing work has increased. The publication has been well received in the country and outside.

The Bulletin deals with the important work carried out by the Laboratory. In addition, information about the projects handled by the Laboratory, papers published, technical services rendered, the lectures given by NPL scientists and visiting scientists, seminars and Get Togethers held at NPL and technical surveys is also published. Information about current projects of the Laboratory has been found useful by other laboratories as it helps to avoid unnecessary duplication of work. The articles published in the Bulletin are being reproduced by Technical Journals and are also given wide publicity by the Press. A list of the important articles published in the Bulletin is given below:

1. The National Physical Laboratory.
2. Reconditioning of Mercury Arc Rectifiers

Fig. 1. Visitors to exhibition of thermometers.

Fig. 2. Dr. S. Bhagavantam delivering "Krishnan Memorial Lecture".

Fig. 3. Visitors to the exhibition.

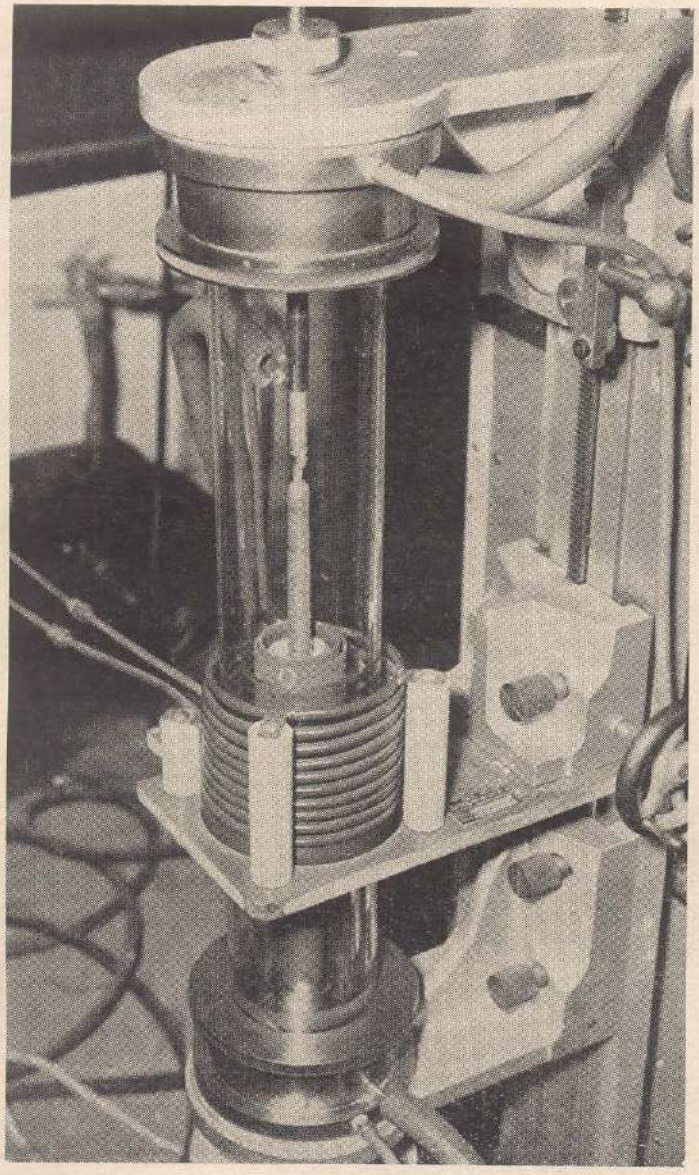


Fig. 4. Crystal pulling equipment.

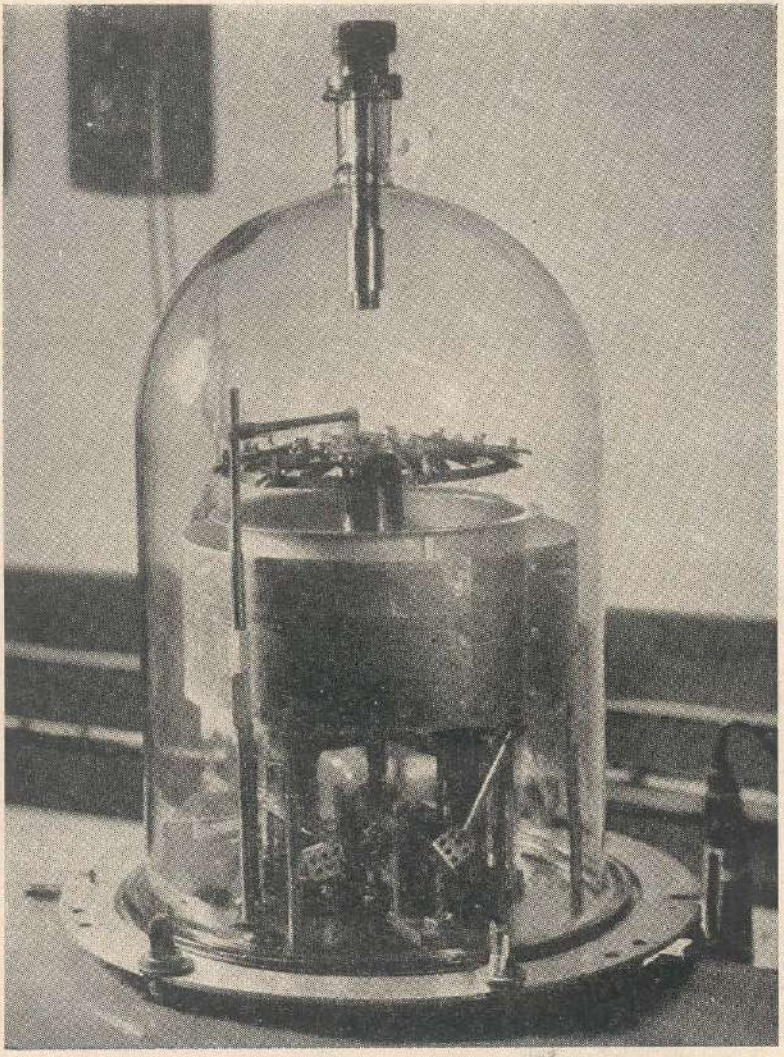


Fig. 5. Vacuum evaporation unit for production of interference filters.

3. Krishnan Memorial Lecture on the Evolution of the Government Science Relationship in the United States by Prof. Fredrick Seitz
4. What to look for in a Refrigerator
5. Propagation of Sound in Sand and Soil
6. Daylight Studies
7. Sirens—Old and New
8. Materials Research Programme in USA
9. Photometric Standardisation and Testing
10. Crystal growth and Polytypism
11. Precision Platinum Resistance Thermometry
12. Mercury Filling Equipment for Clinical Thermometers
13. Clinical Thermometers: Their Testing
14. Interferometers for Optical Testing
15. Chromatographic Studies at NPL
16. An Automatic Recording Infrared Spectro-photometer for Region 1 to 3 microns
17. Radio Detection of Atmospheric Nuclear Tests.

Scientific Activities

It has been mentioned earlier that the number of divisions in the Laboratory has been reduced from 22 to 14. This has led to better coordination of the work, which is project orientated, requiring inter-divisional collaboration.

The scientific activity of the Laboratory, as in the previous year, has been classified under six separate categories. The progress of work done on the projects falling under the different categories is given separately. Thirtynine investigations out of eightyone have been completed during the year . In this report only a few selected projects have been mentioned. This year, inter-divisional projects, called Laboratory Projects, have been introduced.

Laboratory Projects

There are certain areas in which immediate development of know-how is necessary from the point of view of the country's industrial development and defence requirements. These areas include solid state devices, micro-miniaturization, crystal growth and a few of similar type. It is obviously not possible for one single individual or a single division devoted to a narrow specialised field to develop the complete know-how in these fields. Taking for example the case of solid state devices, the project starts with making pure silicon and ends with a fabrication of a device

which will be acceptable to the industry. This range of activity requires the help of specialists in diverse fields such as chemists, analysists, material scientists, those trained in the electronic circuitory, solid state physics, etc. Hence a few Laboratory Projects have been formulated, taking into consideration the immediate need of the country, wherein specialised knowledge of various divisions would be pooled to work out the given project and achieve the desired objective within a specified time. It is hoped that such cooperative efforts would bear fruits. The projects so far formulated are:

1. Solid State Electronics Devices,
2. Thin Film Devices, and
3. Crystal Growth.

Solid State Electronic Devices

In the Laboratory project on solid state devices, the aim has been to develop complete know-how of various solid state devices which are vitally needed by industry and defence and which are being currently imported. This project is divided into two interdependent groups, namely, the cookery group and the testing group. The cookery group is charged with the responsibility of the developmet of know-how of (1) obtaining pure materials such as silicon, gallium arsenide, etc; (2) casting and zone refining; (3) cutting, lapping and polishing; (4) impurity diffusion; (5) contacts and encapsulation. (Fig. 4)

The testing group which includes scientists from chemistry division, X-ray section, low temperature section, electricity division, etc., tests the materials at every stage of development. These test include: (1) the purity of materials by chemical, X-ray and spectrochemical methods, (2) determination of the crystalinity of the zone refined specimen and its orientation, and (3) determination of galvanomagnetic properties, diffusion length, impurity profile, carrier mobility, etc.

The testing group feeds the information to the cookery group which in turn alters suitably the recipie.

Thin Film Devices

The second Laboratory project is on thin films. This project is designed ultimately to lead us, in coordination with the earlier solid state device project, to develop micro-miniaturization of electronic circuitory. At present, the laboratory project on thin films is divided into two parts (1) devoted to the development of optical devices such as metal-dielectric-metal filters, narrow band pass multilayer filters, neutral density filters, etc., all of which are being presently imported (Figs. 5 & 6), and (2) the other dealing with the fabrication of thin film resistors which have several advantages for communication purposes such as low noise, good high

frequency response, etc. (Fig. 7). In this project also, the interdisciplinary approach is pursued in as much as scientists from the divisions of optics, chemistry, electronics, basic physics, work hand in hand. In all these thin film activities, it is very essential for the sake of reproducibility, to monitor the thickness of the thin film and to control the rate of evaporation, and the electronics division is engaged in developing these gadgets.

Crystal Growth

In the present day technology, the need for pure single crystals of various materials cannot be over-emphasized. It is our aim to provide facilities so that crystals of any material could be grown by one of the several available techniques developed. Consequently, a group has been organised to work on crystal growth. This group will grow crystals from melt, solution, using hydrothermal, flux, flame, fusion or other methods.

Progress of Laboratory Projects

During the short time of four months, that we have been working on these Laboratory projects, the results obtained have been encouraging. In solid state devices project, we have been able to make pure silicon tetraiodide, cast silicon powder in rods as long as 25 cm, zone refine them, etc. All the test facilities have also been rigged up to determine carrier concentration, carrier mobility, diffusion length, crystalinity, Hall effect, etc.

In the thin film project, the complete know-how for metal-dielectric-metal filters has been developed and batch production is being contemplated. Most of the preliminary work on thin film resistors has been carried out and it is hoped that we will be in a position to develop these very shortly. A thin film thickness monitor and an automatic controller have been fabricated using indigenous components to control the thickness of thin films within a few angstrom units. (Figs. 8 & 9).

In the crystal growth project, we have been able to grow single crystals of tin, cadmium, aluminium, calcium fluoride and also of tiny ruby.

Research Activities

The research work, which can be broadly described as basic-objective, has been dealt with under developmental activities. There have been over 85 research investigations spread over various divisions and reported in Appendix I. Some of the research activities, namely, the Laboratory Projects on Solid State Electronics Devices, Thin Film Devices and Crystal Growth, have already been mentioned.

Sirens

The testing of sirens reported last year had shown that the radiation of sound from a siren is not uniform in all directions, resulting in low

efficiency of sound radiation in the desired direction. To improve the efficiency, it was thought necessary to carry out investigations by providing a canopy to increase the directionality of sound radiated in the desired direction. Experiments are being conducted by providing a suitable canopy on a small model source of sound with non-directional properties.

Another important aspect of the problem is to find the sound output of the sirens. This is being studied by the reverberation chamber method.

Insulating Materials

With the development of the manufacture of electrical appliances, especially for household services, the question of safety assumes great importance, especially as these appliances are mostly manufactured in the small scale industries sector. The safety, in turn, depends upon the electrical insulation provided. With a view to helping the industry by providing data on indigenously available insulating materials, investigation was undertaken on these materials under high temperature and high humidity conditions.

Daylight Studies

The importance of these studies was indicated in the last Annual Report. It was found that the distribution of the chromaticities for Delhi could be explained in terms of the meteorological factors for Delhi. This distribution has been found to be different from that of other countries. A note on this subject is being submitted to the Commission International De L' Eclairage.

New Rocket Experiment

Another important activity is the New Rocket Experiment for studying the lowest part of the ionosphere by measuring the radio noise from the galaxy. This experiment was conducted on March 16, 1967 in collaboration with National Aeronautics and Space Administration (NASA), USA. The rocket was launched from Wallops Island, USA.

This is a new experiment conceived and designed in the NPL, and is expected to be superior to the other available rocket experiments, for the study of the lower atmosphere between 50-70 km.

The experiment is based on the cosmic noise technique in which the ionosphere absorption is estimated by measuring changes in the cosmic radio noise. This technique, known as the Riometer technique (Relative ionospheric opacity meter), is now being used on a world-wide scale for studying the normal ionospheric absorption as well as flare time excess absorption. Fig (10)

Preliminary data showed that the experiment is successful. It is proposed to conduct further flights from Thumba Equatorial Rocket Launching Base, near Trivandrum.

Fig. 6. Interference filter.

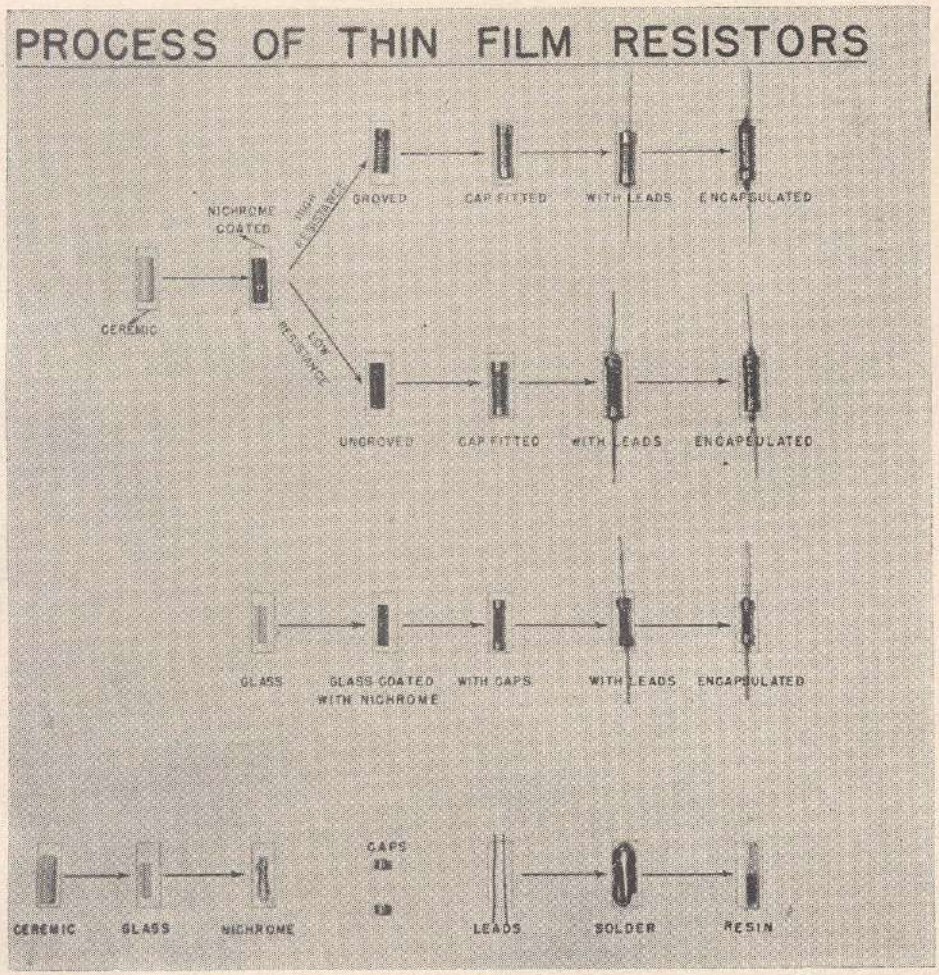


Fig. 7. Thin film resistors.

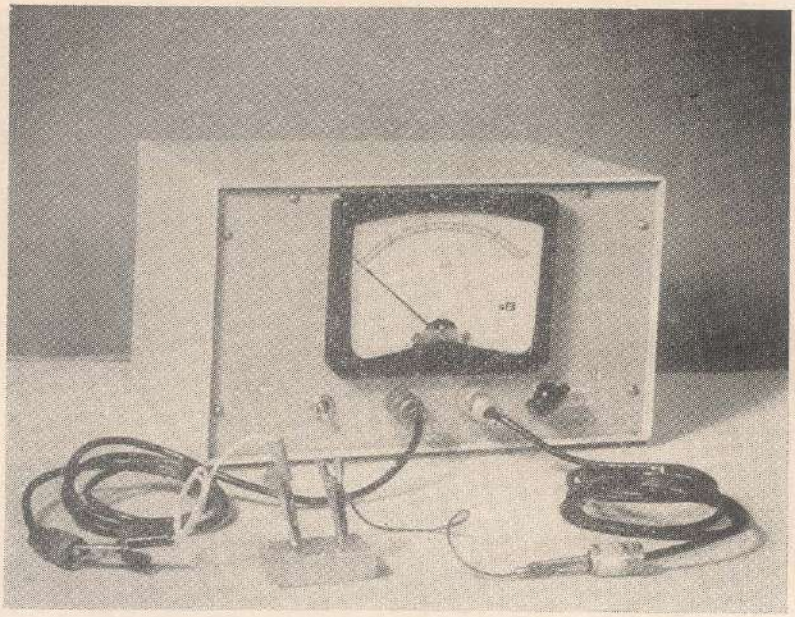


Fig. 8. Thin film thickness monitor.

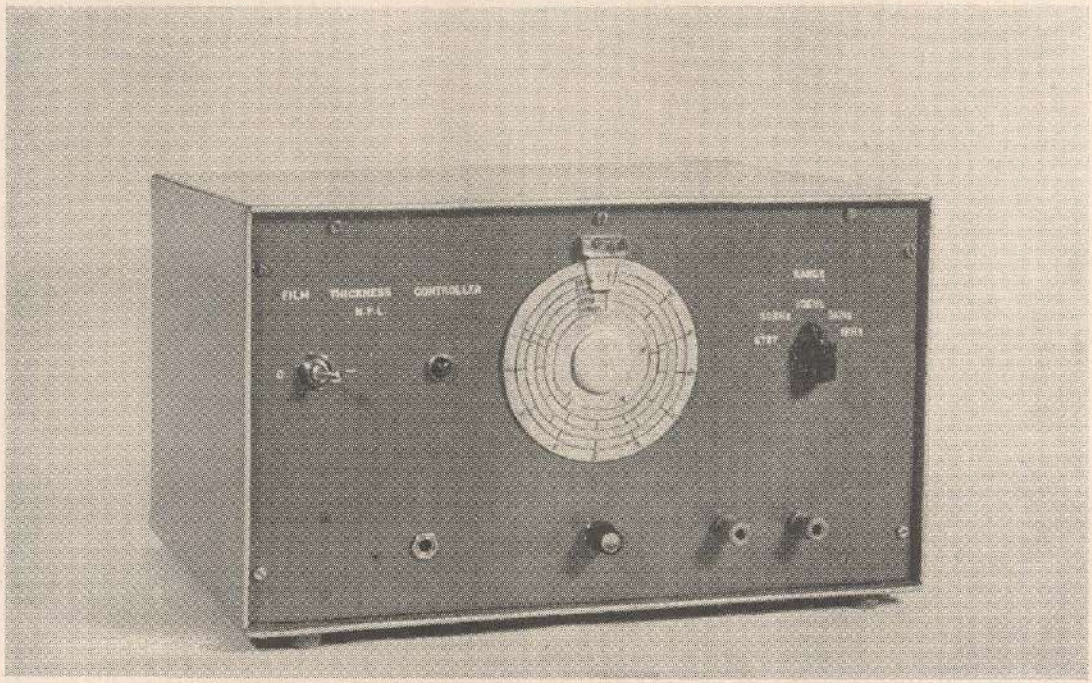


Fig. 9. Thin film automatic controller.

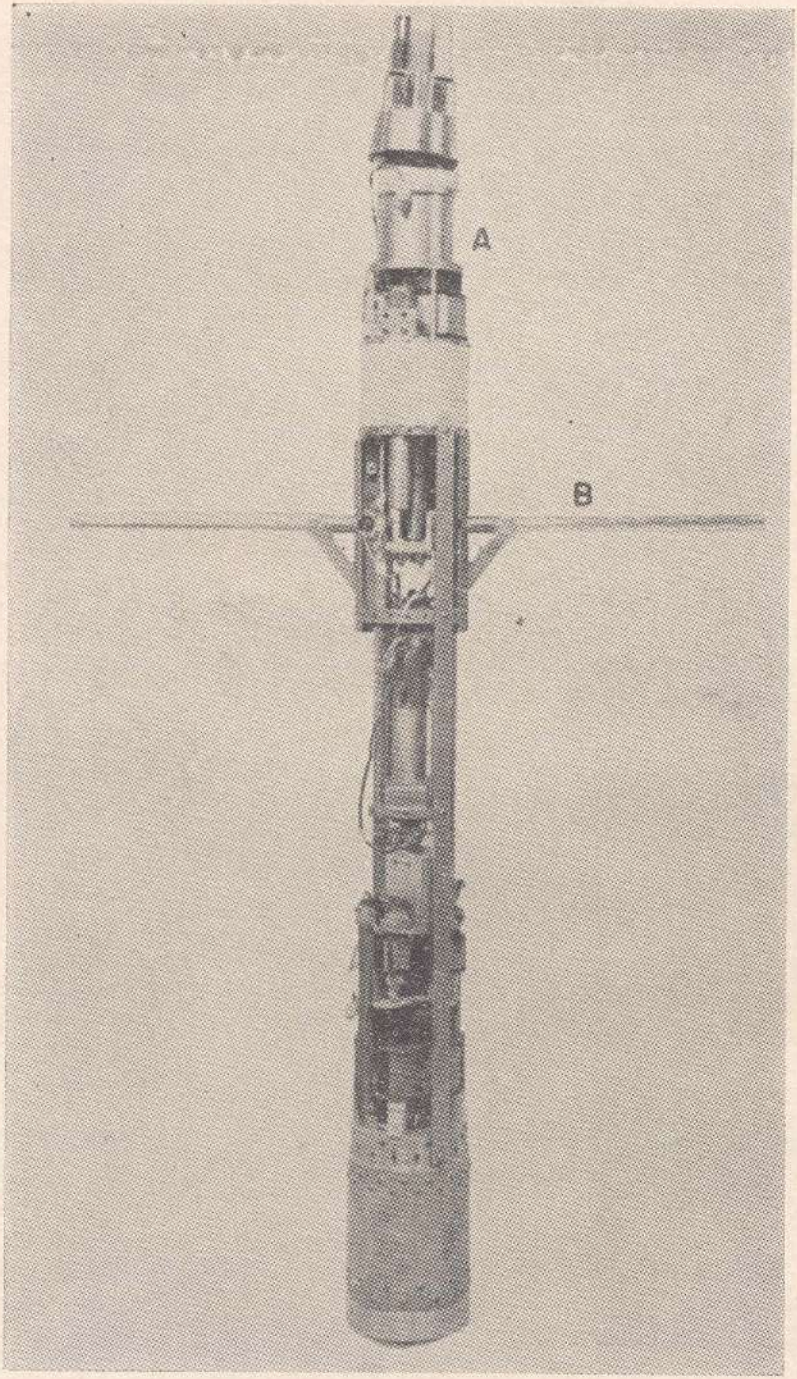


Fig. 10. Complete payload of Nike—Apache Rocket.

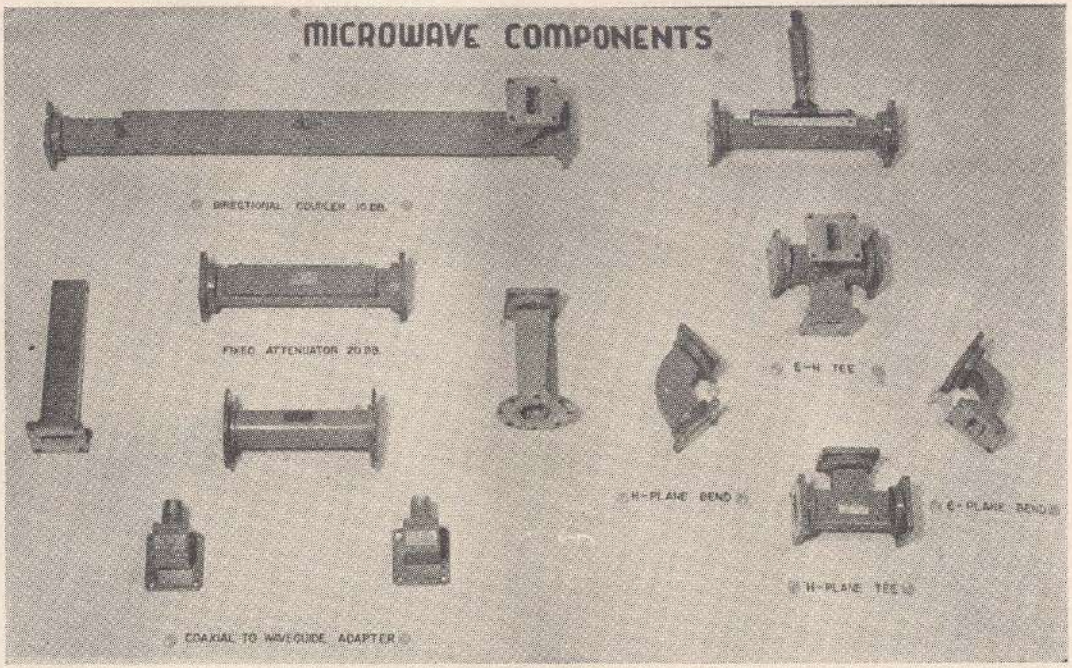


Fig. 11. Waveguide components.

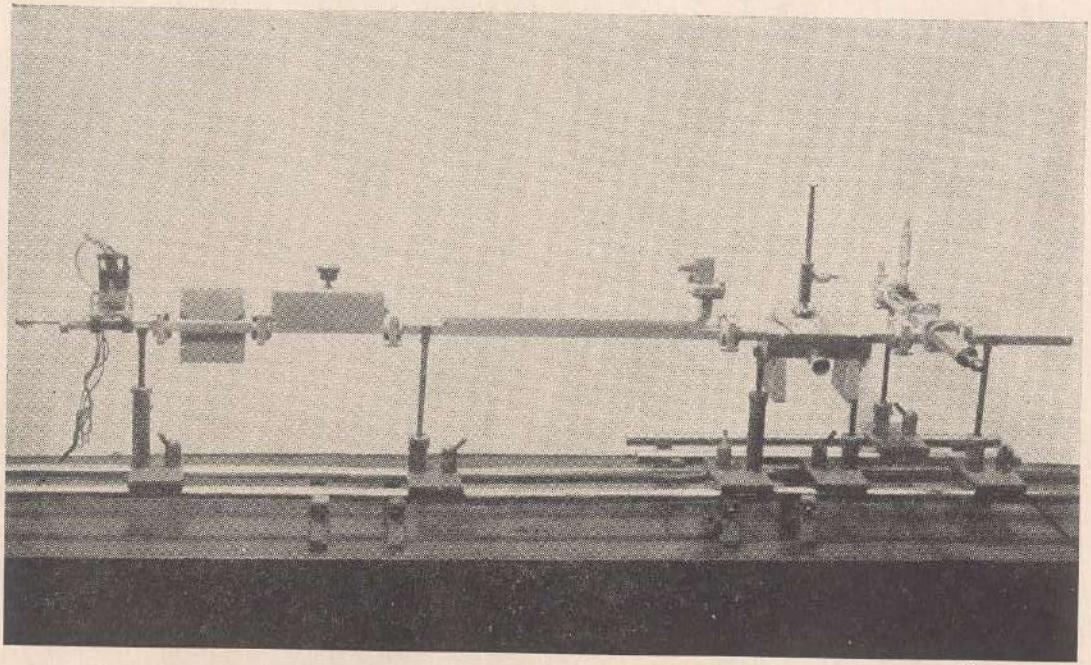


Fig. 12. Microwave test bench for 3-cm band.

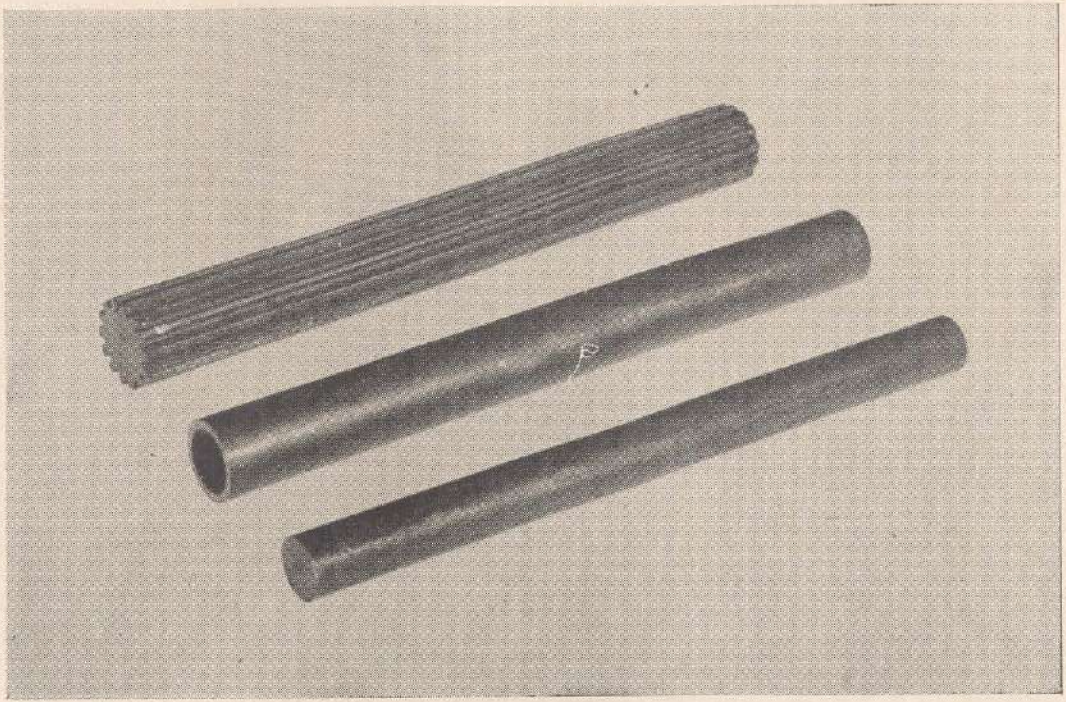
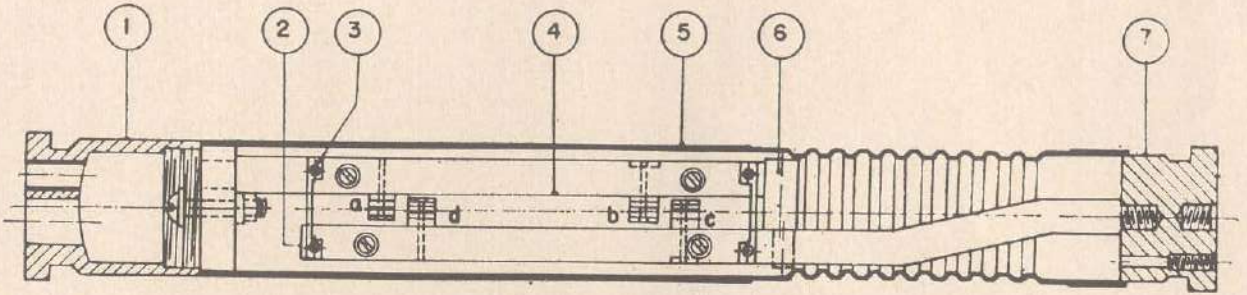


Fig. 13. Extruded solid, tube and finned rods of lead.

CARLSON STRAIN METER



(1 , 7) FLANGES.
(2 , 4) MILD STEEL BARS.
(3) ELASTIC FLAT STEEL SPRING.
(5) BRASS TUBE.
(6) ECCENTRIC STOP.
(a)(b)(c)(d) CERAMIC SPOOLS.

Fig. 14. Carlson strainmeter.

Developmental Activities

There have been over forty developmental investigations spread over various divisions and listed in Appendix II.

Optical Data

Optical instruments are widely used in scientific institutions and in industry. With the scientific, technological and industrial development of the country, the optical industry is now rapidly growing to meet the demands made on it. The development of the optical glass in the country has also helped in this growth.

One of the difficulties of the industry has so far been the non-availability of "Optical Data" for various systems to be manufactured in the country. The "Optical Data" worked out in the Laboratory are released to the industry on payment of a nominal fee, which varies from system to system. The manufacturers submit two prototypes of each system for laboratory tests,. The Laboratory also offers advice to the industry for improvement of their existing designs. About fifty systems have so far been designed, and the industry has taken advantage of nearly thirty systems.

Process Carbons

As a corollary to the work on projector carbons, which had already been developed, work on process carbons was undertaken. These are high intensity arc carbons, having applications where a source of high brilliancy is required, and are used in photo-lithography and printing industry for block making. Various sizes of carbons ranging from 12 mm diameter to 22 mm dia. (cored, non-coppered) have been made and tested. These have been found satisfactory by the users. A few thousand rods have been sold to the industry. The commercial development of technical know-how would save foreign exchange, as these carbons are being imported at present.

Microwave Test-Bench

Microwaves are being increasingly used day by day in radars, in microwave communication systems, in research, etc. Consequently, study of microwave techniques is forming an important part of the syllabus for engineering students and postgraduate physics students, specialising in electronics and communications. The microwave components used in the above mentioned applications and for teaching purposes, are being imported. Due to the shortage of foreign exchange, most of the universities and colleges are not properly equipped for experiments in microwaves. With the idea of import substitution, work was undertaken in the electronics division of the Laboratory on the design, development and fabrication of microwave components, and prototypes of 25 components, including ferrite isolator and circulator normally used in a test-bench, have been

developed (Fig. 11). A complete microwave test-bench for 3 cm frequency band to be used for teaching and research purposes has been fabricated. The establishment of batch production unit, to meet the demands of the Universities, colleges and research institutions, is being considered (Fig. 12).

Binary-Quinary Decade Counters

Techniques were developed for a binary-quinary decade counter, particularly, diode-logic was replaced by resistance-logic. The work may be considered basic-objective, as the circuit developed will form the basis of developments of counting techniques, and also for use in instruments like counter-type frequency meter.

A Constant R.F. Amplitude Oscillator for R.F. Standards

Another example of a basic-objective work is that of a constant amplitude r.f. oscillator. This was developed by proper application of negative feedback in the oscillator circuit, In the r.f. voltage standardisation project this work has come handy. A complete instrument based on this work is now being assembled. In this instrument, the r.f. voltage will be taken in overlapping ranges, say 1 to 3 mc/s, 2.5 to 6 mc/s, 5 to 10 mc/s, and so on, upto say 20 mc/s.

The voltage at the lower frequency, say 1 mc/s can be measured using the conventional thermocouple technique, and the voltage so measured can be taken to standardise the voltage at high frequency, where the thermocouple technique fails.

Harmonic Generators

Work on harmonic generation started as a basic objective work. The varactor diodes and the step-recovery diodes were studied for obtaining optimum harmonic generation.

The work developed is now being utilised for Microwave Standardisation . A chain of frequency will be obtained by the process of amplification and harmonic generation, which will be locked to the 100 k.c., master frequency of the high precision quartz resonators already available in the Laboratory. Also the harmonic generation so obtained will be used for obtaining a solid state microwave source as a substitute for the klystrons. Starting from a frequency of 300 mc/s generated by means of vacuum tube or transistor, the frequency would be multiplied in steps to obtain a number of microwave frequencies for utilisation in microwave investigations in the Laboratory and outside.

Hydrostatic Extrusion of Metals and Alloys

Hydrostatic extrusion of metals is the newest metal forming process in which the billet is extruded under a uniform all round pressure. The method has several important advantages over the conventional extrusion process viz. (i) low extrusion pressures (ii) better surface finish, and

(iii) more uniform mechanical properties. The process is particularly useful for the extrusion of difficult metals like tungsten, beryllium etc., in which a uniform hydrostatic pressure prevents cracking. The Laboratory has taken up experimental work to develop an extrusion press. It has been possible to build a small machine which can generate pressures up to 50,000 p.s.i. Preliminary studies have been made with the extrusion of lead. Various shapes such as solid rod, tube and finned rod, have been extruded Fig (13). Dies in EN24 heat treated steel are now under fabrication for the extrusion of various shapes in commercially available pure aluminium. A double cylinder is being designed to obtain extrusion pressure upto 100,000 p.s.i. With the new machine we shall be able to extrude satisfactorily aluminium and its alloys, and different combinations of brass and copper. The experience with this double cylinder will be utilised later in the construction of extrusion press for pressures upto 250,000 p.s.i. for the extrusion of alloy steels and other difficult metals.

Carlson Strain Meter

The Carlson type of strain meter is an instrument used for finding strains in heavy concrete structures such as dams, tunnels, foundations and bridge piers and has provided valuable data for the design and construction of these structures. The instrument has the advantage that in addition to strain, it is capable of measuring temperature also with the same set of observations. The meter has fairly high resistance and, therefore, amplification is not necessary for accurate measurement.

The construction of the strain meter is shown in Fig. 14 It consists essentially of two steel bars (2) and (4). One end of each of the two bars is free while the other end is rigidly fixed to a flange (7) or (1). The two bars are linked together by elastic flat steel springs (3). Two tiny ceramic spools (a), (b) or (c), (d) are screwed on each bar as shown in the diagram. Two identical coils of fine steel wire of diameter 0.0025" are wound under an initial tension of 100,000 p.s.i., one round the spools (a) and (c) and the other round the spools (b) and (d). The coils are wound in such a manner that when one of them is in compression, the other is in tension and vice versa. For example, when the flanges are pulled apart, say on account of the expansion of the material in which the strain meter is embedded, the outer coil wound on the spools (a) and (c) is in tension while the inner coil carried by the spools (b) and (d) is in compression. An eccentric stop (6) guards against possible breakage of the coil caused by either mishandling or excessive deformation. The whole assembly is enclosed in a brass tube (5), a portion of which is corrugated to increase its flexibility. To prevent corrosion of the coil, the tube is filled with a corrosion resistant oil. A cotton tape wound on the periphery of the brass tube prevents its adhesion to the material in which the strain meter is embedded.

The two coils are connected in series and a three lead cable is provided to connect the resistances to the measuring bridge. The green wire

of the cable is connected to the common terminal of the two resistance coils while the black and red wires are joined to the free ends of the inner and outer coils respectively. Such an arrangement permits measurement of the total resistance of the coils as well as the resistance ratio of the two coils.

The meter is required for the construction of dams and other heavy concrete structures and is at present being imported from Japan. The National Physical Laboratory has been able to make the instrument indigenously. Rigid tests have been carried out and the instrument has been found to behave satisfactorily. The process is being leased out to the industry. The Laboratory would test and calibrate each individual instrument to ensure quality.

STANDARDS

There have been over 10 investigations regarding the setting up, maintenance and improvements on Standards. These investigations have been carried out by various divisions and listed in Appendix III.

Acoustics Block

For most of the experimental work on acoustics, (whether research, standardisation, developmental testing or calibration), two environmental conditions are essential; one, that there should be no interference from extraneous noises, and the other that, either there should be no reflection from the surroundings, or there should be a diffuse sound field within the enclosure.

These requirements which are common to almost all acoustic measurements are particularly needed for primary calibration of the standard microphone, testing and calibration of microphones, sound level meters, loud-speakers and other devices, measurement of auditory thresholds, measurement of noise, etc.

So far the work requiring free field conditions has been done in the open, subject to conditions of wind, weather, ambient noise and reflections from surroundings. Work requiring diffuse field has been done in improvised rooms which do not conform to the International Standards.

In order to meet the ever increasing demands of industry, and to equip ourselves with the necessary facilities to carry out the above mentioned tests, a special Acoustics Block has been designed and is under construction. Unlike other buildings, this block is entirely functional in character and consists of three specially designed chambers to provide the necessary acoustical environment for various kinds of measurements on sound. It includes an anechoic room and two reverberation rooms which also form a set of transmission rooms. A double wall construction is employed to

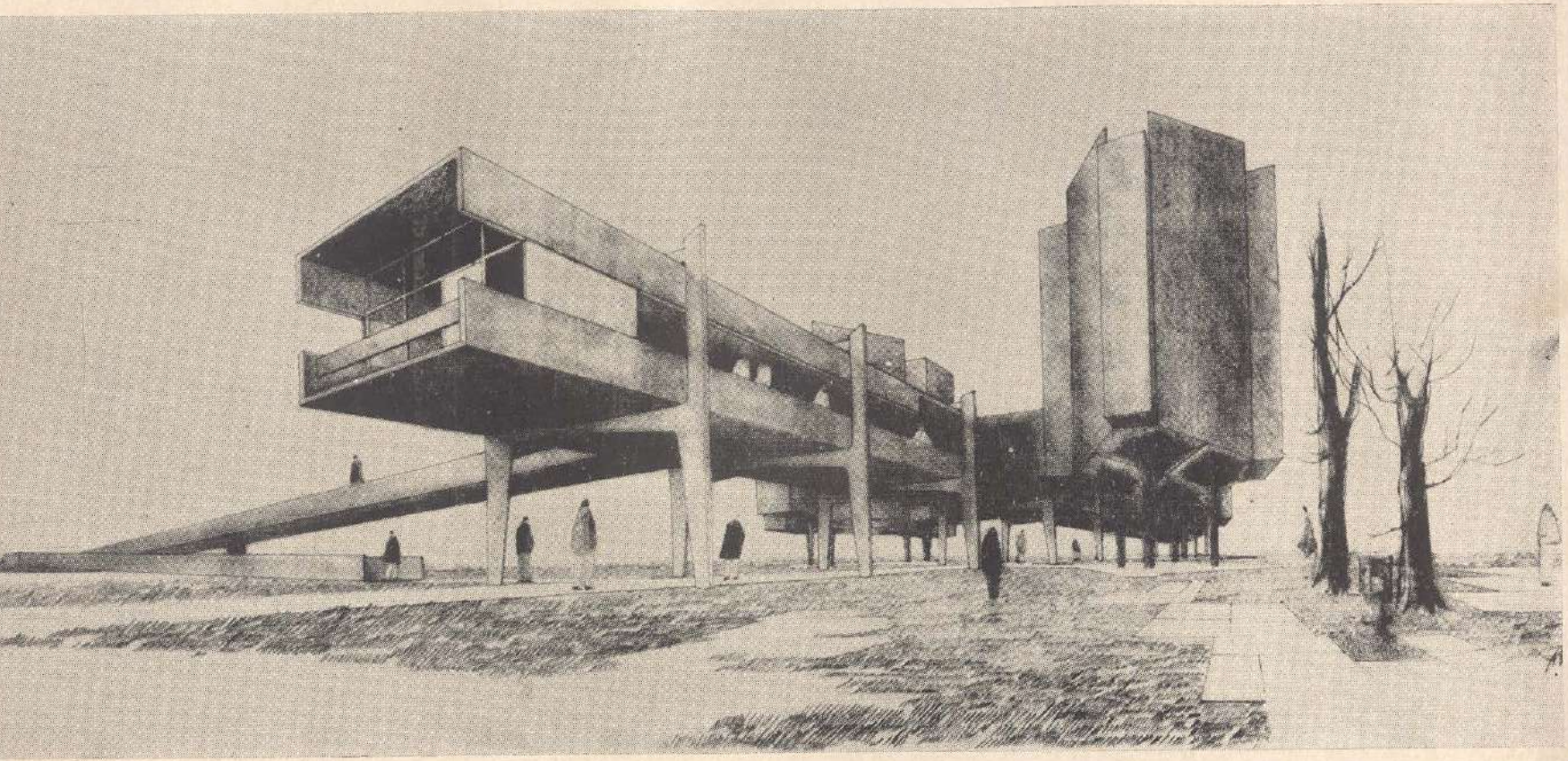


Fig. 15. Artist's view of Anechoic block.

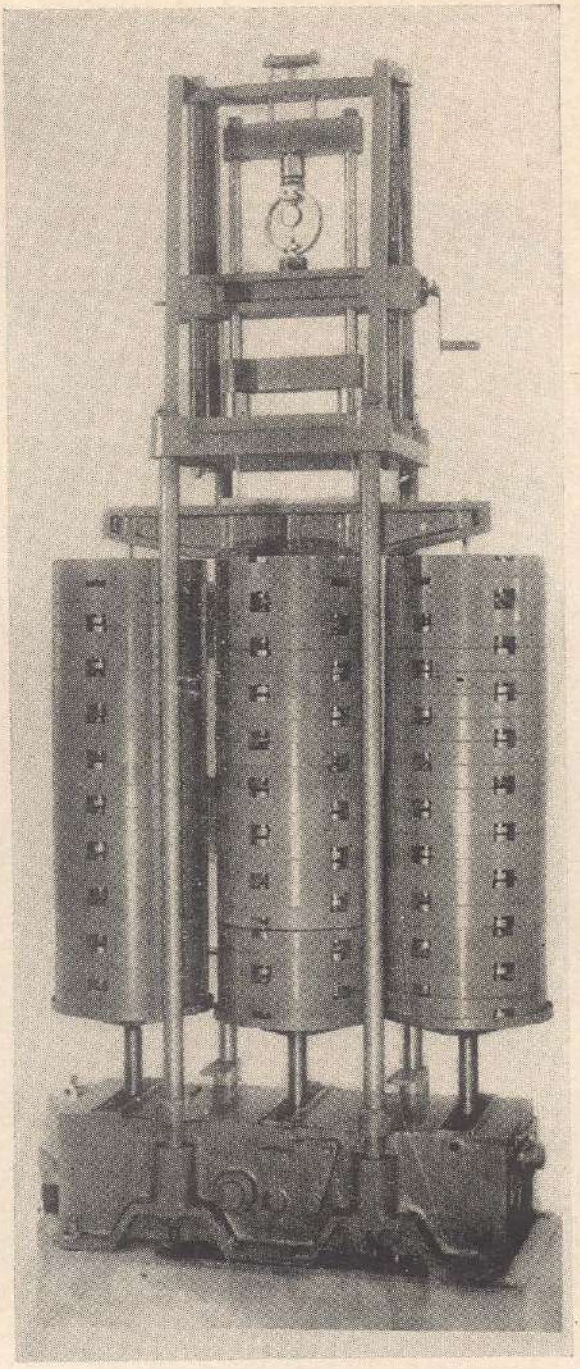


Fig. 18. 3 000 Kgf. dead weight machine.

provide adequate noise insulation, and the inner chamber in each case is floated to provide vibration damping in all the rooms (Fig. 15).

The anechoic room is intended to simulate free-field conditions in the audio frequency range with low ambient noise. The design of the sound absorbing treatment is entirely indigenous and the chambers are the first in the country to make use of locally available materials.

The reverberation transmission rooms are intended to provide highly reflecting boundaries to reflect sound and contain additional diffusing elements to provide the required reverberation and diffusion.

These chambers are designed to conform to the relevant International Standard Specifications.

One Ohm Standard Resistances

The division of electricity has fabricated 1 OHM standard resistances, which are required by scientific institutions and instrument manufacturers for their research and developmental work. At present these are being imported. To stop the imports and also to help these organisations, the division has successfully fabricated "Four Terminal 1-Ohm Standard Resistances" using properly annealed and aged "manganin" coils for direct sale to genuine users with a condition that these could not be resold Fig (16). The Division will undertake to recheck the value of the resistances at an interval of one year without any calibration charges.

The resistance coils are sealed in a suitably designed cylindrical vessel containing moisture and air free insulating oil and the values of the resistances have been observed to remain stable within 5 parts in a million, over a period of one year.

Accurate Measurement of R.F. Power upto Microwave Frequencies

The Laboratory has been equipped so far for the testing of instruments at power frequencies, and testing at higher frequencies was not being undertaken for lack of facilities. A need for these facilities has been felt and, therefore, facilities have now been established for measuring r.f. power upto microwave frequencies with an accuracy of about 2%. These measurements are carried out in terms of primary d.c. standards of voltage and resistance. Measurements upto 10 watts are directly carried out using self-balancing bridges. For higher powers, calibrated attenuators are used. These facilties would be useful for calibration of signal generators and power meters upto microwave frequencies. (Fig. 17).

3 000 Kgf Dead Weight Machine

The machine mentioned in the last report has been completed and is being used as a standard equipment for the calibration of proving rings

and dynamometers. (Fig. 18). A Technical Report describing the design features is being brought out.

Calibration and Testing

The calibration and testing activities continued as in the previous year. However, in the division of electricity there was an increase in the calibration of electrical instruments which may be indicating that the instrument industry is developing in the country. Calibration of universal testing machines used by various industries was carried out at site by the Division of Mechanics as these machines could not be transported to the Laboratory for calibration.

Broadcast of Standard Time and Frequency

The broadcast of Standard Time and Frequency Signals was carried out from the station 'ATA' located at Kalkaji, South of Delhi. This year the broadcast time has been increased from 2 hours to 4 hours. High precision required for such broadcast is maintained and checks are also made against similar broadcasts by stations located in other countries. The standard carrier frequency is 10 mc/s.

Service To Institutions

Service to institutions, universities, Railways and other Government Departments was rendered on about twenty different subjects listed in Appendix V.

In addition to the above, enquiries from 138 private organisations and 86 Govt. Departments were received. Technical advice was rendered to the above enquiries did not require any Laboratory work.

A.R. VERMA

Director

APPENDIX I

RESEARCH INVESTIGATIONS

(*) New Investigations

Code No. and investigation (1)	*Progress* (2)	*Team* (3)	*Reference* (4)
A/R/1 Propagation of sound waves in granular media	Work completed. Laboratory Report prepared	Pancholy, M. & Bindal, V.N.	A:1
A/R/2 Study of kinetics by ultrasonic methods	Work completed.	Pancholy, M., Saxena, T.K. & Singal, S.P.	A:6.
A/R/3 Response of loud-speakers to warble tones	Work completed. Paper under preparation	Chhapgar, A.F., Pancholy, M. & Shrawan Kumar.	
A/R/4 Absorption of sound by indigenous wedge structures	Work on materials for lining of anechoic chambers was further continued in the 40 cm standing wave duct already set up for the purpose. Different grades and densities of available polythene foams were examined. Jointless wedges of polyether foam, now available were studied in detail.	Pancholy, M., Chhapgar, A.F., & Bansal, S.C.	
A/R/5 Physical aspects of architectural acoustics	Field measurements in eight more halls were taken and the results analysed with a view to studying the correlation between design parameters and actual acoustical characteristics of the halls.	Pancholy, M., Chapgar, A.F. & Davinder Singh.	

(1)	(2)	(3)	(4)
A/R/6 Noise	The results of noise survey carried out in Calcutta were analysed and a paper on the subject sent for publication.	Pancholy, M., Chhapgar, A.F. & Singal, S.P.	
A/R/7 Study of steels by ultrasonics	Trial runs on the steel samples taken with the equipment fabricated earlier for the purpose indicated that in some cases the attenuation encountered was very high and it was found necessary to change the design of the oscillator to give higher power and pulses of shorter duration than those obtained with the existing equipment. This has accordingly been done and the r.f. oscillators, associated power supplies and pulse amplifier have been redesigned.	Pancholy, M., & Shrawan Kumar.	
*A/R/8 Improving the efficiency of Indian made sirens	The project has been broken up into several parts, two of which were taken up for investigation: (a) To provide a canopy to impart directionality to the sound radiated, open air measurements on sound intensity and polar response in different planes were carried out and sound power output estimated. In order to evolve a suitable canopy, it was decided to work on a reduced scale model for which various small sources of sound with non-directional output properties were tried out to simulate the output of a siren.	Chhapgar, A.F., Pancholy, M. & Bansal, S.C.	

(1)	(2)	(3)	(4)
	(b) To correlate the airflow pressure with sound output, two sirens of 5 h.p. capacity were obtained from manufacturers. Air flow measurement in these samples was made with an anemometer. A pitot tube has been designed and fabricated for more accurate air flow measurement. Sound power output of the two sirens was also determined by the reverberation chamber method.		
*A/R/9 Sonoluminescence	The study of luminescence in liquids produced by high energy sound waves was undertaken. The necessary equipment was assembled and preliminary observations taken.	Pancholy, M. & Sidkey, M.S. (UAR guest worker)	
AC/R/1 Use of cinnamic acid derivatives in inorganic analysis	Work completed.	Gupta, P.K., Verma, M.R. & Agarwal, K.C.	
AC/R/2 Nitroso derivatives of substituted diaryl amines	Work completed.	Gupta, P.K., Verma, M.R. & Agarwal, K.C.	
AC/R/3 Estimation of phenyl naphthylamine	Work completed.	Gupta, P.K., Verma, M.R. & Agarwal, K.C.	
AC/R/4 Thin layer chromatography of dyes used in tablets and other speciality inks	Work completed.	Rai, J. & Verma, M.R.	AC:1

(1)	(2)	(3)	(4)
AC/R/5 Studies in thin layer chromatography of inorganic ions, Part I, separation and identification of Co, Ni, Cu, Zn and Cd	Work completed. Paper published	Raj, J., & Verma, M.R.	AC:2
AC/R/6 Complexometric determination of thorium and chromium in presence of one another	Work completed. Paper published	Amar, V.K., Agarwal, K.C., & Verma, M.R.	AC:8
AC/R/7 Studies on metal-oxalate complexes Part I, spectrophotometric determination of iron, nickel and copper in the presence of each other	Work completed. Paper under preparation.	(Mrs.) Padma Narayan & Bhuchar, V.M.	
AC/R/8 Studies in Metal-oxalate complexes Part II, determination of traces of iron in some pure metals	Work completed. Paper under print (Ind. J. Chemistry)	Kukreja, V.P. & Bhuchar, V.M.	
AC/R/9 Study of the method for the estimation of fluorides	Study of several standard specifications revealed that for calculating the fluoride content by gravimetric methods, a correction has to be made on account of a small stability of calcium fluoride in wash solutions. An uncertainty also exists in the volumetric determination.	Verma, M.R. & Rai, J.	

(1)	(2)	(3)	(4)
	Preliminary studies have shown that the error in the gravimetric and volumetric methods can be corrected by modifying the procedures suitably. A team of 'Material evaluation programme' of the National Bureau of Standards, Washington, during their visit to the NPL showed interest in this programme of work. Detailed investigations on the estimation of fluorides are being carried out.		
.AC/R/10 Chemical analysis of asbestos-cement compositions	Although the various specifications for asbestos cement products lay down broadly the composition, no method for the estimation of each of the constituents has been given. Chemical method based on the computation of soluble silica, lime and magnesia has been worked out. The preliminary report has been accepted for publication.		Verma, M.R., AC:9 Trehan, J.C. & Dabas, M.S.
.AC/R/11 Volumetric method for the assay of ferrous oxalate	Both ferrous and oxalate being reducing ions, react simultaneously when the solution is titrated against conventional oxidising agents like potassium permanganate or ceric nitrate. When the solution is titrated against dichromate, in addition to iron, oxalate is also particularly oxidised. A method has been worked out in which the steps of oxidation of ferrous and oxalate are separated out. The work has been completed and a paper is under print.		Verma, M.R., Amar V.K. & Gangopadhyay

(1)	(2)	(3)	(4)
.AC/R/12 Spectrophotometric method for the determination of minor quantities of iron in metallic nickel, aluminium, zinc and copper and their salts	A differential spectrophotometric method for the determination of iron in the metallic nickel, aluminium, zinc and copper and their salts has been worked out. Absorbance for iron oxalate complexes increases rapidly below 400 mμ while that for the respective metal oxalate is negligibly small. Measurements were carried out at 320 m/u. This method has been applied to several commercial products and has the advantage of simplicity and speed.	Bhuchar, V.M.	
.ECY/R/1 Survey and investigation of electrical insulating materials	The following investigations were carried out: (a) On mica (3 varieties): Effect of preheating at different temperatures for different periods on power factor at various frequencies. (b) On paper-base phenol formaldehyde laminates (4 grades): Effect of thermal ageing at 75° and 100°C for different periods on power factor at different frequencies. (c) On PVC tapes and sleevings, polystyrene, polythene and polymethyl-methacrylate sheets: Power factor and dielectric constant at different frequencies at room temperature. (d) Effect of thermal ageing at 120°C for different periods on power factor at various frequencies on only 2 grades of samples of phenol-formaldehyde laminates. (e) Effect of storing for different periods in saturated water	Dhar, R.N.	

(1)	(2)	(3)	(4)
	vapour on power factor of phenol-formaldehyde laminates (paper base), PVC tapes of different colours, polystyrene sheet, polymethyl-methacrylate sheets and polythene films.		
ECY/R/1	(f) Effect of immersion in water for 48 hours on power factor of phenol-formaldehyde laminates (paper base) and PVC tapes of different colours. (g) DC resistivity of biotite mica at room temperature. (h) DC resistivity of phenol-formaldehyde laminates (paper base) after 20 days soaking in saturated water vapour.		
*BP/R/1 Study of hyperfine interactions in magnetic materials using Mossbauer effect	The Fe-Ge system have been investigated in its ferromagnetic phase (Fe_5 Ge_3) using Mossbauer effect for Fe^{57}. This study clearly shows the presence of iron ions in two different sites giving two different of fields and throws light on the role played by metalloid atoms.	Date, S.K. & Bhide, V.G.	
	This technique can also be used profitably to study hf interactions in paramagnetic materials. The trivalent polynuclear iron complexes were investigated in order to understand the nature of exchange interactions in these complexes.		BP:1 BP:3
*BP/R/2 X-ray spectroscopy	A 40-cm Bent Crystal X-ray Spectrograph has been designed and constructed. The effect of chemical combination on the X-ray K-absorption edge of yttrium is being	Bhat, N.V., Rambhad, K.R. & Bhide, V.G.	

(1)	(2)	(3)	(4)
	investigated. The observed K-edge shifts have been explained on the basis of the nature of the chemical bond. The K series emission lines of these compounds are also studied using the secondary method of excitation. This reveals the inner $L_{II, III}$ levels in yttrium atoms.		
*BP/R/3 Investigation of the $SrTiO_3$ lattice through Mossbauer effect	$SrTiO_3$ lattice has been explored using Mossbauer effect. The study revealed the existence of two charge states in this lattice; Fe(III) and Fe(3^+). The ratio of these states could be varied by hydrogen firing. It has been shown that the stability of these charge states in this lattice does not only depend upon the ratio of the crystal field parameters Dq/B but also depends upon the stoichiometry of the substance.	Bhide, V.G. & Bhasin, H.C.	BP:2 BP:4
*BP/R/4 A new approach to current algebra	Weak currents are consructed from the phenomenological fields of hadrons themselves rather than from quark fields of symmetry group. Necessity of a ninth baryon Yo* is shown to close the algebra of the group.	Katyal, D.L.	TP:20
*BP/R/5 Baryon mass splittings in an SU(6) X 0(3) quark model (in collaboration with Delhi University)	The positive and negative parity baryon mass shifts are investigated under the assumption that these particles belong to the representations (56,1) and (70,3) respectively of the group SU (6) X O(3). Two different types of SU (2) invarient central forces, each of which is shown to be in conformity with the usual mass relations for the 56 states,	Katyal, D.L. Bhasin, V.S. & Mitra A.N.	

(1)	(2)	(3)	(4)
	are employed. The effect of an SU (2) invariant spinorbit force of the type of modest strength is found to be very helpful in producing a good fit to the actual masses of the negative parity baryons. A paper has been submitted for publication in the Phys. Rev.		
*BP/R/6 Dispersion sum rules for baryon compton scattering	Dispersion sum rules are derived from the consideration of high energy behaviour. New sum rules relating to baryon magnetic moment and transition magnetic moments of baryon resonances are derived. A paper has been submitted to Nuovo Cimento.	Vaishya, J.S.	
*BP/R/7 Super convergence sum rules for the process $\pi+N\rightarrow\pi+N$.	A sum rule for the superconvergent invariant amplitude is obtained from fixed momentum transfer dispersion relation. The results are in agreement with experiments. A paper has been submitted to Phys. Rev.	Vaishya, J.S.	
*BP/R/8 Baryon mass splittings using d-wave quark-quark interaction (in collaboration with Delhi University)	Mass splitting of positive and negative parity baryons is studied using d-wave quark-quark interaction. A paper is under preparation.	Katyal, D.L.	
*BP/R/9 Superconvergence relation for meson-meson scattering	Invariant amplitudes for pseudoscalar-2 menson elastic scattering are constructed from general invariance arguments. Superconvergence relations relating decay widths of 2+ meson with 1-mesons are obtained. A paper is under preparation.	Vaishya, J.S.	

(1)	(2)	(3)	(4)
*BP/R/10 Positron annihilation	Life time measurement of positronium and determination of fermi energy was to be studied. The progress is still in the initial stage.	Sharma, D.C., Ajit Singh & Shah, V.V.	
LT/R/1 Study of torsional and Young's modulii of thin metallic rods at low temperatures: (This project has been combined with the project "Study of mechanical properties of metals and alloys at low temperatures")	Methods to measure torsion and Young's modulii at liquid air temperature have been developed. Work is in progress. Cryostat for the purpose has been fabricated and tested. Some pure metal wires have been obtained from N.S.L., Sydney, Westinghouse (USA) and U.K. for this work.	Baveja, K.D.	
LT/R/2 Specific heat measurement of bismuth alloys, ferrites and magnetic materials	The apparatus to measure the specific heats at low temperature (liquid helium temperature) is nearing completion. The novel features introduced in this cryostat are: (1) Use of vapour pressure bulb within the calorimeter enclosure for accurate measurement of temperature of specimen. (2) Automatic bath pressure regulator which helps to keep the temperature of specimen constant at any desired value during the experiment. (3) Automatic arrangement for switching on and off the electric heating current in the specimen. A synchronous motor having one revolution per five minutes was used for this purpose. (4) A special specimen holder (calorimeter) was made in which	Dhillon, J.S. & Sharma, R.G.	

(1)	(2)	(3)	(4)
	the specimens of different diameters could be fitted. (5) The vacuum system was improved and to measure the pressures accurately, a McLeod gauge was introduced in the system. Some specimens of ferrites were obtained from the Development - cum - Production Electronic Components Unit. (6) The bismuth specimen was made in the division. Most of the parts of high vacuum furnace were made and assembled. The crucible to handle high melting point metals is yet to be perfected. The trials run on the cryostat are in progress.		
LT/R/3 De Haas-van Alphen effect in Dilute bismuth alloys	The work has been enlarged to study the magnetic susceptibilities of various substances. The susceptibility balance has been set up.	Dhillon, J.S. & Reddy, Y. S.	
LT/R/4 Theoretical study of fermi surfaces of metals and alloys	Attempts were made to derive the augmented plane wave pseudo potential from the general pseudo-potential theory of Austin, Heine and Sham. This was with a view to getting some clue to the construction of a model potential which has the same scattering properties of the original potential. The original papers of Korringa & Kohn and Rostoker were studied in detail. It was observed that the Kohn-Rostoker pseudo potential can be derived from the general pseudo-potential theory of Austin, Heine and Sham. Work is in hand to construct a	Sundaram, R.	

(1)	(2)	(3)	(4)
	l-dependent potential for noble metals.		
LT/R/5 Electrical and thermal conductivities of dilute magnetic alloys and ferrites at low temperatures	Thermal conductivity has been measured on a rod of Ag-0.09— manganese at liquid nitrogen and liquid helium temperatures. Electrical resistance has been measured at the room temperature, ice point and at steam point on alloys containing 0.2, 0.3 and 0.5 atoms per cent of manganese in silver. The thermal conductivity at liquid helium temperature has been measured on a polycrystalline rod each of nickel-zinc-ferrite and manganese-zine-ferrite. The data has been analysed and found to yield interesting information. A high vacuum set-up has been made to enable measurements of thermal properties in magnetic fields.	Chari, M.S.R. & Natarajan, N.S.	
LT/R/6 Preparation of carbon film resistors and studying their suitability at low temperature thermometers	A few carbon film resistors have been made and given the necessary treatment. They behave well at liquid nitrogen temperatures, showing a reasonable temperature variation. But they do not show the expected behaviour at still lower temperatures. Other mixtures are being tried for making suitable film resistors.	Chari, M.S.R. & Natarajan, N.S.	
LT/R/7 Hall Effect and magneto-resistance in whiskers and in silicon	The "ordinary" and "extra-ordinary" Hall coefficients in iron whiskers exhibit strong negative anomalies at low temperatures which have not been explained so far. A cryostat	Dheer, P.N. & Chatterjee, H.K.	

has been designed to study these anomalies in detail by measuring Halleffect and magneto-resistance in the temperature range 1-300 degrees K. In order to obtain a continuous variation of temperature, a thyratron controlled on-off temperature controller has been tested in the range 80K-300K. In this temperature range, a 200-0-Cu resistor is used as the temperature sensing element. The resistor forms one arm of an A.C. Wheatstone bridge. The output of the bridge is amplified and fed to the grid of a thyratron whose anode is in series with a heater wound in good thermal contact with the specimen. The bridge is set to balance at the operating temperature. Temperature control is achieved because a temperature drift results in an out-of-balance signal from the bridge which triggers the thyratron (and hence the heavy current) on or off. The short term temperature fluctuations are of the order of 0·1 and the long term drift is less than 0.05° per hour.

An apparatus has been designed and partly constructed for routine measurements of Hall effect and magnetoresistance in silicon samples in the temperature range 80-300°K. This work has been undertaken in connection with the Laboratory project "Silicon and Semi-conductor devices".

(1)	(2)	(3)	(4)
LT/R/8 Topology of d-bands in transition metals including s-d interaction	In the reciprocal lattice representation, the position of the d-bands in relation to Fermi level is located by poles in the energy vs phase shift diagram. Such poles and therefrom the d-band resonances have been obtained for copper for changes in crystal potential and for changes in Wigner-Seitz radii. It was found that for copper the shift of the d-bands for changes is of the order of 0.005 ry. Thus we are able to see quantitatively how sensitive is the d-band level in relation to changes in the crystal potential. The study of the energy vs. phase shift diagram in the reciprocal lattice representation was extended to the case of nickel. The poles in the diagram and therefrom the d-band resonances were obtained for nickel too, Thus we have evidence to postulate a 3 d-resonant state in a plane wave band. At the energy where the nearly free-electron band crosses the d-band, the interaction between them is a resonance interaction with a phase shift which depends upon the width of the resonance and the resonance energy. This resonant point of view must show as a singularity in the matrix elements of the pseudo-potential, in the secular equation for band structure. This equation is being studied.	Sundaram, R.	

(1)	(2)	(3)	(4)
OPT/R/2 Gas discharge studies	A paper on the dependence of residual intensity of different spectrum lines of mercury from high pressure mercury discharge lamps on the excitation potentials of the respective lines, has been published. For the measurement of electron temperature and electron energy distribution in an electrical discharge plasma, three probes are attached to the vacuum system and some preliminary observations using only one probe are being taken for plasma obtained in air. To supplement these findings an alternative method of measuring plasma potential is under preparation.	Das, S.R. & Dandawate, V.D.	OPT: 4
OPT/R/4 Daylight studies	The entire data on the spectral energy distribution of daylight at Delhi for about one year was processed and typical distribution for different colour temperatures were derived by: (1) characteristic vector method and from (2) the mean of a number of distributions. The agreement between the two is good. The distribution of the chromaticities about the Planckian locus on the chromaticity diagram differs from the distribution of the chromaticities for other countries. It was found that the Delhi distribution could be explained in terms of the meteorological factors for Delhi. A paper has been prepared on all	Das, S.R., Sastri, V.D.P. Manamohanan, B. & Bahl, P.P.	OPT:6

(1)	(2)	(3)	(4)
	aspects of the spectral distribution of daylight at Delhi and will be submitted for publication shortly. A detailed note has been prepared for submission to the Commission International De L' Eclairage. Spectral distribution data were collected for daylight at Bombay for three weeks in October 1966. The processing of this data also has also been completed. A telescopic scanning tube has been designed as an improvement over the earlier baffle tube and is being fabricated in the workshop.		
OPT/R/5 Irradiance distribution in fringes of superposition.	First part of the work has been completed.	Sen, D. & Puntambekar, P.N.	
*OPT/R/8 Quantitative spectroscopic studies in diatomic molecules	Investigations on the evaluation of molecular parameters like band strengths, oscillator strengths and electronic transition moments were carried out. These investigations were mainly for the atmospheric gas molecules particularly for N_2 and CO but other molecules like AlO and NS, which are important from the point of view of the investigation of upper atmosphere, were also studied. Analysis of some of the band systems of nitrogen and nitric oxide was completed. In addition to the theoretical work on the determination of molecular parameters, experimental work on the study of intensity variation with different	Joshi, K.C., Sastri, V.D.P. & Parthasarathi, S.	

(1)	(2)	(3)	(4)
	sources was undertaken. A small apparatus for these investigations in flame has been set up. The main idea behind undertaking such work was to know the mechanism of excitation and the above parameters for molecules like A10. The work has been completed.		
SSP/R/2 Study of high temperature properties of metals.	Precise conditions for the validity of the equations developed by Jain and Krishnan to determine the thermal conductivity of metals at high temperatures are obtained. Improvements and modifications in the techniques are suggested to secure the conditions for the validity of the equations and to make the measurements more accurate. The improved method is used to measure the thermal conductivity, electrical conductivity and total and spectral emissivities of nickel in the temperature range 1150-1500. K.	Goel, T.C., Jain, S.C., Verma, N.S. & Narendra Kumar.	
SSP/R/3 Study of colour centres in ionic crystals	(a) The rate of decay and growth of F and F-aggregate centres in highly pure KBr crystals are studied under different experimental conditions, and thermal stability of the centres is determined. The half-width of the M band is found to vary with temperature as $[W = A \coth (h)_g/skT]^{\frac{1}{2}}$ The oscillator strength of the M, R and N centres are found to be 0.11, 0.43 and 0.06 respectively.	Jain, S.C., Mahendru, P.C., Parashar, D.C. & Sootha, G.D.	

(1)	(2)	(3)	(4)
	(b) Electrical conductivity of pure and doped KI crystals is studied. (c) Relaxation dielectric loss is measured in sodium chloride crystals doped with cobalt. The results are consistent with the theory developed by Dreyfus. However, the results do not prove conclusively that cobalt impurity cannot exist in the interstitial positions.		
SSP/R/4 Study of optical, electrical and other properties of thin films	The measurement of electrical and galvanomagnetic properties of thin films of vanadium and titanium have been made. Both resistivity and Hall coefficient increase and the Hall mobility decreases with the decrease in film thickness of vanadium. The results are in qualitative agreement with Sondheimer's theory. The titanium of films show an irreversible increase in resistance on first heating from 20°C to 200°C. On reheating films thicker than 250 A° showed nearly zero temperature co-efficient of resistance while thinner films showed a negative TCR.	Jain, S.C., Jain, V.K., Devindra Singh & Ramesh Chander.	
SSP/R/5 Physical properties of and irradiation effect on ionic crystals and semi-conductors	Extensive electrical and optical measurements on LiF doped with titanium are made. The measurements suggest that titanium is present either as Ti^{2} state or Ti^{3} state and a cation vacancy in the immediate neighbourhood.	Jain, S.C., Jain, V.K. & Krishan Lal.	
SSP/R/6 Ultrasonic	(1) Work on "Thermoelastic internal friction in hexagonal	Dayal, C.R.	

(1)	(2)	(3)	(4)
attenuation internal friction and elastic constants of metal and alloy single crystals	crystals completed. (2) Work on thermal stress distribution, temperature variation of elastic constants in normal and superconducting metal with hexagonal crystals continued. (3) Measurements on elastic constants, internal friction and ultrasonic attenuation was held up for want of time; the time being spent on the study and planning on diffusion in silicon.		
X/R/1 & 2 X-ray studies of solid solutions and phase transformations in semiconductor materials	Due to difficulties in the existing high vacuum and high temperature systems necessary for making crystals of varying bismuth, sulphur and tellurium contents, independent systems have been made. The new high vacuum system with a liquid air trap gives a vacuum of the order of 10^{-6} mm of Hg as indicated by a Penning gauge. A horizontal rocking furnance ($\pm 30°$ from the horizontal) has been set and its constant temperature zone determined. This has also been provided with a quenching arrangement. Several runs have been made to prepare homogenous ingots of composition Bi_5 S_3 Te_{12}, Bi_8 S_5 Te_7, Bi_4 S_3 Te and Bi_4 S_2 Te. The first composition gave a complex x-ray powder pattern, the two major phases being Bi_2 S Te_2 and Te itself. The second composition, $Bi_8 S_5 Te_7$, appeared to be a single phase, similar to Bi_2 S Te_2, but of slightly different	Ali, S.Z. & Kundra, K.D.	

cell dimensions which are being accurately determined.

$Bi_4 S_3 Te$ and $Bi_4 S_2 Te$ compositions which correspond to the minerals grunlingite and Joseite A respectively have also been prepared. The powder patterns have been found to be quite complex, but main phase appear to be $Bi_2 S_3$ and $Bi_7 Te_3$ (hedleyite) in the case of composition Bi_4S_3Te, and $Bi_2 S_3$ with elemental Bi in the case of the second composition, although in one preparation, the final product gave a pattern consisting of lines due to $Bi_2 S_3$ and $Bi_4 S Te_2$ (Joseite B). Single crystal work on one good crystal from the matrix of $Bi_4 S_3 Te$ composition was carried out by taking the a-axis zero- and first level, Weisserberg photographs as well as a Buerger c-axis precession photograph. The cell constants and space group (Pbnm) were the same as for $Bi_2 S_3$.

The a-axis zero, first and second level equi-inclination photographs for a good crystal of composition $Bi_2 S Te_2$ were indexed on a hexagonal cell and the space group confirmed as $R_3 m$.

(b) Finalisation of the X-ray data on $Bi_2 SeTe_2$ at various temperatures upto about 500° C has been done. Accurate lattice parameters by Cohen's least squares method and by Straumanis' method have been determin- Ali, S.Z. & Kundra, K.D.

ed and the thermal expansion coefficients along a_0 & c_0 axes of the hexagonal cell have been obtained. A paper is being finalised.

(c) The new semi-conductor materials chosen for structure and phase transformation studies are In Se and $In_2 Se_3$. The X-ray work reported on the former by various workers does not give consistent cell-dimensions and space-group. Similarly, not enough is known about the phase transformation in $In_2 Se_3$ at about 200° C.

Ali, S.Z. & Nagpal, K.C.

There was a delay of several months in the beginning of this investigation due to the failure of one of the high tension rectifiers of the Novelco Set. A new rectifier with a different base was supplied by the suppliers, and after changing the base (with the help of the Glass Technology Unit), some time was spent in carefully checking the high tension circuits, filtering and changing the high tension transformer oil, etc. The two rectifier circuits have been balanced to minimise the risk of failure.

InSe was prepared in a specially thickened fused quartz tube, evacuated and sealed with the required amount of the elements. Though the melting point of InSe is reported to be about 660° C, heating the capsule at 750° C for several hours yielded a mixture

(1)	(2)	(3)	(4)
	of several phases. Heating at 800°C for several hours and slow cooling has given a single phase as shown by X-ray powder photographs. Single crystal photographs of several crystals have been taken to select one without strains. Even the best crystal has not given good X-ray spots, but it was possible to take a-axis zero, first and second level equi-inclination photographs and index them. The cell constants and space group are: a—4.0 Å c—16.7 Å Sp-gr. P 63_3/mmc Accurate density determination is being made.		
RPU/R/1	Merged with RPU/S/1, where progress is shown		
RPU/R/2	Merged with RPU/S/2, where progress is shown		
RPU/R/3 Satellite radio beacon Studies	(1) Radio transmissions of the satellites Explorer-22 and 27 were recorded regularly.	Somayajulu, Y.V., Narasinga Rao, B.C. &	
	(2) Ionospheric electron content values from Explorer-22 records were calculated for the period Jan. '66 to Dec. '66 and sent to NASA for exchange.	Tyagi, Tuhi Ram	
	(3) A satellite receiving equipment was set up at Kurukshetra to receive satellite transmissions at 20 MHz. This project is being taken up under the collaboration with Kurukshetra University. One Research Fellow from		

(1)	(2)	(3)	(4)
	Kurukshetra University was trained during Jan.-March '67 for running this project. (4) The electron content values derived from Faraday fading of Explorer-22 transmissions for the period Oct. '64 through Dec. '66 were examined for the diurnal and seasonal variations. The effect of solar and magnetic activity on electron content was studied. The seasonal variation of the ratio of the maximum to minimum electron content was examined. The C4 ionograms were also analysed to compare the bottom side electron content with the top side one. The recocords were further analysed for the scintillation studies. The following paper was presented at the ITE Convention at Delhi During December 1966 and the IQSY Symposium held at NPL during Dec. 15-17, 1966: "Satellite Beacon Studies of the Ionosphere Over Delhi."—Tuhi Ram Tyagi.		
RPU/R/4 A rocket-borne riometer payload for D-region	The test flight of the first of the two NPL-constructed riometer payloads, was successfully carried out on March 16, 1967 at 1405 EST from Wallops Islands, USA, by our scientist, in collaboration with NASA. The riometer operated on 13.265 Mc/s. Preliminary data showed that the experiment worked satisfactorily. The rocket carried also instrumenta tion on Faraday rotation, Lyman Alpha and probe experiments.	Narasinga Rao, B.C., Somayajulu, Y.V., Sastry R.S. & Avadhanulu, M.B.	

(1)	(2)	(3)	(4)
	The second payload at NPL is being modified according to the new circuit finally adopted for the first one. Some of the transistors made in India by Continental Devices were tried and found to be satisfactory. The following paper was presented at the ITE Convention at Delhi in December 1966: "Instrumentation of Rocket-borne Riometer for D-region Studies"—Somayajulu, Y.V. and Sastri, R.S.		
RPU/R/6 Riometers	Cosmic radio noise observations were carried out regularly at three frequencies (20, 22.4 and 30 Mc/s). These data have been used to study the ionospheric absorption at these frequencies. The data have also been used to study the effect of solar flares in the ionosphere. Provisional values of the ionospheric absorption at these above (20 and 30 Mc/s) frequencies for the year 1964 had been sent to the World Data Centres for exchange of the data. The following papers were presented at the IQSY Symposium held at NPL during December 1966: 1. Absolute Cosmic Noise Absorption Studies—Sarma, S.B.S.S. and Srivastava, R.N. 2. Effect of Solar Activity on Cosmic Radio Noise Absorp-	Sarma, S.B.S.S., Mitra, A.P. & Srivastava, R.N.	

(1)	(2)	(3)	(4)
	tion Sarma, S.B.S.S. and Srivastava, R.N.		
RPU/R/7 Solar Radiometer	Solar radiometer at 2000 Mc/s is functioning normally and it is manually operated at hourly intervals on ordinary days and at half hourly intervals when the sun is active. Preparations are made to run the equipment continuously by pointing the antenna always towards the sun, for which a synchronous motor and a proper reduction gear system (which reduces the speed of revolution by about 1.5 million times) are needed. The results obtained by this equipment are published every month in Solar and Geophysical Data series.	Rao, M.N.M. & Kushwaha, D.S.	
RPU/R/9 Rocket and satellite studies of the lower ionosphere.	This has been essentially a pioneering effort in harnessing the fastly accumulating rocket and satellite observations for the study of the aeronomy of the lower ionosphere. A new approach to the field of atmospheric ion kinetics has resulted. The following papers were presented at the IQSY Symposium held at NPL during Dec. 1966. 1. Aeronomy of the Lower Ionosphere—Mitra, A.P. 2. Ionospheric Reaction Rates in the Light of space measurements of ionic composition—Mitra, A.P. and Mitra, N.R.	Mitra, A.P. & Mitra, N.R.	

(1)	(2)	(3)	(4)
RPU/R/10 Study of F layer effects with Doppler fading technique (a PL-480 project)	With the increase of solar activity and large number of solar flares, a number of SFD cases have been recorded at Haringhata, the largest one being on Sept. 2, 1966 on ATA transmissions from NPL. Analysis of the records have proceeded fairly satisfactorily and a paper was presented on it at the Indian IQSY Symposium. The project has been proposed for continuance for another three years in a modified and extended form with the title "Study of Flare effects with Doppler fading and phase anomaly techniques". Equipments necessary for the phase anomaly studies are being received on loan from the U.S. counterpart.	Mitra, A.P., Saha, A.K., Lakshminarayana, K.N. & Vashist, A.R.S.	
RPU/R/11* Low and very low frequency radio wave propagation	Three equipments—two to record atmospheric noise at 30 and 75 Kc/s and one to record 164 kc/s transmissions from Tashkent, have been in continuous operation with the following aims in view: 1. To detect solar flare effects on lower ionosphere, 2. Propagation studies. The solar flare effects detected by these equipments are being reported in Solar Geophysical data published by RPU. The sunrise effect in the lower ionosphere is now being studied.	Lakshminarayan, K. & Ramanamurty Y.V.	

(1)	(2)	(3)	(4)
RPU/R/12* Development of new radio forecasting techniques	Some requests made by Posts & Telegraphs Department led us to devise procedures for computing and predicting performances of particular long distance overseas circuits. Consultative discussions with the P&T engineers convinced us about the necessity of preparing a manual for proper utilization of our regular prediction bulletins. This work is in progress. The manual will also contain instructions for utilizing E-layer paths for communications over relatively shorter distances.	Saha, A.K., Mitra, A.P. & Aggarwal (Mrs) S.	
RPU/R/13* Topside ionosphere physics	Theoretical study of the ion composition in the F-region and topside ionosphere during daytime for solar minimum condition was made both for thermal equilibrium and thermal non-equilibrium cases. The ion composition model thus developed gives the height distribution of important ionic constituents like O^+, He^+ and H^+, of plasma scale hieght and mean ionic mass from about 200 km to 1500 km. The implication of the satellite measurements of H^+, He^+ and N^+ in the topside ionosphere on the reaction rates of the loss processes of He^+ and on the density of neutral hydrogen were examined. Analysis of the plasma scale height distribution in the topside ionosphere using Alouette data for winter of 1962-63 was made to obtain the temperatures and mean ionic mass at a height of	Narasinga Rao, B.C., Bhatnagar, V.P. & Tyagi, Tuhi Ram	

(1)	(2)	(3)	(4)
	800 km for equatorial and middle lattitude zones. The following paper was presented at the IQSY Symposium held at Delhi during December 1966: "Daytime ion composition in the topside ionosphere for solar minimum condition"— Bhatnagar, V.P.		
RPU/R/14* IQSY experiments and examination of results	Eleven (11) papers based on data collected during IQSY at the Unit and elsewhere were presented at the Indian IQSY Symposium in Dec., 1966. Regarding collection and scaling of the data and circulating them, the following items are ready: 1. Ionosonde data 2. Satellite radio beacon data 3. Solar flares SID data. The parts remaining are: 4. Cosmic radio noise absorption data 5. Ionospheric true heights data.	Saha, A.K. & Mitra, A.P.	
DNPL/R/1,4	The projects have been merged with the project on Thin Films and recorded as TF/D/1.		
DNPL/R/2,3,6 & 7	The projects have been merged with the project on Crystals Growth and recorded as CG/D/		
DNPL/R/5	The project has been merged with the project Development of and Physical Study of Phosphors' and recorded as M/D/3.		

(1)	(2)	(3)	(4)
DNPL/R/8 High pressure X-ray aparatus for studying structural transformations	To study those structural transformations in solids which are reversible with respect to pressure, a high pressure X-ray apparatus is being developed. The important part of this apparatus is the X-ray camera. A high pressure X-ray powder camera has been designed and fabricated. A large number of powder photographs of different materials such as platinum wire, copper wire, KCI, NaCl powders, etc. were taken with this camera using copper radiations. The results show the satisfactory working of the camera at atmospheric pressure. Copper-radiation, because of its low penetration power, is to be replaced by Molybdenum radiations. Further work is in progress.	Kapoor Y.M. & Joginder Singh	
DNPL/R/9 Study of single crystal films of Noble Metals	The project has been merged with the project on silicon and semiconductor devices.		
CG/R/3 Study of whisker growth in crystals	A high vacuum apparatus for the study of whisker growth in crystals was designed and fabricated, and experiments were carried out with 99% pure cadmium. Whisker growth was observed by vacuum deposition in high evacuated samples (10^{-6}mm) and in samples with (100 mm) mercury. The morphology of the observed whiskers was studied with light microscopy technique and the observations coincide with those made by others. Preliminary studies have also been	Peneva, S.P.	

(1)	(2)	(3)	(4)
	carried out with the help of the electron microscope with a view to see the whiskers tips under high magnification. The effects of added impurities on the whisker growth was also studied, and the results observed coincided with those made by the reduction process carried out in the Bell Telephone Laboratory by Prof. Wagner and his group. Similar rounded shapes of the Whisker's tips were observed with the help of a light microscope. Studies on the whisker structure are being carried out with the X-ray technique.		
IP/R/1 Micromeritics of indigenous industrial material like carbon powder	Permeability study on different types of metallic, inorganic, organic, flacky, fibrous, granular powders was made. The study was extended to study the effect of variations in pressure difference on powder beds. The permeability (and hence surface area) for most materials seems to be independent of pressure differences applied within a certain limit. It was found that in the case of carbon powders, the permeability (and hence the surface area) is a function of pressure differences applied. This observation is important while dealing with problems involving surface area of carbon powders. It was concluded from the study of experiments carried out that surface area of granular car-	John, P.T. & Bohra, J.N.	

(1)	(2)	(3)	(4)
	bon powders determined by oil absorption method using Wicke's equation is in very good agreement with permeability surface area (using small pressure differences). A theoretical study on surface area and pore-volume distribution of powders was made using published data. An equation was derived for the computation of the above distributions.		
IP/R/2 Study of rheological properties	The conditions of measurment in order to get repeatable and reliable results in extrusion have been determined. The extrusion properties of shell mix has been completed. The parallel plate method of determining the rubber like modulus for shell mix has been completed. A new approach on the basis of dielectric orientation has been made to explain the extrudate irregularities. A paper on this is being presented at the 8th International Carbon Conference to be held in June 1967 at Burralo, USA. A paper on comparative techniques of measuring rheological properties of pitch tar binder has been published in the Indian Journal of Technology. Stormer's viscometer for the measurement of rheological properties of pure tars has been designed and fabricated.	Chari, S.S. & Awasthy, B.R.	

(1)	(2)	(3)	(4)
	With this instrument viscosity of road tar Nos. 3, 4 and 5 has been determined at room temperature. Temperature susceptibility of these tars around room temperature have been determined.		
RC/R/1 Hygroscopic and ice-forming aerosols	Complete analysis on investigation and aerosols distributions at different field stations including Delhi have been undertaken. The monthly means over the available data has shown significant relation with other mean values of climatic parameters such as vapour pressure, minimum temperature and range of temperature. Data is being further analysed to find correlation with day to day values also. One year's simultaneous study of ice-forming nucleii and chloride ion concentrations appear to show an inverse relationship when examination of the data is made on monthly basis showing that the source or sources of these are probably different.	Kapoor, R.K., Sekhon, R.S. & Ramanamurty, Bh. V. RC: 5, 6, 7	
RC/R/2 Aerosols measurements on board aircraft	With the helpful cooperation from Plant Protection Directorate of the Ministry of Food and Agriculture, it was possible to continue research flights on board 'BEAVER' aircraft during the pre-monsoon period. The aircrafts could not be made available to this Unit during monsoon. Studies upto a height of 10,000 ft. have shown that in most cases hygroscopic particle concentration decreases with height in	Biswas, K.R., Khemani, L.T., & Paul, S.K.	

(1)	(2)	(3)	(4)
	(a) fair-weather, (b) increases with height on a day with overcast sky or rain or squalls or before thunder storms etc. Concentration variation is indefinite when there is existence of cloud, haze, etc., at the intermediate level. Generally, non-hygroscopic or dust particle concentration decreases with height. On some occasions when there is a presence of dust-haze or dust-storm there is increase in concentration at some intermediate level. *Estimation of atmospheric chloride particles on ground and aloft:* Estimation of concentration of chloride particles taken up earlier on ground air-layers has also been extended upto cloud height. The few observations which could be made when aircraft was available shows in general that chloride concentration increases with height, particularly on days with overcast sky, squall or before occurrence of rain or thunderstorms. Tentative conclusions cannot be drawn due to very limited obsevations so far made. Study of chloride particles at surface air-layers has also been extended to field station at Calcutta.		
RC/R/4 Precipitation chemistry and trace gases	(a) Analysis of rain water samples has shown that the trend of variation of concentration of chloride ion in rain water with the progress of rain shower seem	Khemani, L.T. & Chugh, G.L.	

to suggest that the growth of rain drops in convective clouds at Delhi often takes place as a function of sea-salt nuclei distribution present in cloud air. Further it was noticed that the characteristics of precipitation at Delhi are dependent on the amount of airborne soluble particles present in the cloud-forming air, small cation concentration (<1 ppm) and higher value of cl/Na (>1.8) distinguish rain from cold layer cloud from that of other types in which both freezing and non-freezing mechanisms operate (rain from cold convective clouds). Smaller ratio values of So_4/cl (<6) and higher ratio values of chloride to sodium characterise heavier rainfall.

(b) *Studies on trace gases:*

Measurements have been continued on both gaseous and particulate concentration in respect of ammonia, chloride and No_2 in ground air-layers. Investigations suggested an annual trend for chloride and no specific feature for ammonia. Efforts have been made for detection of So_2 in the atmosphere. The data so far collected is being analysed to find out day to day variation in the concentration of trace gases and their relationship with ice-forming nuclei.

(c) *Analysis of hail-water content:*

Precipitation samples collected on rain occasions with and

(1)	(2)	(3)	(4)
	without hail have been chemically analysed for chloride, sulphate, sodium, potassium and calcium. Higher ionic concentrations were noted in rain water when the rain occasion was associated with hail than when it was not. The finding helps corroborate Ludlam's suggestion that hail embryos form on giant hygroscopic aerosols.		
RC/R/5 Preliminary investigations on cloud-forming nuclei	Visual method of estimation of cloud-forming nuclei continued from last year has shown that the nuclei concentration seem to be directly proportional to the extent of impact (or influence) of monsoon or maritime air-masses on local weather which is true for both pre-monsoon and monsoon period. There is no washing out effect on cloud-forming nuclei even by heavy rain, but the count is reduced by dust-storm or prolonged dustiness. The study has been extended to upper levels by collecting air samples on board aircraft from different heights upto 10,000 ft.	Sekhon, R.S.	
RC/R/6 Studies on wake effect of freely falling droplets	Previous measurements which have shown that droplets in drizzle size range tend to undergo collisions even when they are separated initially a few tens of diameter vertically was further extended under conditions of high vertical electric field. Initial analysis has shown that coalescence just starts at about 65 v/cm and the extent of wake effect is extended further with the application of field,	Bohra, J.N., Paul, S.K., & Gurumukh Singh	

(1)	(2)	(3)	(4)
	Study which was conducted in the drizzle size simulated droplets by releasing water droplets in kerosene media is being extended further to different oil media to study behaviour of cloud particle size droplets in conditions without electric field and with electric field.		
RC/R/7 Preliminary investigations on atmospheric electricity	The possibility that the hygroscopic aerosols are of sea origin may have some charges associated with them, the vertical earth's potential gradient data of both surface and upper air were collected and their relations were studied with that of hygroscopic and non-hygroscopic nuclei data. Preliminary investigation has shown a negative persistent correlation which suggests that there might be some charges on these nuclei.	Raman Rao, T.	
RC/R/8 Radar studies	(a) Evaluation of results of seeding analysis by radar at Delhi have been continued for this year also. Data is being analysed.	Biswas, K.R. & Chatterjee, R.N.	
	(b) Pending procurement of iso-echo contour device which will automatically enable us to ascertain the total rainfall of the day around the locality, it was decided to try multiple exposure of radar scope pictures on the same photographic film at regular short intervals for a period of full 24 hours and then measuring the echo density in the film at different locations in the regular distribution. Then the density at some known loca-		

(1)	(2)	(3)	(4)
	tions thus evaluated are compared with actual 24 hours rainfall reported by standard raingauges. The rainfall at other places are estimated on the basis of calibration from this value. Preliminary investigation has shown that this method for estimation of total rainfall is feasible. Initial instrumentation in this regard has been finalised.		
RC/R/9 Cold cloud seeding	Gadget fabricated for silver iodide smoke spraying from aircraft has been tried from ground in the winter season and total seeding operation was made without evaluating the result.	Biswas, K.R., Chatterjee, R.N. & Sekhon, R.S.	
RC/R/10 Warm cloud seeding	Seeding experiment using the technique of dispersal of giant hygroscopic particles from ground has been reported for 9th monsoon season at Delhi. Results of this year have shown positive trend for the season and also if taken month-wise. Complete 20 years data have been analysed which has suggested that warm cloud seeding technique increases seasons total rainfall by at least 10% for this area (Delhi and neighbourhood).	Biswas, K.R., Paul, S.K., Kapoor, R.K. & Kanugo, K.K.	
IR/R/1 Preparation of infrared sensors.	Lead sulphide films have been deposited chemically on glass plates. The method involves the homogeneous precipitation of lead sulphide from the reaction mixture of lead acetate, thiourea and sodium hydroxide. The kinetics of the reaction is dependent on the composition and the temperature of the reaction mix-	Agarwal, K.C.	

ture. A large number of depositions were, therefore, carried out to ascertain the conditions (time, temperature and the composition of the reaction) for getting a coherent and uniform film. Evaporated gold films on the ends of the glass plate have been used as electrodes. Gold films have been found to be better than silver films in their adhering capacity when the plate is put in the reaction mixture. Lead sulphide film of the area of 6 mm × 1 mm thus deposited has a resistance varying from 0.2 megohms to 1 megohms.

To make the plates photoactive these were subjected to heating in air, oxygen, hydrogen and in vacuum in separate experiments. After heating the plates were annealed and cooled rapidly or slowly, in air, oxygen or in vacuum. After cooling the plates were found to have resistance between 0.5 megohms to 10 megohms.

An apparatus has been set up for measuring signal to noise ratio of the lead sulphide photoconductive film. The apparatus involves the use of a globar, chopper, grating and wave analyser, besides the pre-amplifier, amplifier and a phase sensitive detector. Signal to noise ratio of the lead sulphide plates heated in vacuum was found out.

Further work is in progress.

APPENDIX II

DEVELOPMENTAL PROJECTS

Code No. and Project (1)	*Progress* (2)	*Project team* (3)	*Ref.* (4)
AC/D/1 Developing a suitable filter for the ultra violet region 320 for use in filter photometer	This filter has the pecularity and advantage that it may also be used in the nearer ultraviolet region. The filter has a direct application in one of the earlier work, "Determination of Minor Quantities of Iron in Ni, Al, Zn and Pb etc., besides other determinations". A paper is under preparation.	Sen, D. & Bhuchar, V.M.	
AC/D/2/ Salaya balsam—a substitute for Canda Balsam	Work has been completed. Paper has been published in June, 1967 issue of Journal of Scientific Instruments, London.	Bhuchar, V.M. AC : 5	
AC/D/3* Preparation of elemental silicon	Several alternative methods for the preparation of elemental silicon from quartz and precipitated silica were tried. In all, total of 50 runs were made. The resulting mass was leached free from metal oxides. The material was analysed for silicon and silica content. Fairly rich samples were obtained. Several samples of silicon prepared by the Materials Division were also analysed. It was finally decided to use ferro-silicon as the starting material and direct efforts toward the preparation of silicon halides from the latter material.	Verma, M.R., Gupta, P.K., Amar, V.K., Masood Raza. & Gangopadhyay, N.	

(1)	(2)	(3)	(4)
	Necessary amount of quartz equipment has been obtained. Programme of drawing of standard calibration curves by spectrophotometric and polarographic methods for impurity estimations in silicon has been drawn up.		
AC/D/4* Quantitative evaluation of colour changes in indicators	Absorption spectra of a series of indicator of phthaleins, sulphothaleins, cresol red and thymol blue have been taken at different pH values. Results of specific colour discrimination of some of these have been calculated and others are in progress.	Bhuchar, V.M.	
AM/D/1 Design and fabrication of the 3000 kg dead load testing machine	The project has been completed. The machine has been commissioned and proving rings of capacities up to 3 tons are being tested on it. A detailed report on the machine is being prepared and will be published shortly.	Das Gupta, M.K. & Sharma, R.S.	
AM/D/2 Design and fabrication of abrasion testing machine	The project has been completed. The machine is now working and abrasion tests are being carried out. A detailed report on the machine will be brought out soon.	Das Gupta, M.K. & Nayar, R.K.	
AM/D/3 Design and fabrication of photoelastic bench	The mechanical design of the photoelastic polariscope has been completed. The design and fabrication of the lens system has been taken up in collaboration with the Indian Institute of Technology, New Delhi.	Agarwal, B.K., Das Gupta, M.K. & Agarwal, A.K.	
AM/D/4 Design and fabri-	The project has been completed. A sample strain meter has	Das Gupta, M.K. & Agarwal, B.K.	

(1)	(2)	(3)	(4)
cation of Carlson strain meter	been supplied to the Central Power & Water Commission for detailed tests. Preliminary investigations have shown that the strain meter meets all the operational requirements and compares favourably with the imported strain meter. A detailed report of the working of the strain meter is being prepared.	Bindal, M.M., Agarwal, A.K. & Nayar, R.K.	
AM/D/5 Hydrostatic extrusion of metals and alloys (generation and utilisation of high pressure)	Satisfactory progress of the project could not be made because the steel required for fabricating the high pressure cylinders has not been imported yet. The following parts, however, have been designed and fabricated: (a) A single cylinder for the extrusion of lead and aluminium. The cylinder has been designed for a pressure of 50,000 p.s.i. with a safety margin of 3. (b) Dies for the gear: owing to technical difficulties the rectangular dies have not yet been fabricated. A circular rod and tube in lead have been extruded. The maximum extrusion ratio is 70%. The products are, however, slightly curved after extrusion. The causes of this are being investigated. A solid gear in lead has also been extruded. EN 24 steel for material dies for extruding aluminium has been received. Work on the dies will now be started. The design of a compound cylinder has been completed. The fabrication will be taken up	Agarwal, B.K., Agarwal, A.K. & Das Gupta, M.K.	

(1)	(2)	(3)	(4)
	when the special steel has been received. A small machine which can generate pressure upto 50,000 p.s.i. has been built. Preliminary studies have been made with the extrusion of lead. Various shapes such as solid rod, tube and finned tube have been extruded.		
*LT/D/1 To duplicate the existing Sterling cycle liquefier	A new scheme to get the technical know-how for producing air liquefiers was undertaken. Duplication of a sterling cycle air-liquefier was taken up in September 1966. Sketches were made for about 14 parts; drawings, tracings and blue prints were made for about 100 parts. Parts and components of 3 sub-assemblies were given to the workshop for fabrication. 50% of the jobs have been completed. Parts assembly is being done. A few components are ready.	Singh, N.N.	
OPT/D/3 Optical test methods based on interferometry	An interferometric method has been developed for testing the equality of the optical thickness of two plane parallel glass plates. It makes use of the reflected system of the fringes of superposition and is suitable for use in optical workshops during the polishing of the plates. The test apparatus does not require components of high precision and is comparatively simple but has adequate sensitivity for the determination of a difference of $\lambda/10$ in the optical thickness. A new inverting interferometer has been designed and set up for	Sen, D. & Puntambekar, P.N.	

(1)	(2)	(3)	(4)
	testing concave mirrors and telescopes and camera objectives. This interferometer also makes use of the reflected system of the fringes of superposition and is of very simple construction, the only precision component required being a small miniscus type lens having an accurately made spherical surface. The performance of the interferometer has been thoroughly investigated. Its sensitivity for the measurement of wave aberration is better than $\lambda/10$. The interferometer is in use for testing components fabricated in the laboratory. A prototype of the instrument is being designed. Methods have been devised and roughly tried out for the measurement of small tilts and of the pyramidal error in right angle prisms by use of the inverting interferometer. Apparatus for these are under construction.		
OPT/D/6 Development of I.R. Spectrometer.	(a) An equipment for testing the characteristics of lead sulphide detectors has been designed and fabricated. Several detectors have been tested.	Agarwal, A.C., Pahwa, D.R., Parthasarthy, S. & Saksena, B.D.	
	(b) The prototype of the cheap infrared grating spectrometer for the region 1-3μ is being made. A high resolution instrument of the same type is also being made with the help of an infrared grating 8″×5″ in size obtained from Prof. Plyler of the National Bureau of Standards. In this	Saksena, B.D. & Chaddha, V.K.	

(1)	(2)	(3)	(4)
	instrument, the spherical mirrors 23 cm in size and 100 cm focal length, have been made. These mirrors are in Gerney Turner mounting. The arrangement for mounting the grating and rotating it by 1° in 2 min. has been made. The assembly of the instrument is being done.		
	(c) A spectrograph of 150 to 300 microns has also been designed and made. The spectrograph is a wiremesh infrared grating spectrometer. The wiremesh has been obtained through the courtesy of Prof. Genzel of the University of Freiburg, Germany. Prof. R. Ulrich of the same University worked in the Laboratory for about a year and designed the elctronics and optics of the instrument. These have been completed and on receipt of a Golay cell with diamond window, orders for which have been placed, the assembly of the spectrometer will be completed and it will be put into operation.	Ulrich, R., Verma, S. P. & Saksena, B.D.	
	(d) An equipment for exciting the ruby laser (i.e. the power and the electronics) has been made in the Laboratory. As soon as Xenon, orders for which have been placed is received, Xenon lamps for exciting the laser will be undertaken. The laser work is at present being undertaken to provide a source for spectrographic purpose which is fairly monochromatic. The ruby laser and the mirror are a gift from the University of Freiburg.	Pradhan, M.M. & Saksena, B.D.	

(1)	(2)	(3)	(4)
*OPT/D/7 Precision optical component development	The following instruments, optical components and tools have been fabricated: One Fizeau interferometer of 15 cm aperture: in use for testing components being fabricated, accuracy $\lambda/10$: Nine optical test plates and interferometer mirrors of diameter 15 cm, 10 cm ,7.5 cm and 5 cm : Plane to $\lambda/10$. One beam divider, 7.5 cm dia. : Plane to $\lambda/10$, parallel to 4" of arc. Two plane parallel silica windows, 4 cm dia : Plane and parallel to $\lambda/4$. Three concave and convex test plates of R 30 cm and 16 cm and dia 7.5 cm and 6 cm: Accuracy $\lambda/10$. Five Spherical mirrors interferometer: Accuracy $\lambda/10$. One test plate for inverting interferometer : Accuracy $\lambda/10$. One glass slideway for Michelson interferometer, $23\times6\times2.5$ cm: Accuracy one wavelength. Five 36° prisms for spectrophotometer: Accuracy one wavelength. Eight spherical mirrors for spectrophotometer : Accuracy $\lambda/4$. Ten pyrex flats 2.5×4 cm : Accuracy one wavelength made for the photocell project. One glass slitting machine with 15 cm dia wheel. Eight cast iron flat and spherical tools of dia 23, 15 and 10 cm : Accuracy two wavelengths. In addition to this, four silicon wafers have been lapped and polished.	Sen, D. & Grover, C.P.	
*OPT/D/8 Design and construction of spec-	Selection has been made of the design of the monochromator including its wavelength drive	Sen, D., Ram Prasad, Grover, C.P. &	

(1)	(2)	(3)	(4)
trophotometer	and slit mechanism. Fabrication of the optical components, i.e. prisms and telescope collimator mirrors of two monochromators of respectively 35 cm and 60 cm aperture have been completed. In case the industry is interested, further work will be undertaken.	Puntambekar, P.N.	
*OPT/D/9 Spectrochemical analysis	The necessary accessories required for quantitative spectrochemical analysis were assembled using the Q 24 spectrograph. Some experiments on the calibration of emulsions were made to establish the conditions of development etc., which would avoid intensity retardation, Eberhard effects, etc. With the experimental conditions adopted, it was found that a sufficiently good precision was obtained in the determination of logI element/logI internal standard. With the same conditions it was found that sufficiently good accuracy was obtained when some prepared samples were analysed. The necessary auxiliary equipment was provided for the Steinheil Spectrograph to keep it ready for regular qualitative and quantitative spectrochemical analysis work. The working of the stepsector was checked and found suitable for quantitative work. Some standard reference spectra were taken for a few elements like Li, K, etc.	Sastri, V.D.P., Manamohanan, S.B.	

(1)	(2)	(3)	(4)
	Details of the spectrochemical standards development programme of work on the spectrochemical standards at NBS, Washington, were obtained to study the possibility of starting a programme of work on the spectrochemical standards at NPL.		
*OPT/D/10 Design and development of optical systems	The aim of this project is to establish indigenous manufacture of optical components by making available to the manufacturers the technical know-how on various optical systems. With this end in view, optical systems of different types have been designed and the design data compiled in the form of optical data, optical specifications and moulded blank sheets. These are released to the industry in accordance with the terms and conditions laid for the purpose. The manufacturers send prototypes for critical examinations at the laboratory. Any suggestions for improvement are made at the stage. The prototypes are also sent for users' trials. Thus the designers, the manufacturers and the users work together to develop optical components. Optics for microscopes, telescopes, enlargers, projectors, etc., have so far been designed and for some of these prototypes have been made successfully. In working out the designs, the types of optical glass made in India at the Central Glass &	Ram Prasad	

Ceramic Research Institute, Calcutta and various national/ international standards are carefully considered. Thus the manufacturers making use of the NPL design data will produce optical components of standardised pattern.

List of Optical Systems designed at NPL during 1966-67

Eyepiece, Huygenian, 5X; 10X; 15X

Eyepiece, Ramsden, 15X.

Objective, Projection, Episcope, 400/4.5.

Doublet, Achromatic, 600/12.5.

Condenser, Photo-elastic Polariscope.

Triplet, Cemented Achromatic, Photoelastic Polariscope.

Objective, Projecion, Photoelastic Polariscope.

Objective, Projection, Filmstrip, Junior Model No. 1.

Condenser, Filmstrip Projector, Junior Model No. 1.

Condenser, Microscope, .65 NA (PIF); 1.2 NA (PIF).

Eyepiece, Ramsden, Astronomical Telescope: 15X.

Eyepiece, Ramsden, Microscopes: 20X, 25X and 15x.

Objective, Triplet, Enlarger, 105/4.5.

Objective, Triplet, Microfilm Reader, 12.5X.

Condenser, Microscope, Abbe, 2 Elements 1.2 NA.

Condenser, Microscope, Abbe, 3 Elements 1.3 NA.

Objective, Achromatic Microscopes. (4X, .1 NA), (6.4X

(1)	(2)	(3)	(4)
	.16 NA), (1CX, .3 NA), (16X, .35 NA), (25X, .45 NA), (40X, .65 NA), (60X, .95 NA) and (100X, 1.25 NA). Condenser, Enlarger 105/4.5 (Oil immersion). Condenser, Microfilm Reader, 12.5X.		
DPEC/D/1 Permanent magnet ferrites	Further work on developing a method of pressing Ceramic magnets in a strong electro-magnetic field is under investigation. Such oriented ceramic magnets are very much in demand for use in loudspeakers.	Ganapathy, C.V., Gupta, S.C. & Aftab Ahmed.	
DPEC/D/2 Soft ferrites	(a) *Short-cum-Medium Wave Ferrites*: Orders for short-cum medium wave ferrites have been received from the radio industry. Though the antenna rods are satisfactory, the demand for short-cum-medium wave ferrites is not very much compared to medium wave ferrites. However, development work is continuing in order to make soft ferrites for higher frequency in the form of toroids, pot cores, etc. These will be used as cores for inductances in electronic equipment. Replacement of nickel which is imported and used in NPL 5 and NPL 7 for short-cum-medium wave by magnesium has been tried successfully. Further experiments are on to improve the permeability and other characteristics.	Ganapathy, C.V., Govindaswamy, G. Narayanan, K., Khanduja, R.S. & Kalsi, H.S.	
	(b) *Manganese Ferrites:* Major development in the repla-	Ganapathy, C.V. Gupta, S.C.,	

(1)	(2)	(3)	(4)
	cement of nickel which is imported, in the nickel-zinc ferrites, at present being used in production of NPL 3, by manganese has been further standardised and chemical formulation which gives properties identical with, if not better than NPL 4, has been made. Production trials with a view to further improvements are on.	Govindaswamy, G. & Smt. Rama Devi.	
	(c) *Microwave Ferrites:* Small quantity order for microwave ferrites has been received from CEERI Pilani and from other research laboratories and these are being executed.	Ramamurti, T.V., Ganapathy, C.V., & Gupta, S.C.	
	(d) *Square Loop Ferrites:* New chemical formulations to give the required properties have been evolved. Tests will be undertaken with the specialised equipment when available.	Ganapathy C.V., & Gupta, S.C.	
DPEC/D/3 Piezoelectric ceramics	Ceramic filters have been made in large batch samples and have been supplied to the radio industry, to assess the possibility of replacing the I.F. Transformers.	Ranamurti, T.V., Ganapathy, C.V., Menon, T.R.K. & Narayanaswamy, N.	
DPEC/D/4 Technical ceramics	(*a*) *Machinable Ceramics.* This is a process by which the ceramic body can be formed into complicated shapes by machining and then sintered. This process lent itself very conveniently for small scale production of different types of ceramic ware for the electronic industry. The samples of coil formers have been supplied to the Ministry of Home Affairs who have approved them and they have placed bulk orders which are now being executed.	Shiv Saran, Rangarajan, S. & Ramamurti, T.V.	

(1)	(2)	(3)	(4)
	(*b*) *Pyrolytic Carbon Film Resistors*:		
	The study of the variables in the manufacture of carbon film resistors for which the porcelain rods were developed was undertaken in order to improve the quality of the porcelain rods. In the course of these investigations a process has been developed by which vacuum can be eliminated for depositing carbon composition film on ceramic substrates.	Shiv Saran & Rangarajan, S.	
	(*c*) *Ceramic tracks for variable carbon resistors*: Initial experiments on making ceramic wafers which can be utilised as the base for depositing a resistance film or variable resistors has been successful. The economics of the process as compared to other methods of manufacture of carbon tracks is being assessed.	Shiv Saran & Rangarajan, S.	
	(d) A method of processing ceramic bodies by isostatic process was tried. This process has now been established as a feasible production process in western countries which gives dimensionally accurate ceramic bodies or metal parts. The equipment for commercial production is being designed.	Shiv Saran & Rangarajan, S.	
DPEC/D/5 Professional ferrites. (high permeability ferrites)	Further intensive work has been done on standardising the methods of testing of professional ferrites. Suitable dies have been designed for pressing pot	Ramamurti, T.V., Ganapathy, C.V., Gupta, S.C., Khanduja, R.S. & Santokh Singh	

(1)	(2)	(3)	(4)
	cores and toroids. As the special presses and dies for them are not being made in India, the available presses had to be modified suitably and dies also had to be designed and made. Meanwhile small quantities of professional ferrites in the form of pot cores have been supplied to CEERI, Pilani. Defence Research Laboratories, the Home Ministry and other Research organisations.	Ved Singh, Nair, N.R. & Khurana, B.S.	
DPEC/D/7 Thermistors.	(*a*) *High Temperature Thermistors*: The Research Design and Standards Organisation has asked us to carry out long term durability tests under field conditions using a kerosene lamp itself as the source of supply of heat. A suitable alternative method using electronic control is being designed.	Ramamurti, T.V., Nair, N.R. & Md. Izar Alam.	
	(*b*) *Low temperature miniaturized Thermistors*: At the request of the Meteorological Department work on thermistors to work from room temperature to 70° C. has been taken up.	Ganapathy, C.V., Sharma, V.N. & Smt. Rama Devi.	
DPEC/D/8 Volume control tracks	(*a*) *Volume Control Tracks/ Carbon Composition Resistors*: Two firms have expressed their wish to enter into collaboration with the NPL for the manufacture of carbon composition resistors; this is being pursued. Same applies to moulded carbon tracks.	Ramamurti, T.V., Nair, N.R., & Md. Izar Alam.	

(1)	(2)	(3)	(4)
	(*b*) *Carbon Tracks for Volume Controls*: Chemical formulation for carbon tracks have been successfully developed and made. A process by using steam to accelerate aging and stabilise the tracks has been developed. Jigs and fixtures to produce these tracks ind suitable shapes have been made. Further work is going on to produce them in quantity. These tracks will be economical an especially suited for small cost radio (low cost) receivers, in view of the simplicity of the process involved and the raw materials.	Ganapathy, C.V., Khullar, S.M., Santokh Singh & Khurana, B.S.	
DPEC/D/9 Special chemical preparation for electronic industry	(*a*) *Silver Paint (Conducting Cement)*: Small quantitites of silver paint is being regularly produced as many organisations had shown their interest in the process. Samples of magnetic oxide suitable for magnetic tapes have been supplied to two firms who have entered into collaborative agreement for the manufacture of magnetic tapes.	Ganapathy, C.V., Khullar, S.M. & Smt. Rama Devi.	
	(*b*) *Ceramic to Metal Seals:* Ceramic to metal seals based on noble metals like platinum, rhodium, etc., have been developed as per special requirements of Defence for general purpose use in microwave devices. The chemical formulations have been suitably evolved and initial samples of seals made using our	Khullar, S.M. & Ganapathy, C.V.	

(1)	(2)	(3)	(4)
	formulations have been found satisfactory. We shall continue to supply items required for ceramic to metal seals, for regular production in Defence.		
TF/D/1 Thin films	The existing plant for growing single crystals of Ge and other semiconductors was modified particularly to suit the purpose and a few filters were prepared. However, the uniformity of the film thickness could not be achieved satisfactorily and as such further modification of the plant was undertaken. This includes the following:— 1. Arrangement to rotate the substrate holder under vacuum at a speed of 50 rpm 2. Arrangement to monitor the thickness of metal and dielectric layers 3. Arrangement to heat the substrate upto 300°C 4. A shutter between the source and substrate. After carrying out the necessary modifications, a few filters were made. The film consists of silver-zinc sulphide-silver layer deposited on glass substrates of $1'' \times 1\frac{1}{2}''$ size and cut from standard gold seal microscope slides. The characteristics of filters made by us and those quoted by foreign firms are given below for the sake of comparison:	Shah, V.V.	

(1)	(2)	(3)	(4)
Make	Peak Wavelength	Transmission %	Half band-width (Hbw)
NPL	4600-5370 A.U.	33 to 44	160 to 210 A.U.
Bausch & Lamb	5460-5800 A.U.	60 to 63	180 to 220 A.U.
Baird- Atomic	4480-5510 A.U.	47 to 48	180 to 200 A.U.

Further work on testing of these filters regarding the effect of humidity, temperature, etc., is in progress. A suitable mount for the filters is also under construction.

CG/D/1
Crystal growth

(*a*) *Production of Optical Materials*: Ved Prakash

An apparatus for the production of optical quality crystals of calcium fluoride, barium fluoride, lithium fluoride, etc., has been successfully operated after incorporating some changes in the design of an existing 10 KW vacuum furnace. A number of 1″ size calcium fluoride crystals were grown and the infrared transmission of a cleaved specimen was studied which gave the following results:

1. 60% transmission upto 9/μ
2. Practical transmission range (transmission better than 20%) upto 11.5/μ

Normally the transmission is about 90% upto 6/μ and the practical transmission limit is 9/μ (Stockbarger D.C. 1944, Hohl 1937), while the practical transmission shows a considerable improvement; percentage transmission was relatively low. This may be attributed to

either roughness of the specimen or some impurities of uncertain nature. A 2" size KBr crystal was also tried. Though the crystal was good and perfectly colourless and transparent, it was found to be broken in several pieces, a phenomenon which is common with NaCl and KBr etc. when these crystals are left to cool in the crucible. Experiments are in progress with calcium fluoride and other materials.

IR transmission was studied on the same specimen after polishing it. The results show that the poor transmission recorded in earlier tests was due to the surface. This proved that the material produced in the laboratory is comparable to the standdard material as far as IR transmission was concerned. Tests on UV transmission could not be carried out so far because of the lack of facilities.

Another chamber for the furnace was designed and is in the process of fabrication. This will improve the performance of the crystal growing apparatus in many respects.

(*b*) *Study of Crystal Growth and imperfections*: Govind Singh.

Microphotometer traces of 20 Weissenberg photographs having 600 spots were taken. They were integrated with the help of intensity wedge by graphical

method to give intensities of reflections for 6H polytype of silicon carbide. The data so obtained was used for computing three dimensional Fourier synthesis of 6H polytype. The results thus obtained showed unexpected higher peaks on (OOZ) axis.

In the meantime atomic structure of two polytype 54H and 66H has been worked out.

The unexpected high peaks on (OOZ) axis was now to be attributed to computational error by the electronic computor. A new programme was written and computations were done on IBM 7044 at the Indian Institute of Technology, Kanpur. The electron density contour maps have been drawn for different atoms in (1120) and (0001) planes. The contours reveal anisotropic thermal vibrations along (0001) axis in (1120) plane whereas no such affect is observed in the (0001) plane. In order to study the electron density distribution more accurately, anistropic thermal parameters have to be refined and used. A detailed account of this is being incorporated in a dissertation for Ph.D. degree.

(*c*) *Study of structure of monolayers of straight and branched chain fatty acids*: Srivastava, R.K.

A detailed study of the structure of monolayers of several straight and branched chain fatty

acids like stearic, palmitic, etc., was carried out. It was found that branched chain fatty acids do not spread into the usual monolayers like other fatty acids, and hence it was not possible to study them further.

(*d*) *Study of surface features of silicon carbide crystals*: Bhalla, A.S.

The electron microscope has been installed. Replicas of the silicon carbide crystals have been made. Spiral growth has been observed. Steps of small height have been studied in order to use in the magnification calibration of the electron microscope at higher ranges. Glass and ceramic surfaces have been used to study the substrate effect on thin film resistors.

(*e*) *Transmission studies on silicon carbide crystals*: Verma, S.P.

A set up for the measurement of the reflectivity of silicon carbide crystals was made. It enables both the transmission and flectivity of a specimen to be mearesured with the same setting. A few crystals of 6H polytype of silicon carbide were ground to a thickness of 150 microns such that the two surfaces remain parallel and then both the faces were polished.

The set up was completed for the transmission and reflectivity measurements in ultraviolet and visible regions of light. These measurements have to be taken

(1)	(2)	(3)	(4)
	in a wide range of wavelength, i.e., from ultraviolet to infrared. Therefore, the construction of a far infrared spectrograph was undertaken and it has been completed.		
	(*f*) *Production of synthetic gems*: We have in the Laboratory a Vernueuil's apparatus which is suitable for making synthetic gems. Accordingly an attempt was made to produce synthetic gems of various types (ruby, sapphire, etc.) by this technique. A number of sapphires were prepared and were found to be semi-transparent. The crystals also crack while growing when they become bigger in size. So far small single crystals of sapphire approximately half centimeter in length and half centimeter in diameter were produced, which are transparent and have no cracks. Attempts are being made to grow transparent single crystals of sapphire of bigger size.	Malhotra, M.L.	
Elec/D/1 Microwave tube design, development and fabrication of prototypes of 10 cm reflex klystrons	(a) A re-entrant cavity suitable for 10 cm reflex klystron was designed and fabricated. It can be tuned from 2,900 mc/s to 3700 mc/s with the help of tuning screws.	Chandra K., Parshad, R. & Arora, T.R.	
	(b) Oxygen free copper discs to be used for disc seals in reflex klystrons have been designed and the process of fabricating these discs by pressing has been completed. Suitable jig for mounting these discs while making disc seals with the help of induction heating has		

(1)	(2)	(3)	(4)
	been constructed and is being tested. (c) Ni-matrix cathodes to be used in these tubes have been pressed, processed and tested. They are capable of giving the required current density. It has been found that the Ni-matrix shrinks after sintering. This defect is being eliminated by controlling the pressure and quantity of the powder. Coiled tungsten heaters have also been made. The alumina insulating coating on these heaters is now satisfactory. Life tests on these cathodes are yet to be performed. (d) Other parts of the klystron are now ready. Cathode sub-assembly has been completed and is being tested before final assembly. (e) The assembly of the demountable double-gap reflex klystron has been completed. The experimental tube is under test.		
Elec/D/2 Microwave components, materials and ferrite devices (including waveguide components)	(a) A material has been developed which can be moulded to desired shapes without shrinkage for making waveguide components by electroforming. The material is cheap and can be melted away after the components has been electroformed. (b) Design and fabrication of the following x-band components has been completed:	Chandra, K. & Ram Prashad.	

(i) slotted section
(ii) slide screw turner
(iii) moveable short
(iv) co-axial to waveguide adapter
(v) variable attenuator
(vi) dielectric phase shifter
(vii) probe with crystal holder
(viii) waveguide horns

A small batch production set-up for making bends, junctions and small lengths of waveguides by electroforming has been started. Components have been supplied to University of Delhi, University of Roorkee, Air Headquarters, Solid State Physics Laboratory and University of Rajasthan costing about Rs. 4,765/-. The process has been sent to the NRDC for being handed over to industry.

(c) Dies for making flexible waveguides and straight waveguides by drawing have been designed and are being made in the workshop. Experimental waveguides for X and C bands have been made by drawing process.

(d) Work on light-weight waveguides has been initiated. Few components using a thin conducting film embedded in resin have been fabricated. Their weight is about one-sixth of the conventional all metal components.

(e) Broad-band resonance isolators for X-band and C-band were completed last year. Patent on "Broadbanding of resonance isolators" has been filed. The

Chandra, K., Ram Parsad, Agarwal, V.K., Shiv Saran & Ranga Rajan.

process has also been given to the NRDC. These isolators require a high-dielectric low loss material for concentrating the microwave energy in the centre of the waveguide. So far a mixture of titanium dioxide and paraffin wax in certain proportions was used, which has worked well. Now a low loss ceramic material is under development in collaboration with the Development-cum-Production of Electronic Components Unit. Few samples have been made and were found to be quite satisfactory. The dielectric properties are being studied further. Prototypes of X-band and C-band isolator are ready. Permanent magnets for the isolators have also been obtained. Two prototypes of resonance isolators are being fabricated for the Post & Telegraph Department as per their specifications.

(*f*) It has been found that the narrow band performance of circulators is due to mismatching produced by the ferrite loaded junction. Techniques of broadband matching using dielectric loaded junction have been perfected. We have been able to increase the band-width of X-band circulator from 400 mc/s to 2000 mc/s by this method. This much band width is enough for most of the applications of circulator, namely, microwave communication systems and parametric amplifiers. Another circulator for C-band has been

Chandra, K., Ram Parshad, & Agarwal, V.K.

fabricated and is under test. The performance characteristics of broadband, isolators and circulators are given below:

(i) *Broadband resonance isolators:*

X-band isolators:

It covers the entire X-band frequencies (9.2 to 12.4 Kmc.)

Performance data:

Frequency band for isolation greater than 20 db: 8.2 to 12.4 kmc.

Maximum isolation: 45 db Maximum forward loss: 1.1. db Maximum V.S. W.R.: 1.1

(ii) *C-band isolator:* It covers the frequency band 5.8 kmc to 8.2 kmc.

Performance data:

Frequency band for isolation greater than 20 db: 5.8 to 8.2 kmc

Maximum Isolation: 40 db Maximum forward loss: 1.1 db

Maximum V.S.W.R.: 1.1

The dielectric material, microwave ferrites, etc., have all been made in NPL. Maximum forward loss can be reduced to 0.6 db if narrow band isolator is required.

(1)	(2)	(3)	(4)
	(iii) *Broadband three Port 'Y' circulators:* Typical performance data of a broad band three port 'Y' circulator is given below:— Frequency band for isolation greater than 20 db: 8.2 to 10.2 Kmc (Bandwidth) 2000 Mc/s). Maximum isolation : 34 db Maximum insertion loss : 0.5 db Maximum V.S.W.R.L. : 1.2 db (g) Some experimental work on Faraday rotation ferrite attenuator-cum-isolator has also been done. Investigations are in progress.		
	(h) The resonance isolators described above require a high dielectric low loss material for concentrating the microwave energy in the centre of the waveguide. So far a mixture of titanium dioxide and paraffin wax in certain proportions was used and has worked satisfactorily. Now a low loss ceramic material is under development in collaboration with the Development-cum-Production of Electronic Components Unit. Few samples have been made and were found to be quite satisfactory. The dielectric properties are being studied further. Know-how has been developed and the proposal for handing it over for commercial production is under consideration.	K. Chandra R. Parshad V.K. Agarwal Shiv Saran Ranga Rajan	

(1)	(2)	(3)	(4)
Elec/D/4 Electronic circuits	A new type of decade counter using binary-quinary logic introduced recently in literature was improved. The circuit has many desirable qualities, e.g., use of less number of transistors, ease of reverse counting, ease of interpolation, etc. Further work on this circuit is continuing. In modern technique, the input number stores in the counter is read by an inline readout system. The most straight forward system is the use of nixie tubes which are not available indigenously. As an alternative, resistance matrix techniques were evolved for achieving a tenlight system for the required interpolation. The techniques used also eliminate the use of diodes in the matrix, resulting in an economical circuit. The technique of binary-quinary has been developed further to take account of the fact when the stored subtrahend is greater than the minuend. Work is continuing. Investigations were carried out on developing multivibrator circuits giving almost consistant frequency with respect to change of temperature and supply voltage. By use of thermistors and zener diodes, an almost consistancy of frequency for nominal frequency of 50 c/s has been achieved over a wide temperature range (from say 10° to 80° C) and voltage.	Ram Parshad, Suri, S.P., Singh, S.K., Taneja, K.C. & Devi (Mrs.), P.S.	

(1)	(2)	(3)	(4)
	Work has been started on a 1000 c/s stabilised source.		
Elec/D/5 Development of electronic instruments	*Transistor Curve Tracer* A trasistor curve tracer has been completed, and was displayed at various exhibitions. This instrument displays the dynamic transistor characteristics on a C.R.O. for various outputs, and is invaluable for rapid checking of individual transistors and for choosing symmetrical transistor pairs for class B operation.	Suri, S.P., Ram Parshad, Parminder Singh, Devi (Mrs) P.S., Prabhakar, A.C., and Inder Bhan.	
	Preset Counter A demonstration unit for the automatic packaging or batching of steel balls by a preset counter has been completed.		
	Another version of a preset counter is under development. The older preset counter has been sent for display at the International Exhibition in Montreal, Canada.		
	Industrial Process Timer Industrial process timer (two stage) has been completed. This timer controls on and off timings in a two-channel transistor switching system.		
	Surge Detector This instrument was developed at the request of M/s. International Computors and Tabulators. The instrument in the finished form has been sold to them.		
	This instrument detects transients of predetermined levels set		

by a knob on the instrument. As a transient is detected, a visual indication is provided by the instrument. The instrument has use in installation of equipment like computors which operate erratically in the presence of mains transients.

Instrument for unilateralisation of transistors I.F.amplifier stages:

In this instrument, the intermediate frequency stages used in transistor radios and elsewhere can be rapidly unilateralised for both capacity and resistance values. The unilateralised stages give optimum gain, and do not produce self oscillations which make the I.F. stage useless or produce squealing in the output. After unilateralisation, the instrument also indicates the power gain of the I.F. stage. The instrument has been completed, and it should be widely useful in helping the radio industry in improving the quality of the I.F. stages, saving of time and decrease of overall rejection factor in radio manufacture.

An instrument for rapid determination of frequency:

A frequency meter, using the technique of diode pumping is almost complete. The instrument measures the frequency from 0 to 500 Mc/s by giving a straight input, the frequency being indicated by a deflection of an output meter, and is useful for

(1)	(2)	(3)	(4)
	rapid and routine determination of frequency in the audio range when the costly counter type frequency meter is not available.		
	Quartz crystal microbalance for monitoring thickness of thin films:	Suri, S.P.	
	An ultrasensitive microbalance to measure thickness of evaporated thin films during preparation in a vacuum system has been developed. Preliminary trials have been highly satisfactory.		
	Calibration of the instrument is to be done. The instrument has been made for helping the Laboratory Project on Thin Films, and for measuring extremely small weighings (of the order of micrograms.)		
Elec/D/6 Thin film devices	The project has been merged with the Laboratory Project on Thin Films.		
Elec/D/7 Semi-conductor electronics (effect of magenetic field on diodes and transistor operation)	The decrease of diode current in various kinds of germanium diodes at room and liquid air temperatures has been investigated. The decrease (beta) of germanium and silicon transistor has also been investigated.	Ram Parshad & Mehta, S.C.	
	Papers on this subject are under publication in the Journal of Pure and Applied Physics. The above work leads to expectation of decrease of mobility or/and life-time of minority carriers with magnetic field. Experimental investigations of behaviour of life		

(1)	(2)	(3)	(4)
	time under magnetic field was done with negative effect. Investigations about mobility have to be done. The previous work also lead to expectation of increase of built-in voltage with magnetic field. In this connection, the change of diode capacitance with magnetic field was investigated. The capacitance, in the early stage of application of backward voltage has been found to decrease with magnetic field. Further work and interpretation of results are continuing.		
H/D/2 Clinical thermometers.	5,000 thermometers were received in one lot and this enabled the study of some difficulties of the installation of the testing equipment to be undertaken. However, the period of availability of the thermometers was too small to finalise the time and work study. As a result of the work, the following improvements have been made: (a) A quick counting arrangement has been made and the industry has started using this. (b) The shake down equipment has been provided with an integral accelerometer. (c) Feeding arrangements for shadowgraph for bulb and stem diameter measurement have been improved.	Bansal, T.D. & Wasan, V.P.	

(1)	(2)	(3)	(4)
	(d) Sand blasting equipment, pigment applicator and pentagraph engraver have been developed and multiplied as desired by ISI. (e) Temperature constant of baths have been studied. (f) Arrangements are being made for obtaining NPL certification mark. (g) A syllabus has been drawn out for the training in the testing of clinical thermometers. (h) Details for running a pilot plant have been drawn up for testing on experimental basis.		
H/D/3 Developing a simple method for k-value tests.	Steady state, radial heat flow method of finding thermal conductivity has been applied to sands, successfully. Great anomalies were observed when it was applied to foam plastics. The material seems to be non-isotropic, but was to be confirmed by further experiments. Application of this method to insulation wools was found to give non-reproducible results. The matter is under investigation.	Sastry, K.S.	
H/D/4 Investigations to recommend the convection coefficient of heat transfer under steady state free convection.	*Empirical study of known data for single horizontal cylinder*: A bi-logarithmic conic has been found to fit the data better than any known theoretical or empirical formula. The results can be represented by the curve within 1% over the whole range of steady state, whereas presently used formulae misfit the data by	Bansal, T.D. & Chandna, R.C.	

(1)	(2)	(3)	(4)
	as much as 20% or even more and are applicable to different portions of the range.		
HP/D/1 Drying of coal fines obtained during coal washings by solar energy utilization (in collaboration with CFRI, Dhanbad.)	The Indian Patent No. 99523 entitled, "A method for heat storage and/or heating of fluids, with special reference to Solar Energy Utilization" was accepted in January, 1967. A paper entitled, "Industrial Solar Drying" was presented at the last Annual Meeting of Solar Energy Society, held in Boston, USA, in March 1966. The paper was subsequently modified and has now been accepted for publication in the SES Society's Journal, "Solar Energy". In the meantime it was realised that the development of the shell-and-tube heat exchanger will take some time because, as compared to the shell-and-tube heat exchanger which is used in the petroleum industry and for general purposes, operate under very high pressure, while this heat exchanger operates only at atmospheric pressure. Instead of this heat exchanger, an assembly comprising of a radiator, fan, a variable speed motor and a water circulating pump, as commonly used in an automobile, could effect heat transfer to air. These two systems have been described in a recent paper entitled, "Drying of Materials with Solar Energy" communicated for publication.	Khanna, M.L.	

(1)	(2)	(3)	(4)
	The amount of heat transfer from water to air in the shell-and-tube heat exchanger and the temperature of the outgoing air have been estimated by considering the various parameters, such as, flow rate and temperature of incoming air, temperatures of incoming and outgoing water, length and diameter of the tube etc., under forced convection mode of heat transfer. A paper entitled "Design Data" for heating air by means of heat exchanger-cum-reservoir for utilisation of solar energy has been communicated to Solar Energy Society for presentation at the forthcoming Annual Meeting to be held in Tempe, USA in March, 1967.		
IP/D/1 Development of manufacturing process for silver graphite relay contacts	A new composition having carbon black has been made, sintered and tested for physical characteristics. Successful life test extending over 100 hours, with 20 makes and breaks a minute was carried out in case of one: the other one failed, possibly because of mechanical defects in the contact. Further work is in progress. Some imported relay contacts having copper plating on the contact making surface has been examined for their physical characteristics and are being put on life tests over 100 hours. New formulations for the above contacts are in progress	Sen, D., Awasthy, B.R. & Joglekar, G.D.	

(1)	(2)	(3)	(4)
	making them cohesive and less electro-eroding.		
M/D/1 To develop and study photovoltaic cells	Photovoltaic cells of the type Se-Cd, Se-Au and Se-Al have been prepared which are comparable to and in some cases better than the imported cells. Open circuit voltages of the order of 400 mv and short circuit currents of the order of 90 microamperes have been obtained. Efforts are being made to further improve the cells and to bring them to the manufacturing stage.	Singh, R.G. & Marwah (Mrs) R.	
M/D/2* Development and study of phosphors	Steps have been taken to establish a phosphors preparation and a luminiscence laboratory. A versatile multipurpose cryostat is being designed. Experimental set up for purification of base materials, for making highly pure zinc sulphide and other phosphors is under progress. Attempt is also being made to activate imported zinc sulphide with maganese, copper and silver impurities. Spectral response of these materials will also be determined: materials prepared in the laboratory would be compared with this.	Agarwal, J.P. & Bahawalkar, R.H.	
M/D/3* Construction of pencil type alkaline mercury cell.	The causes of some of the defects observed in the experimental cells have now been traced out and remedied. Pure mercuric oxide was prepared in the laboratory on an experimental scale for use in the cells since there has been some difficulty in obtaining the material from the	Iyengar, T.R.G.	

(1)	(2)	(3)	(4)
	market. Cells constructed with the laboratory made HgO showed the theoretical voltage, but the output was about fifty per cent of the calculated value in the next cell made. Since commercial zinc powder gave off hydrogen with the electrolyte, very pure zinc had to be prepared in the laboratory. The main difficulty was in the fabrication of anode from the powdered zinc. This difficulty has been overcome and methods of preparing the powdered zinc anode have been evolved. Die for making the specified size of cathodes has been fabricated. Method of granulating HgO to obtain the trequired weight in the cathode has been worked out. General construction of the cell has also been evolved.		
M/D/4* Rheological instrumentation for milk products.	The torsion device fabricated in the laboratory is now on trial in the National Dairy Research Institute, Karnal, for measuring the consistency of butter. Further instruments would be fabricated in due course for measuring rheological properties of butter, condensed milk, jelly and cream. One fundamental property of this instrument would be that it could be used both in summer as well as in winter.	Chari, S.S.	
M/D/5* Preparation of semi-conductor devices (silicon)—	(a) Ferro-silicon containing 75 to 80% silicon was obtained from the market. It was leached with different acids. Successive treatment of ferrosilicon with hydrochloric,nitric,sulphuric and	Jain, G.C., Sarin, V.K., Gupta, P.K., Amar, V.K., Raza, M. & Sen, D.	

hydro fluoric acids, has brought down the total impurities to within 0.3%. The silicon powder thus obtained was packed in a quartz tube and iodination carried out at about 800°C. Silicon tetra-iodide has thus been obtained. It has been fractionally distilled and apparatus is now being set up for cracking silicon.

(b) Techniques have been developed to cast silicon into rods of various diameters. The cast rods have been successfully fused with a single crystal seed and zone refined. As soon as semi-conductor grade purity grade silicon is available, it will be cast into rods and zone refined. (This is a continuation of Project SSP/R/1).

APPENDIX III

STANDARDS

(1)	(2)	(3)
A/ST/1 Maintenance of standard of sound pressure	In the maintenance of standard of sound pressure, periodic calibration of the Laboratory standard microphones in the frequency range 50-10,000 c/s by the reciprocity method in a coupler cavity was continued to an accuracy of O.I. dB. Other electro-acoustical equipment used in the laborarory for standardisation and testing work were also calibrated periodically for accuracy and stability. These items include oscillators, amplifiers sound level meters, attenuators, microphones, loudspeakers, filters, power meters, level recorders, etc.	Pancholy, M., Chhapgar, A.F. & Khanna, R.K.
ECY/ST/1 Setting up, maintenance and improvements of the electrical standards: (1) Resistance	Fortnightly readings of the resistance standards comprising of ten 1-ohm resistors were taken under controlled conditions of temperature at 20°C by the method of substitution,for intercomparison and ensuring that their values are accurate to better than one part in a million. The record of their values is being maintained.	Batra, V.K., Tandan, R.K. & Sircar, B.
(2) Electromotive force	Fortnightly readings of the electromotive force standards comprising of seventeen cadmium cells were taken under controlled conditions of temperature of	Batra, V.K., Tandan, R.K. & Sricar, B.

(1)	(2)	(3)
	20°C for intercomparison and measuring their values accurate to one part in one million, i.e., one microvolt. The record of their values is being maintained.	
(3) DC/AC transfer	The sensitivity of the instrument was further increased from 15.6 cm/volt to 25.14 cm/volt. The following steps were taken for this purpose: (a) The length of the bifilar suspension was increased from 28 cm to 33.4 cm and the separation of the fibres was made more uniform. (b) The suspension fibres were reannealed. This resulted in a considerable increase in the sensitivity of the instrument throughout the range of deflection. The maximum sensitivity (25.14 cm/volt) was found between 27.3 volts to 29.4 volts. The instrument was thoroughly checked against an electro dynamometer both for d.c. and a.c. voltage measurements. It was found that: (a) There is a difference in the deflection between d.c. reversal voltage. The difference is 0.30 volts for 393.4 cm of ES voltmeter deflection to 0.35 volts for 42.2 of ESV deflection. The instrument always gives higher deflection when positive terminal of the d.c. voltage is connected to fixed sector than for negative terminal of d.c. voltage connected to fixed sector.	Tandan, R.K. & Pradhan, M.M.

(b) There is still a considerable transfer error at 50 cycles. For different ESV deflections both d.c. and a.c. voltages were applied and their values were measured in the dynamometer. There is a a difference of 0.825 volts for 42.2 cm of deflection and 3.75 volts for 393.4 cm of deflection.

To remove the above errors, firstly the mechanical adjustment of the instrument was checked. It was found that the moving vanes were not tightly attached to the central shaft. The central shaft should be bronze rod of 0.5 mm diameter and having 20 BA threads at its both ends on to which nuts could be tightened. The shaft and nuts are under fabrication.

In the meantime, on the request of Air India the question of testing the instruments for them at 400 cps was taken up. For this the harmonic contents of a generator of 115 volts at 400 cps were checked. It was found that:

(a) at open circuit the generator contains a high percentage of 4th to 8th harmonics and again 11th to 16th harmonics, i.e., total harmonic contents were equal to 27.5%.;

(b) at open circuit with a filter (80 m.h. inductance and 2/uF capacitance in series) the total harmonic contents reduced to

(1)	(2)	(3)
	16.6%, but there was a considerable increase in III harmonic (1.6%); (c) at closed circuit with a load of 0.74 amp current and filter, the harmonic contents were further reduced to 13.6%, but the third harmonic was still more dominating (5.9%). Thus the available generator was found to be fit only for instruments with lower accuracy and where harmonics did not matter. In order to have a good source which can be used for accurate instruments a fixed frequency oscillator of 400 cps coupled to a power amplifier was decided to be fabricated. The necessary components are being procured to assemble the above.	
(4) Fabrication of standard type resistors	Nine 1-ohm standard resistors have been completed raising the strength of the NPL made resistances to ten in the resistance bank. Four more manganin coils for 1-ohm resistors have been annealed in vacuum at 550°C. Work on the 10 ohm build-up boxes has been initiated and twelve 1-ohm coils for this purpose were annealed at 550°C	Batra, V.K., Tandan, R.K. & Sircar, B.
AM/ST/1 Maintenance of standard of force	A force standard of 3000 kgf capacity has been designed and fabricated in the laboratory. The machine has been commissioned	

(1)	(2)	(3)
	and is being used for the calibration of load measuring instruments like proving rings. The machine can be used both in compression and tension. The load can be applied on the device to be calibrated in steps of (1) 50 kgf, (2) 100 kgf, (3) 150 kgf. The maximum distance available between the platens for fixing the load measuring device is 40 cm.	
LT/ST/1 Precision platinum resistance thermometry	(a) *Range* 450°C *to*—183°C: Evaluation of the various constants for the eight platinum resistance thermometers from the first run of calibration at the various fixed points has been completed for the range 450°C to —183°C. Work for repeating the calibration of these thermometers has been underaken to check the constants as well as to improve our techniques of calibration. (b) *Range* —183°C *to* —253°C: Four capsule type platinum resistance thermometers have been constructed. Work has been started for their calibration at the various fixed points. These would be calibrated down to —153°C (liquid hydrogen point). Some parts of the cryostat for liquid hydrogen point have been constructed.	Baveja, K.D. & Ram Krishan

(1)	(2)	(3)
Elec/ST/1 Broadcast of standard time & frequency signals from Kalkaji	The broadcast of standard time and frequency signals from the station at Kalkaji (New Delhi) which was previously being carried out for two hours daily (11 hrs to 13 hrs) has now been extended to four hours every day, i.e., from 11 hrs to 15 hrs, with effect from January 1967. Necessary modifications required in this connection were successfully carried out. Due to shortage of dry batteries a simple highly stable low-voltage supply system of novel design was developed from indigenous materials. This equipment is in everyday use in the project.	Ghose, T.N., Sood, P.C. & Gopal Krishan
Elec/ST/2 Standardisation of time & frequency at NPL and development of instruments for accurate measurement of time and frequency	The normal maintenance of time and frequency standards and their associated equipment was carried out during the period under review. The frequency calibration service as offered previously was limited to 500 megacycles. It has now been extended to measure and calibrate frequencies upto 30,000 megacycles against standard oscillators. In collaboration with the Post & Telegraph Department, a land line was laid between NPL and the Eastern Court, New Delhi, the calibration centre for the Post & Telegraph Department. Standard frequency signals are passed over this line to calibrate the equipments for the Depart-	Ghose, T.N., Taneja, P.N. & Inderjit.

(1)	(2)	(3)
	ment in New Delhi, which in turn synchronise similar equipments located at other parts of the country like Bombay, Calcutta, Madras, etc. A quartz clock suitable for use in universities and other institutions where precise frequencies are needed, is under development.	
Elec/ST/3 Microwave standards:	(a) Bridge circuits for measuring microwave power in terms of d.c. have been completed. These two bridges would measure r.f. power upto 10 watts. Measurement of d.c. quantities by potentiometer method has been completed. Determination of the efficiency of bolometer mounts is also in progress.	Chandra, K., Ram Parshad, Aggarwal, R.K., Dube, D.C. & Yadav, R.S.
	(b) For frequency standardisation work, two harmonic generators, one for 30000 mc/s from 300 mc/s using step recovery diode and the other one for 6000 mc/s from 3,000 mc/s using a varactor have been completed. Signal source for v.h.f. region are yet to be made. Another harmonic generator for 9000 mc/s has been constructed and is being investigated. Frequency measuring set upto 30 mc/s has been tested and is ready for use.	
	(c) For obtaining standard r.f. voltages, work has been started using the breakdown characteristics of zener diodes. Experimental work with transistors is also in progress.	Ram Parshad, Chandra, K., Ghosh, T.N. & Suresh Chander.

(1)	(2)	(3)
	For accurate measurement of r.f. voltages of the order of 30 volts or higher, oscilloscope technique using d.c. is being investigated. Both r.f. and d.c. could be simultaneously applied to the deflection plates of the oscilloscope for the purpose of comparison. R.F. oscillators for voltages of the order of 50-100 volts are being made to complete the above study. A frequency independent voltage divider consisting of r.c. combinations is being constructed.	
OPT/ST/1 Secondary standards of photometry.	The work on setting up of a suitable appartus for photometric calibration of fluorescent and other gas discharge lamps has been taken up. A large integrating sphere of about 2.5 m. dia. is being made in our workshop. Recalibration of the existing secondary standards of incandescent sources of light is in progress.	Sarma, K.S., Dandawate, V.D. & Kailash Chand.
OPT/ST/2 Laboratory standard for colour temperature.	An antivibration mount for a sensitive galvanometer amplifier to measure the radiometer output with precision has been designed. Because of the difficulties experienced with a single monochromator due to large amount of straylight, two monochromators have been combined to give the performance of a double monochromator. Measurements of spectral transmission and dispersion of the double monochromator are	Das, S.R. & Mrs. Shanta Bai Mallela.

(1)	(2)	(3)
	now in hand. The ultimate object of the project is the determination of spectral radiant energy distribution in absolute energy units from incandescent radiators operating between 1700°K to 2400°K and at 2854°K.	
H/ST/1,2,3 & 4	Have been combined and grouped under H/ST/1	
H/ST/1 Setting up, maintenance and improvement of international temperature standards	*Standard Optical Pyrometer* Effective wavelength was partly studied and calibration work started. *Zinc and Indium Points* New types of apparatus have been fabricated for determination of these points. *Triple Point Water Cells* A number of cells have been made. *Gold Point* The technique of the wire method of calibrating thermocouples and optical pyrometers at gold point has been improvided. *Commercial Optical Pyrometer* Calibrating equipment has been fabricated. In connection with Ice point apparatus and triple point water cells apparatus, an ice shaving machine has been developed and a patent applied for. *Bridge for high precision resistance thermometry* A frame work has been fabricated. Stability of: (1) different wires, (2) methods of making	Bansal, T.D., Wasan, V.P. & Sharma, M.M.

(1)	(2)	(3)
	resistors, and (3) resistance of available switches are being studied. Stirring arrangements for a salt bath are being arranged. The boiling point of water apparatus and the sulphur point apparatus are being modified with a view to arrange a more convenient working.	
WM/ST/1 Setting up and maintenance of standard barometer	Fabrication of various components has been completed and the work of sub-assemblies is in hand. Out of the five sub-assemblies, one is complete, two are nearing completion. It is estimated that the work will be completed by March, 1968. Necessary quantity of mercury has been obtained and arrangements are being made to purify it to the required degree. Special distillation apparatus has been designed and its fabrication is almost complete. Suitable containers are being procured. Other items required for its installation and temperature measurements are on order and as soon as these are received, arrangements to set up the system will be taken on hand.	Prem Prakash, Om Prakash & Jain, V.P.

APPENDIX IV

CALIBRATION & TESTING

Code No.	*Materials*	*No. of items*
	ELECTRONICS	
Elec/T/1	Radio Receivers, and community Receivers	10
	Electro medical devices	1
	Oscillators	3
	Helmets	11
	WEIGHTS AND MEASURE	
WM/T/1	**Length Section:** Length measures for Weights and Measures Enforcement Departments, sets of slip gauges, test sieves, nozzles for air flow measurement, flash point apparatus Redwood viscometers, flow cup viscometers, precision gauges, steel tapes, etc.	347
WM/T/2	**Mass Section:** Sets of weights for scientific purposes.	163
WM/T/3	**Horology Section:** Stopwatches	42
WM/T/4	**Volumetry Section:** Sets of capacity measures for Weights and Measures Enforcement Departments, pipettes, burettes, flasks, measuring cylinders, butyrometers, etc.	114
WM/T/5	**Hydrometry Section:** Different types of hydrometers	204
WM/T/6	**General Testing Section:** Balances of various capacities, pressure gauges, soil testing equipment, autorickshaw faremeter, electrical appliances, coking bulbs, etc.	211

(1)	(2)	(3)
	ELECTRICITY	
ECY/T/1	Calibration of D.C. and A.C. substandard and precision measuring instruments, viz. voltmeters, ammeters, wattmeters, ohmmeters, potentiometers, bridges, standard cells and resistances, etc.	98
ECY/T/2	Developmental testing of industrial products, viz., electric motors, chokes, horns, cables of different types, transformer oil, cable compound, transformers, wires, bridges, resistances, etc. etc.	107
	HEAT STANDARD	
HS/T/1	Thermometers, pyrometer, viscometer etc.	72
	Glass plate, boards & fuses etc.	4
	Mineral wool	1
	Thermocouple	1
	HEAT AND POWER	
HP/T/1	Oil	6
	Sewage Gas	1
	Diesel Engine	2
	ANALYTICAL CHEMISTRY	
AC/T/1	Water	42
	Steels and ferrous materials	81
	Non-ferrous alloys and compositions	61
	Building materials, quartz	15
	Wires, electric, galvanised, etc.	17
	Acids, gases and other chemicals	36
	Miscellaneous	47
	APPLIED MECHANICS	
AM/T/1	**Calibration at factory premises**	
	Universal testing machines	3
	Transverse testing machines	3
	Compression testing machines	4
	Tensile testing machine	1

(1)	(2)	(3)
AM/T/2	**General Testing and Calibration**	
	Proving rings	220
	Hydraulic jacks	16
	Universal pulling and lifting machines	5
	Hardness testing machine	1
	Concrete cubes, cylinders and tiles	20
	Tension and suspension clamps, dead-end assemblies and compression joints.	22
	Steel rods, plates, wires and joints	102
	Miscellaneous	60
	ACOUSTICS	
A/T/1	Loudspeakers	12
	Vibrating machines	27
	Sirens	7
	Sound absorber material	2
	Audiometer	5
	Strobometer	1
	Battery eliminator	1
	Audio output transformer	2
	Horn (automobile)	3
	Vibrator	3
	INDUSTRIAL PHYSICS	
IP/T/1	Carbon brushes	2
	Carbon block (sample)	1
	Brushes block	6
IP/T/2	Wagner turbidimeter	6
	LOW TEMPERATURE	
LT/T/1	Sample of modified Domestic refrigerator	1
	Liquid gas containers	4
	D.P.E.C. UNIT	
DPEC/T/1	Transformer	4
	Capacitors	1

(1)	(2)	(3)
	Resistor	4
	Fire detector	1
	D.N.P.L. DIVN.	
DNPL/T/1	Diffusion pump	1
	OPTICS	
OPT/T/1	Lamps	20
	Lenses, glass sheets etc.	16
	X-ray Films, microscope, objective microscope etc.	6
	Refractometer	2
	Taxiway light	4
	Flourescent tubes	4
	Liquid paraffin	1
	Gauze cloth and tracing cloth	2

TESTING FEES DURING THE YEAR 1966-67

Name of the Division	*Amount* Rs. P.
Applied Mechanics	21815.00
Weights and Measure	23708.00
Materials Analysis	9349.00
Electricity	11341.00
Optics	4111.00
Acoustics	5136.00
Heat, and Heat and Power	3758.00
Industrial Physics	1661.00
D.P.E.C. Unit	633.00
Electronics	1472.00
Low Temperature	1840.00

MISCELLANEOUS RECEIPTS

Sales of carbon products	7905.00
Sales of electronic equipment	2828.00
Jobs done in the workshop	4240.00
Supply of optical design data	2400.00
Supply of infrared spectra	422.00
Repair of instruments.	4860.00

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(1)	(2)	(3)
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	Carbon block (sample)	1
	Brushes block	6
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	LOW TEMPERATURE	
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	Liquid gas containers	4
	D.P.E.C. UNIT	
DPEC/T/1	Transformer	4
	Capacitors	1

(1)	(2)	(3)
	Resistor	4
	Fire detector	1
	D.N.P.L. DIVN.	
DNPL/T/1	Diffusion pump	1
	OPTICS	
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	Lenses, glass sheets etc.	16
	X-ray Films, microscope, objective microscope etc.	6
	Refractometer	2
	Taxiway light	4
	Flourescent tubes	4
	Liquid paraffin	1
	Gauze cloth and tracing cloth	2

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Jobs done in the workshop	4240.00
Supply of optical design data	2400.00
Supply of infrared spectra	422.00
Repair of instruments.	4860.00

APPENDIX V

SERVICE TO INSTITUTIONS/INDUSTRY

Code No. and Problem (1)	Service/Advice (2)	Reference (3)
A/S/1 Acoustics of Auditoria, elimination of noise etc.	Advice was given in as many as 17 cases	For Government Departments, Railways, Educational Institutions and Cultural Organisations.
A/S/2 Study of methods of test of hand driven sirens	The range of audibility under different environmental conditions was studied in relation to the acoustic output.	Civil Defence Organisation, Delhi.
A/S/3 Measurements on frequencies	Measurements on the frequencies of notes on the Indian musical scale were made.	Khan Sahib Abdul Karim Khan, Sangeet Prachar Mandal, BOMBAY.
A/S/4 Measurement of the performance characteristics of indigenous hearing aids.	Work was taken up on measuring the performance characteristics of indigenous hearing aids with a view to finalising the performance requirements to be incorporated in the relevant standard specifications	Indian Standards Institution.
A/S/5 Reaction of high frequency and high intensity sound	A study of the reaction of birds perching in workshops to high intensity frequency and high intensity sound was carried out.	Railways Workshop, Varanasi
AC/S/5 Study of chemical microscopic, dimensional, infrared and X-ray properties	Special type of papers were examined to study the chemical microscopic, dimensional, Infrared and X-ray properties and results reported.	Ministry of Home Affairs

(1)	(2)	(3)
LT/S/1 Running and maintenance of air and nitrogen liquifier plants.	A total of 6654 litres of liquid air and 1143 litres of liquid nitrogen was produced. 1953 litres of liquid air and 853 litres of nitrogen liquid was supplied to various parties on payment. Rest of the quantity was used for Laboratory work.	Universities and research organisations
LT/S/3 Purified helium gas	One Litre of purified helium gas was supplied.	Optics group, C.S.I.O.
LT/S/4 Measurements at low temperatures	Facilities were provided to a Scientist from R.R.L. Jammu and Kashmir to produce temperatures down to 60°C in connection with the de-waxing of pyrethreum oil.	R.R.L., Jammu
LT/S/5 Ultra-sonic attenuation in metals	Facilities were provided for the measurements of the ultrasonic attenuation in metals at liquid helium temperatures.	Physics Deptt. University of Delhi, Delhi.
LT/S/6 Congealing temperatures of PVC plasticisers	The temperatures of the commencement and the completion of solidification of specimens of PVC Plasticisers were measured.	Shri Ram Institute for Industrial Research, Delhi.
LT/S/7 Congealing temperatures of monoglycerides.	The temperatures of the commencement and the completion of solidification of specimens of glycerides were measured.	—do—
LT/S/8 Compressor damper tube breakage and suspension	Technical advice was given	—do—
LT/S/9 Setting up of a test room	Technical advice was given	M/s. Hyderabad Allwyn Metal Works
LT/S/10 Installation and	Technical advice was given for the installation and lay out of	Indian National Scientific and

(1)	(2)	(3)
layout of water coolers	water coolers for photographic rooms.	Documentation Centre
OPT/S/1 Railway Lenses	Technical advice was given on development of doublet lenses and their testing.	M/s. Paisa Fund Glass Works, Telegaon.
OPT/S/2 Auditoria/Lighting	Technical advice was given on the stage and auditoria lighting.	i. M/s. Ravindra Bharathi, Hyderabad ii. Christian Medical College, Vellore. iii. Operation Theatre for Radiotherapy Christian Medical College and Hospital, Vellore. iv. Pant Agricultural University, Pantnagar, U.P.
OPT/S/3 Setting up of Optical Workshop.	Technical advice was given on setting up of optical workshops	i. M/s. Hindustan Optical, Dehradun. ii. I.M.D.A., New Delhi. iii. M/s. Rajasthan Industrial Corpn., Jaipur.
RPU/S/2 Radio Propagation Service.	RRC-A series (21 issues) on the ionospheric data, RRC-A Series (12 issues) on solar and geophysical data RR-B series (12 issues) on ionospheric predictions and sunspot predictions (12 issues) have been published and issued.	
RPU/S/1 Regular Ionospheric soundings and true heights	Routine round the clock sounding of the ionosphere at 15 min. intervals were carried out fairly satisfactorily. Routine scaled data were provided for radio propagation services of the Unit.	Saha A.K., Rao, B.C.N. & Jain, V.C.

(1)	(2)	(3)
	Weekly summary data were sent to interested people in India and abroad. Selected records have been specially scaled for reduction to true heights with an electronic computer programme. Adequate computor time (free of charge) has not so far been available. A 100 ft. mast has been purchased for erecting a new and modified antenna system. Procurement of accessory materials required has not been completed.	
RUP/S/2 Propagation data service	Radio propagation data services were provided, on a regular basis, to the radio traffic organisations in India, (eg. AIR,OCS, Defence, P &T)and abroad in the following form: i. through regular dissemination of basic ionospheric data (RRC-A series, Part I) ii. through regular dissemination of solar and geophysical data (RRC-A series, Part 2) iii. through predictions (6 months in advance) of radio propagation conditions over Asia and part of Europe. iv. through consultation on specific radio service problems (AIR, P&T, Defence) v. through special predictions of radio propagation conditions for the border areas (NEFA and LADAK)	Mitra, A.P., Saha, A.K., Jain, V.C. & Aggarwal, (Mrs) S.

(1)	(2)	(3)
	vi. through special research efforts in non-typical problems (a) Television interference through sporadic E (CEERI request), (b) disturbance forecasting (P&T) etc. This is a continuing service.	
RPU/S/3 Radio patrol of solar flares and SIDs	During the period under review a number of SIDs accompanying solar flares have been detected, and reported in URSIGRAM code to the India Meteorological Department for transmission to the different national and International user organisations for use in short term forecasting of radio propagation conditions. All the data regarding these are published in Solar Geophysical Data series of the NPL, as well as in the CRPL series (USA). The following papers were presented at the IQSY Symposium held at NPL during December 1960: i. Level of solar flux in the 3,000mc/s region in relation to the concurrence of Sudden Ionospheric Disturbances — A.P. Mitra and C.V. Subrahmanyam ii. X-ray flares and SIDs— A.P. Mitra and C.V. Subrahmanyam iii. A talk entitled "Ionospheric Effects of Solar Flares" was delivered by Dr. A.P. Mitra at the Annual Session	Subrahmanyam, C.V. & Mitra, A.P.

of the Indian Academy of Sciences at Madurai at the invitation of Sir C.V. Raman.

Completed Projects

IQSY Project: The observational part of the programme, which involved essentially continuous measurements in several areas of ionospheric physics, space research and solar activity as part of the Indian programme for the International Quiet Sun Year, lasted for 24 months (Jan 1964—Dec 1965). The data are being brought out in 2 volumes.

Results of analysis of the observations and scientific conclusions are contained in a series of articles that were presented at the IQSY symposium held in December 1966. The articles are being brought in the IQSY Proceedings, and will be issued in a collected form as Vol. 3 of contributions to the ISQY by the Radio Science Division.

Topside Ionosphere

This project involved the use of satellite drag observations of some fifty satellites, electron density profile observations of the Canadian satellite Allouette and several new measurements of H and He ions by U.S. Satellites and the Russian satellites Electron I Electron II. The primary goal was to develop a model of the neutral atmosphere appropriate for the Quiet Sun, and the corresponding model for the ionised atmosphere, including the distributions of 0, H and He and He in the topside ionosphere, upto about 1000 Km. This has been done. The results are contained in a paper published in the Journal of Atmospheric Sciences (USA) and a second paper shortly to be communicated to another foreign journal.

The four service projects

Radio Propagation services
Radio patrol of solar flares
Associate Regional Warning Centre
Development of new radio forecasting techniques
have been reorganised into two projects

i. Solar Geophysical and propagation data services, and
ii. Development of radio forecasting and service techniques.

A:1 Pancholy, M. and Bindal, V.N., Transmission Loss Studies in Granular Materials, Acoustica., **17**; (1966), 51

A:6 Pancholy, M. and Saksena, T.K., Ultrasonic Study of Esterification Equilibria, Jour. Phy. Soc., **22**; (1967), 1110-1114.

A:9 Pancholy, M., Acoustics of the Auditorium of the Music Academy, Madras Journal of the Music Academy., **37**; (1966), 144.

A:10 Singal , S.P. and Pancholy, M., Luminescence in Liquid Irradiated by Sonic Waves, J.S.I.R., **26**; (1967), 101.

AC:1 Verma, M.R. and Rai, J., Identification of Dyes in Inks by Thin Layer Chromatography, J. American Ink Maker., **44**; (1966), 97-98. Also presented at IV International Conference on Chromatography, Brussel, 1966.

AC:2 Verma, M.R. and Rai, J., Thin Layer Chromatography of Inorganic Ions, Part I. Separation of Copper, Cobalt, Nickel, Zinc and Cadmium as their thiocyanate complexes, Current Science., **35**; (1966), 478-480. Also presented at IV International Conference on Chromatography, Brussel, 1966.

AC:5 Bhuchar, V.M. and Sen, D., Saleya Balsam as a Substitute for Canada Balsam, J. Sci. Instrument., **44**; (1967), 486.

AC:8 Verma, M.R., Agarwal, K.C. and Amar, V. K., A Complexometric Method for the Estimation of Thorium and Chromium from a Mixture, J. Chem., 5; (1967); 79-80.

AC:9 Verma, M.R. and Trehan, J.C., Analytical Studies in Basic Magnesium Carbonate and Asbestos Lagging Compositions, Chem. Age. of India *18*; (1967), 50.

BP:1 Bhide, V.G. and Date, S.K., Mossbauer Study of Intermetallic Fe_5Ge_3 System, Solid State Communications., 5; (1967), 435-437.

BP:2 Bhide, V.G., Bhasin, H.C. and Shenoy, G.K., Observation of Iron Clusters in Hydrogen Fired Fe^{57} Doped $SrTi0_3$ by Mossbauer Studies, Physics Letters, *24A*; (1967), 109-110.

BP:3 Bhide, V.G., Date, S.K., Shenoy, G.K. and Umadikar, P.H., The Mossbauer Study of Polynuclear Trivalent Iron Complexes, Physics Letters, *24A*; (1967), 91-92.

BP:4 Bhide, V.G. and Bhasin, H.C., Mossbauer Study of the SrTi03:Co^{57} System, The Physical Review., *159*; (1967), 586-593.

Elect:17 Parshad, R., Suri, S.P. and Singh, T., A Ten-Line Readout for

Decade Counter using Resistor Logic, Electronics Communicator., *I*; (1966), 3.

HP:6 Khanna, M.L., A Russian View Point on Problems in the Utilization of Solar Energy, SUN AT WORK, *11*; (1966), 3.

OPT:4 Vaidya, W.M. and Dandawate, V.D. High Pressure Mercury Discharge Lamps, J. Opt. Soc. America., *56*; (1966), 1693-1697.

OPT:6 Sastri, V.D.P. and Das, S.R. Spectral Distribution and Colour of North Sky in Delhi. J. Opt. Soc. America, , 56; (1966), 829-830.

RC:5 Ramanamurthy, Bh. V. and Kapoor, R.K., Sulphate Aerosol at Delhi in Relation with the Associated Chloride Component, J. Appl. Meteoroly., 5; (1966), 493-499.

RC:6 Sekhon, R.S. and Ramanamurthy, Bh. V., Some Characteristic Features of Hygroscopic and Non-Hygroscopic Aerosol at Delhi, J. Atmospheric Sciences., *23*; (1966), 771-777.

RC:7 Ramanamurthy, Bh. V., Roy, A.K. and Kapoor, R.K., Sources of Origin and Meteorological Importance of Hygroscopic and Ice-Forming Nuclei, Tellus XIX (1967), 1, Sweden. p. 136-142

RPU:3 Mitra, A.P., Subrahmanyam, C.V. and Jain, V.C., Multifrequency Riometers and SID Analysis, Radio Science, U.S.A., *I*; (1966), 1188.

RPU:5 Mitra, A.P., A Comparative Study of Solar Flare X-ray Measurements from Satellites and Sudden Ionospheric Disturbances, Space Science, *VI*; (1966), 558. Second Conference on direct aeronomic measurements in the lower ionosphere, Illinois, U.S.A.

RPU:7 Narasinga Rao, B.C., Control of Equtorial Spread F by the F-layer Height, J. Atmosph. Terr. Phys, England., *28*; (1966), 1206.

RPU:11 Tyagi, Tuli Ram, and Somayajulu, Y.V., Some Results of Electron Content Measurements at Delhi from Faraday Fading of S-66 Transmissions, R.P.U. (Scientific Report No. 26, June, 1966) and Radio Science, U.S.A., *I*; (1966), 1125.

RPU:13 Chandra, S. and Rangaswamy, S., Daily Response of the Ionospheric F-Region to Changes in Thermospheric Temperature, J. Geophys. Res., U.S.A., *71*; (1966), 217-225.

RPU:14 Bhatnagar, V.P. and Mitra, A.P., An Upper Atmospheric Model for Solar Minmum Condition, R.P.U. (Scientific Report No. 27, June, 1966) and J. Atmospheric Sciences, U.S.A. *23*; (1966), 233.

RPU:15 Mitra, A.P. and Mitra, N.R., R.P. U. (Scientific Report No. 28, July, 1966) and Appleton Memorial Issue, J.I.T.E., *12*; (1966), 287.

RPU:16 Somayajulu, Y.V. and Mitra, A.P., Rocket-Borne Riometer as a Technique for D-region Study, R.P.U. (Scientific Reprt No. 29, August, 1966) and Second Conference on direct aeronomic measurements in the lower ionosphere, Illinois, U.S.A. (1965), 111.

RPU:17 Mitra, A.P., Narasinga Rao, B.C. and Mahajan, K.K., Determina-

tion of Loss Coefficient and Vertical Transport Velocity in the Ionospheric F-region, J. Atmosph. Terr. Phys., England, *29*; (1967) 43.

RPU:18 Mahajan, K.K., F-Region Effects Following Two Severe Magnetic Storms over Delhi, J. Atmosph. Terr. Phys., England., *29*; (1967), 61.

RPU:19 Mitra, A.P., An Ionospheric Estimate of Nitric Oxide Concentration in D-region, J. Atmosph. Terr. Phys., England., 28; (1966). 945.

RPU:20 Chandra, S. and Rangaswamy, S., Geomagnetic and Solar Control of Ionization at 1000 km, J. Atmosph. Terr. Phys., England., *29* (1967), 259.

RPU:21 Tyagi, Tuli Ram, Electron Content Measurements over Delhi from Faraday Fading of Satellite Explorer-22 (S-66) radio transmissions, R.P.U. Scientific Report No. 32, November, 1966.

TP:17 Gupta, S.N., Sun Rules for Coupling Constants in Exact and Indian SU (6) W., Phy. Rev. *151*; (1966), 1235 .

TP:18 Gupta, S.N., Baryon-Meson Couplings in SU (6) W., Phy. Rev. *154*; (1966), 1456.

TP:19 Gupta, S.N., Some Corollaries of Goldstone's Theorem, NUOVO Cimento.

TP:20 Katyal, D.L., A New Approach to Current Algebra, Nuovo Cimento, *97A*; (1967), 839.

TP:21 Gupta, S.N., Proton-Antiproton Anhilation into Two Paus Mesons in Broken SU (6) W., Nuovo Cimento., *47A*; (1967), 915-918.

WORKSHOP

During the year under review the workshop executed 2262 work orders. The major jobs are listed below:

a. Hopper for Electronics Division.
b. Two silver Iodide burner assembly for Rain & Cloud Division
c. Wave guide pcs. for Electronics Division.
d. Six needle valves for Low Temperature Division.
e. Three cylinders of C.I. of Extrusion machine for DPEC Unit.
f. Fabrication of calibration unit for strainmeter for Applied Mechanics Division.
g. Lens holder for Applied Mechanics Division.
h. To fabricate endless belt drive unit for Electronics Division.
i. Ebert mounting for grating spectrograph
j. Three constant temperature baths of thermometer comparator for Heat Division
k. Parts for primary standard barometer for Weights and Measures Division.
l. Applied camera stand for Insdoc.
m. Gear box for S.S.P. Division.

A number of design jobs were carried out by the Drawing and Design section. The following are the important ones:

a. Drawing & Design for the standing wave guide apparatus for Accoustics Division.
b. Drawing & Design of the socket and stand for Mossbauer effect for S.S.P. Division
c. Drawing & Design of variable gear box for Patel Chest Institute.
d. Drawing & Design of a reduction gear box ratio 1:10,000 for Insdoc.
e. Drawing & Design of a nozzle for Rain & Cloud Division.
f. Drawing & Design of a mount for 5X, 10X and 15X Huygenian for Optics Division.
g. Design & Drawing of an adjustable mirror mount for Optics Division.
h. Drawing & Design of a grinding machine to the ball joint for G.T.U.
i. Drawing & Design of a housing for mercury lamp for Materials Division.
j. Drawing & Design of a Trolley with chain block pulley for Low Temperature Division.

20 jobs were carried out for outside institutions.

The Laboratory services its own instruments, saving thereby valuable time and money. Spare capacity was offered to educational, industrial and public institutions on payment basis.

Fulfilling a Need

That there exists a pressing need for such a service is borne out by the fact that the Laboratory has been receiving instruments from all parts of the country. Since the work is restricted to portable instruments sent with an escort, majority of the work has come from nearby areas. (Some of the instruments received for servicing were referred by the local agents of foreign manufacturers, themselves).

The list given below shows the large variety of instruments. Every serviced job goes back after a demonstration of the correct method of its use.

Design Data on Instruments

In the process of servicing a wide range of instruments over the past few years, the Laboratory by now has a sizable data on the designs used by a number of manufacturers from the various countries to achieve the same objective. Being in contact with the users, the Laboratory was in a position to convey back to the manufacturers—inherent design defects discovered in the instruments, or the difficulties experienced by the users in operating them. This feed back has been appreciated by the manufacturers.

List of Instruments Serviced: NPL Instruments (38 Nos.)

Magnahelic Gauge; Megger; Three potentiometers; Two multimeter; Seven galvanometers; Vibration pick-up; Rolliflex camera; Graflex camera; Oplarex camera; Battery eliminator; Temperature meter; Toulene relay; Electric meter; Cathetometer; Two signal generators; Two avometers; Recording M.A. meter; A.C. Ampere meter; Tektronix oscilloscope; Wide-band speaker; Combination meter; Philips oscilloscope; Dumont oscilloscope; Orion oscilloscope; Variac; Spectrophotometer; Pyrometer.

Instruments from outside institutions (76 Nos.)

Audiometer; Two Opthalmoscopes; Slit-torch; Torsion balance; Electric de-salter; Two Electrophoresis apparatus; Five flame photometer; Optitherm electrograph; Eye electrolysis instrument; LCR bridge meter; Three controlled ovens; Synaptophore; Two perimeters; Blood pressure

instrument; Irrigauge; Five pH meters; Nefluorometer; Seven microscopes; Pace maker; Laryngoscope; Twin-light carrier; Eight colorimeters; Temperature recorder; Encaphalograph; Photometer; Balance Universal bridge; Four spectrophotometers; Petrol meter; Electric meter; Moisture meter; Absorption meter; Two eye machines; EFG (Oscillo-portion); Two ECG; Two radioactive assay instrument; Fundus camera; Amblyscope; Van Slyke cysloscope; Materials tester; Blood suction instrument; Oscilloscope.

LIBRARY

The total number of additions to the Library during the period 1st April, 1966 to 31st March, 1967 was 2670.

The total number of accessioned publications in the Library upto 31st March was 58016.

PATENTS FILED

4844	Conducting silver paint	Sh. C.V. Ganapathy Sh. S.M. Khuller
4970	Dielectric loaded wave guide broad band and plane ferrite resonance isolators for microwave frequencies.	Dr. Ram Parshad Dr. Kailash Chandra Sh. V.K. Aggarwal
6818	Ice shaving machine	Sh. T.D. Bansal Sh. V.P. Wasan Sh. S.S. Kalra
6803	Improvements in or relating to method of cutting ceramic rods or tubes	Sh. T.V. Ramamurti Sh. Shiv Saran Sh. Rangarajan
7057	A new method for manufacturing barium titanate material with infrared characteristics	Sh. T.V. Ramamurti Sh. V.V. Ganapathy Sh. S.C. Gupta Sh. T.R.K.Menon

PATENTS ACCEPTED

8432	A process for obtaining a machinable ceramic body	Sh. T.V. Ramamurti Sh. Shiv Saran Sh. S. Rangarajan
9523	A method of heating fluids with solar energy	Dr. M.L. Khanna Dr. N.M. Singh

SPONSORED SCHEMES

1. Study of F-layer effects with Doppler fading technique, sponsored by National Bureau of Standards, U.S.A. under PL-480 scheme.

2. Determination of physical properties of and irradiation effects on Ionic Crystals and Semi-Conductors with a view to develop more useful Solid State devices: PL-480 scheme.

3. 'Crystal Growth and Imperfections' : PL-480 scheme.

4. "Dielectric properties of rutile structures and domain dynamics in ferroelectrics, ferromagnets and measurements of internal fields of Mossbauer techniques".

APPOINTMENTS AND PROMOTIONS

Dr. V.G. Bhide joined as Scientist 'F' with effect from 26.11-1966.

Dr. G.C. Jain joined as scientist 'E' with effect from 16-8-1966.

HONOURS AWARDS

1. T.K. Saksena was awarded the degree of Ph. D. by the University of Delhi on the thesis "Ultrasonic Study of Rates and Equilibria in Chemical Reactions".

2. P.K. Gupta was awarded the degree of Ph. D. by the University of Delhi for his thesis entitled "Investigation on organic Reagents in Inorganic Analysis".

I.S.I. MEETINGS

...e of the scientist	*Meeting Attended*	*Place and date*
(1)	(2)	(3)
...Tandan	i. Instruments Transformers Sectional Committee ETDC:34	16/25-7-'66 Bangalore
	ii. Insulating Materials Sectional Committee ETDC:18	1/3-7-1966 Madras
	iii. Electrical wiring Accessories Sectional Committee ETDC:44	12/14-9-'66 Bombay
	iv. Electrical Instrument and Meters Sectional Committee ETDC:6	23/25-5-'66 Delhi
	v. Electrical Appliances Sectional Committee ETDC:43	27/29-7-'66 Delhi
	vi. Electro Technical Standards Sectional Committee and its sub-committee ETDC:1, ETDC:3	11/12-8-'66 Delhi
	vii. Standing Working Committee of Electro-Technical Division Council SWCET	19-8-1966 Delhi
	viii. Automobile Electrical Parts Sectional Committee ETDC:14	1/3-3-'67 Bangalore
	ix. Electro Technical Division Council ETDC	16-3-1967 Delhi
...Singh	i. Air Conditioning and Refrigeration Sectional Committee ETDC:66 ETDC:66:3	2-8-1966 8-3-1967
...M. Pancholy	i. Acoustics and Heat Insulation Subcommittee ETDC:12:5	28-6-'66 Delhi
	ii. Acoustic Sectional Committee ETDC: 27	19-8-1966 Madras

(1)	(2)	(3)	(4)
	iii. Panel for Acousticas ETDC 27/13		16/18-8-'6 Madras
	iv. Panels for Hearing Aids and Tape and Tape-recorder ETDC:27		19/22-12-' Bombay
	v. Panel for Hearing Aid ETDC:27		29/30-3-'6 Delhi
Dr. A.F. Chhapgar	Cinematographic Equipment Committee ETDC:47		13-3-1967 Delhi
M.R. Verma	i. Chemical Standards Committee CDC:1		14/15-4-'6 Delhi
	ii. Water Sectional Committee CDC:26		28-4-1966 Calcutta
	iii. Chemical Standards Committee CDC:1		18-3-1966 Delhi
Dr. Ram Parshad	i. Radio Receivers ETDC:1 in joint session with ETDC 24:1:1		2/3-9-'66 Delhi
	ii. Electronic Instruments ETDC:24:2		29-30-4-'66 Bombay
	iii. Electronic Equipment ETDC:24 Sectional Committee		5-10-1966 Delhi
	iv. Semi-conductors ETDC:40 Devices Sectional Committee		11/12-10-'6 Poona
	v. High Frequency Cables and Waveguides ETDC:42		14/15-10-'6 Bombay
	vi. Semi-conductors ETDC:40 Devices Sectional Committee		7/11-3-'67 Delhi
Suresh Chandra	Radio Receivers ETDC:24:1 in session with ETDC 24:1:1		2/3-9-'66 Delhi
S.P. Suri	Semi-conductors ETDC:40		9/11-3'67 Delhi
Ram Parshad	i. Optical Instruments Sub-Committee EDC 36:2		
	ii. Material and Components for instrument sub-committee ETDC 36:5		1-7-1966 Dehra Du

(1)	(2)	(3)	(4)
S. Sarma	i. Electric Lamps and Accessories Sectional Committee ETDC:23		29-11-1966 Delhi
	ii. Illumination Engineering Equipment ETDC:45		13-2-'67 Delhi
	iii. Cinematographic equipment ETDC. 47 Sectional Committee		13-3-'67 Delhi
B.K. Agarwala	Non-Destructive Testing SMDC:25 Sectional Committee		30/31-5-'66 Durgapur
V. Ganpathy	Environmental Testing Sectional committee ETDC:26		16/17-6-'66 Bangalore
m Parkash	i. Screw Threads Sectional Committee ETDC:27		28/30-7-'66 Calcutta
	ii. Engineering Metrology Sectional Committee ETDC:43		22/23-8-'66 Poona
	iii. Sirens Sectional Committee BDC:19		18-11-'66 Calcutta
	iv. Screw Threads and Sectional Committee EDC:27		21/23-12-'66 Madras
	v. Water Meters Sub-committee BDC:34		23-1-1967 Bangalore
	vi. Medical Sectional Committee CPDC:12		28-3-'67 Bombay
M.L. Khanna	i. Grease and graphited lubricants Sub-committee EDC 1:7		1/3-11-'66
	ii. Lubricants Sectional Committee CEDC:1		Bombay
D. Joglekar	i. Sub-Sieves Sizing Sub-committee BDC 1:2		17/18-11-'66 Calcutta
	ii. Sieves Sectional Committee BDC:19		

MISCELLANEOUS MEETINGS

Name of the Scientist	*Meeting Attended*	*Date & Plac*
Dr. A.R. Verma	21st Meeting of the Physics Committee of Bhabha Atomic Research Centre	4-3-1967 Kanpur
Dr. A.P. Mitra	Indian National Committee for Space Research at Tata Institute of Fundamental Research.	22-7-1966 Bombay
Sh. G.D. Joglekar	3rd meeting of the Mechanical & Electrical Engineering Sub-committee of the Central Board of Railway Research	21-7-'66 Lucknow
	4th meeting of the signals and Telecommunication Research Sub-committee of the Railway Board (RDSO)	7-7-'66 Lucknow
	6th meeting of the Central Board of Railway Research	7-4-'66 New Delhi
Sh. Prem Parkash	Xth Conference of Controllers of Weights & Measures at Srinagar	25/27/7-66 Srinagar
Dr. Pancholy, M.	Committee on Speech & Hearing formed by the All India Workshop on speech & hearing	4/6-4-'66 Vellore
	Sub-committee on Sirens in the Directorate General of Civil Defence, Ministry of Home Affairs	3-3-'67 New Delhi
Dr. S.R. Das	Meeting on Development of Double Continuation Lenses for Column signals (RDSO, Ministry of Railways)	3/5-10'66 Bombay
Dr. Kailash Chandra	Electronic Course Committee (Women's Polytechnic) (Seven meetings)	New Delhi
Sh. Ram Parshad	Committee on Film Strip Projector, Development of Audio Visual Education,	27-7-66 New Delhi
	Meeting on development of optical system Directorate of Technical Development,	17-12-1966 New Delhi

R. A.R. VERMA

R. A.K. SAHA

R. A.P. MITRA

R. S.C. JAIN

RI F. KISS

FOREIGN DEPUTATIONS

i. Attended the 7th International Congress on Crystalography at the invitation of the Academy Services, U.S.S.R. from 12th to 21st July, 1966.

ii. Participated in the Conference on Crystal Growth at Boston (USA) and visited National Bureau of Standard, Washington (12-6-1966 to 2-7-1966).

Visited Russia for 4 weeks from 29-4-1966 to 29-5-1966 as a member of the Indian delegation sponsored by the INCOSPAR under the Indo-Soviet Cultural Exchange programme.

Attended the 9th Plenary Assembly and the International Space Symposium 10-19 May, 1966 as Chairman working group III COSPAR, member Indian delegation visited GDR (Ionospheric and Radioastronomical Institution from 20-5-66 to 2-6-1966).

Attended the International Conference on Crystal Growth from 20-24.6.1966.

Conference on "Luminescence" in Budapest, Hungary 28-30.8.1966.

Went to Thailand to act as a Consultant to the Government of Thailand on Unesco Contract for a period of six month from 1-5-1966.

FOREIGN DEPUTATIONS

DR. A.R. VERMA	i.	Attended the 7th International Congress on Crystalography at the invitation of the Academy Services, U.S.S.R. from 12th to 21st July, 1966.
	ii.	Participated in the Conference on Crystal Growth at Boston (USA) and visited National Bureau of Standard, Washington (12-6-1966 to 2-7-1966).
DR. A.K. SAHA		Visited Russia for 4 weeks from 29-4-1966 to 29-5-1966 as a member of the Indian delegation sponsored by the INCOSPAR under the Indo-Soviet Cultural Exchange programme.
DR. A.P. MITRA		Attended the 9th Plenary Assembly and the International Space Symposium 10-19 May, 1966 as Chairman working group III COSPAR, member Indian delegation visited GDR (Ionospheric and Radioastronomical Institution from 20-5-66 to 2-6-1966).
DR. S.C. JAIN		Attended the International Conference on Crystal Growth from 20-24.6.1966. Conference on "Luminescence" in Budapest, Hungary 28-30.8.1966.
SHRI F. KISS		Went to Thailand to act as a Consultant to the Government of Thailand on Unesco Contract for a period of six month from 1-5-1966.

GUEST WORKERS

Sl. No.	*Institution*	*No.*	*Placement Division*
1.	Banaras Hindu University, Varanasi	5	Electronics
2.	Indian Institute of Technology, Bombay	1	-do-
3.	Indian Institute of Technology, Delhi	2	-do-
4.	Govt. Polytechnic, Ajmer	1	-do-
5.	Indian Institute of Technology, Kharagpur	2	-do-
6.	Allahabad University, Allahabad	1	-do-
7.	Punjab Engineering College, Chandigarh	6	-do-
8.	Thappar Engineering Institute, Patiala	2	-do-
9.	B.I.I.S., Pilani	5	-do-
10.	Punjabi University	1	-do-
11.	Roorkee University	1	-do-
12.	J.K. Institute of Applied Physics	1	-do-
13.	Prof. in Physics, H.I.T., Sindri, Dhanbad	1	-do-
14.	Jain College, Baraut	1	-do-
15.	Animal Nutrition Research Station Agriculture Institute, Dhanbad	1	Instrumentation
16.	Engineering College, Dayalbagh, Agra	6	Workshop
17.	Govt. Polytechnic Ajmer	1	-do-
18.	Regional Engineering College, Allahabad	4	-do-
19.	Guru Nanak Engg. College, Ludhiana	2	-do-
20.	B.I.I.S., Pilani	4	-do-
21.	Govt. Polytechnic, Kota	3	-do-
22.	Thapar Engg. Institute, Patiala	2	R. P. U.
23.	M.M.H. College, Gaziabad	1	-do-
24.	Allahabad University, Allahabad	1	-do-
25.	Bhagalpur University, Bhagalpur	1	-do-
26.	Kurukshetra University, Kurukshetra	2	-do-
27.	Allahabad University, Allahabad	1	D.P.E.C.
28.	Indian Institute of Technology, Madras	1	-do-
29.	Allahabad University, Allahabad	1	Solid State Physics
30.	Punjabi University	1	-do-
31.	Indian Institute of Technology, Madras	2	Electricity

(1)	(2)	(3)	(4)
32.	Thapar Institute of Engg. & Technology	1	-do-
33.	Indian Institute of Technology, Delhi	2	-do-
34.	Indian Institute of Technology, Madras	1	Applied Mech.
35.	Allahabad University, Allahabad	1	Optics
36.	M/s J.K. Institute, Allahabad	1	-do-
37.	Inspectors of weights and Measures from States	153	Weights and Measures

CULTURAL AID AND TRAINING PROGRAMME

1. Dr. V.N. Bindal: To U.K. for training in the Techniques of Standardisation, Calibration and Measurements in Various branches of Acoustics under Colombo Plan.

2. Shri P.K. Mittal: To Canada for training in 'Calculable Unit of Capacitance' under the Colombo Plan.

3. Shri M.K. Das Gupta: To U.K., East Germany, and West Germany for training in the design and fabrication of machines.

4. Mrs. Stephenka Kirilove Peneva, Research Assistant, in the Department of Physical Chemistry, University of Sofia, Bulgaria; working on Crystal Growth under the programme of exchange of scholars between India and Bulgaria.

5. Shri Mustafa Ahmed Sidkey, Researcher from U.A.R.; working on Sonoluminescence under the agreement for Scientific and Technical Co-operation between India and U.A.R.

LECTURES BY VISITING SCIENTISTS

Sl. No.	*Name*	*Institute*	*Subject and Date*
(1)	(2)	(3)	(4)
1.	Dr. Iyengar P.K.P.	Atomic Energy Establishment, Bombay	Neutron scattering and neutron diffraction—on 12-4-66
2.	-do-	-do-	Magnetic order and neutron scattering—on 14-4-66
3.	-do-	-do-	Lattice dynamics and neutron scattering—on 15-4-66
4.	Prof. Maurer R.	Materials Research Lab., Urbana, USA	Trapping of electrons by vacancies—on 18-4-66
5.	Prof. R. Tutkevich	U.S.S.R.	Semi-conductor development in USSR —on 18-4-66
6.	Prof. R. Maurer	Urbana, USA	Material Research Programme in USA —on 19-4-66
7.	Dr. J.V. Ramsay	Nat. Standards Laboratory, Sydney, Australia	Automatic control in Fabry-Perot interometer—on 20-4-66
8.	Dr. M. Dreschler	West Germany	Form and surface energy of metal single crystals—on 30-4-66
9.	D,W.E. Stuhrke	Air-force Material Laboratory, Ohio, USA	Metal matrix composite materials development in USA—on 11-5-66

(1)	(2)	(3)	(4)
10.	Prof. M.S. Farag	National Research Centre, Cairo	X-ray studies on some oxides—on 12-5-66
11.	-do-	-do-	X-ray studies of Egyptian clays and cotton—on 16-5-66
12.	Dr. R.K.P. Sinha	N.C.L., Poona	Electronic processes in polar semi-conductors —on 28-5-66
13.	Dr. C. Ramasastri	I.I.T., Madras	Lasers—on 25-6-66
14.	Prof. K. Vedam	Pennsylvania Univ., USA	Optical properties of solids at high pressure —on 8-7-66
15.	Dr. David Carter	San-Diego California, USA	Movie on semi-conductors and demonstration on Shockley Haynes and other experiments—on 11-7-66
16.	Prof. H.A. Flasheka	USA	Photometric titration —on 19-7-66
17.	Dr. K.L. Chopra	Ledgemot Laboratory, Mass, USA	Growth of thin metallic films under applied electric field—on 1-8-66
18.	Prof. M. Balkanski	Inst. S.S. Physics Faculty of Science, Paris	Optical properties of semiconductors—on 3-8-66
19.	Dr. G.A.M. King	Geophysical Laboratory, New Zealand	Ionospheric F-region studies in the Geophysical Observatory, New Zealand—on 9-8-66
20.	Prof. A.K. Ramdas	Purdue University, USA	The hydrogen atom and its analog in solids—on 16-8-66

(1)	(2)	(3)	(4)
21.	Prof. A.K. Ramdas	Purdue University, USA	Vibration and electronic spectra of oxygen defect complexes in silicon and germanium —on 20-8-66
22.	Dr. Warlimont	Electron-microscopy; Max Planck Instt. for Metal Research, Stuttgart, West Germany	Diffusionless transformations in metals—on 22-8-66
23.	Prof. E.W.J. Mitchel	Reading University, England	Recent work on physical properties of materials at the Reading University
24.	Dr. H.P.R. Frederikse	National Bureau of Standards, Washington, D.C.	Science (Physics) organisation in the United States—on 16-9-66
25.	-do-	-do-	Recent work on solid state physics at the National Bureau of Standards, USA—on 20-9-66
26.	Dr. G. Venkataraman	Atomic Energy Estt, Bombay	Study of liquid dynamics by neutron scattering
27.	Prof. William Paul	Harvard University, USA	Recent work on semiconductors—on 26-9-66
28.	Prof. H.C. Loebster	University of Queensland Brisbane, Australia	Ionosheric Irregularities—on 26-9-66
29.	Dr. Rose	R.C.A. Laboratories, Princeton, USA	Energy losses by hot electrons in solids—on 30-9-66
30.	Dr. T.V. Ramakrishnan	Columbia University, USA	Transport properties of metals in a pseudopotential model —on 12-10-66

(1)	(2)	(3)	(4)
31.	Prof. J.S. Dryden	CSIRO, Sydney, Australia	Defects in crystals—on 13-10-66
32.	Dr. A.R. Beauilt	Plessey Computers Ltd., England	Survey of thin film and vacuum research at Plessey Comp., England—on 24-10-66
33.	Mr. F.J. Lehany	National Standards Laboratory, Australia	Some of the recent work at N.S.L. Australia—on 25-10-66
34.	Dr. R.E. Howard	National Bureau of Standards, USA	Diffusion in dilute alloys—on 10-11-66
35.	Prof. Dr. Varsanyi Gyorgi	Physical Chem. Polytechnical University Budapest, Hungary	Determination of the direction of vibrational transition moments from infrared band contours—on 2-12-66
36.	Mr. B. Langvad	Bruel and Kjaer, Denmark	Noise and vibration measurements—on 5-12-66
37.	Prof. Dr. Varsanyi Gyorgi	Physical Chem Poly. Technical University, Budapest, Hungary	Correlation between vibrational forms and frequencies of bending vibrations of benzene —on 6-12-66
38.	Dr. R. Ulrich	University of Freiburg, West Germany	Cerenkov radiation at sub millimetre wavelengths—on 22-12-66
39.	Dr. Weston A. Anderson	Varian Associates, Palo Alto, USA	EPR, NMR and related topics—on 26-12-66
40.	Dr. R.N. Dixon	University of Shieffield, U.K.	Recent work on hydro-carbon flame bands—on 6-1-67

(1)	(2)	(3)	(4)
41.	Prof. G. Herzberg	National Research Council, Canada	Recent applications of Franck Condon Principle—on 7-1-67
42.	Dr. W.G. Proctor	M/s. Varian AG, Switzerland	Nuclear acoustic absorption and phonon interactions —on 21-1-67
43.	Dr. Frank E. Edlin	Solar Energy Society, Tempe, Arizona, USA	Solar energy utilisation—on 16-2-67
44.	Dr. Ing. W. Thomas	P.T.B., Germany	Gas thermometer research at high temperature—on 21-2-67
45.	Mr. J.A. Hall	International Bureau of Weights and Measures, Sevres, Paris	The needs of a metrological laboratory—on 2-3-67
46.	Dr. A.N. Prasad	Liverpool University, U.K.	Spectroscopy of non-equilibrium plasmas —on 13-3-67
47.	Dr. I.M. Stephenson	University College, London	Semiconductor devices for microwaves—on 30-3-67

Sl. No.	*Name of the Person*	*Name of the Institution*	*Subject and Date*
(1)	(2)	(3)	(4)
1.	Dr. Verma, A.R.	Indian Institute of Technology, Delhi	Lecture on "symmetry in crystals"—on 23-9-66, 30-9-66, 28-10-66, 4-11-66
		D.A.V. College, Muzzaffarnagar	Convocation address—on 16-1-67
2.	Dr. Mitra, A.P.	Cospar Symposium, Vienna, Austria	Aeronomy of lower ionosphere—on 14-5-66
		Leipzig International Symposium on Absorption, Leipzig, East Germany	Aeronomy of lower ionosphere; ionospheric effect of solar flares; Riometer absorption studies
		Penn State University, Pennsylvania, USA	Ion kinetics of lower ionosphere—on 15-6-66
		Summer Institute on Physics, Waltair	Lectures on Sun and Earth and 2 lectures on D-region—from 27-66 to 8-7-66
		Aligarh Muslim University, Aligarh	11 Lectures on ionosphere and space physics—from Nov., 30 to Dec., 9
		IQSY Symposium, New Delhi in N.P.L.	Aeronomy of lower ionosphere—on 16-12-66
		IQSY Symposium, New Delhi	Ionospheric effects of solar flares—on 17-12-66

(1)	(2)	(3)	(4)
		Annual Session of Indian Academy of Sciences, Madurai	Ionospheric effects of solar flares—on 21-12-66
3.	Sh. Joglekar, G.D.	Representatives of Industry at Industrial Estate, Okhla	Lecture on "The NPL and the Indian Manufacturers"—on 14-10-66
		Representatives of Industry at the premises of M/s Radiola Corp, New Delhi	-do- 18-10-66
4.	Dr. Ram Parshad	Institution of Telecommunication Engineering	Time and Frequency Standards in Sept., 66
		Jain College, Barot	Microwave and millimeter waves in Nov., '66
5.	Dr. Pancholy, M.	All India Workshop on Speech and Hearing, Vellore	Acoustical problem in audiometry
		College of Architecture, Chandigarh	Auditorium acoustics
		School of Tower Planning and Architecture, Madras	Architectural acoustics
		Scudders Memorial Hall, Vellore	Acoustical design of the Scudder Memorial Hall
6.	Dr. Jain, G.C.	National Institute of Sciences, New Delhi	Ferro-electric energy conversion—on 23-11-66
		Indian Institute of Technology, Delhi	One on semiconductors and one on direct energy conversion. 2 lectures per week from 2nd Jan., '67 ending May, 1967

(1)	(2)	(3)	(4)
	Dr. Jain, G.C.	Indian Institute of Technology, Kanpur	Thermo-electric refrigeration on 11-3-67
7.	Shri M.R. Verma	Summer School, University of Roorkee, Roorkee	Chromatographic methods developed at NPL—on 6-6-66 Spectrophoto metric methods developed at NPL—on 7-6-66
8.	Sh. Suri, S.K.	Indian Institute of Petroleum, Dehradun	Applied electronics
9.	Dr. Chandra, K.	Institution of Tele-communication Engg., New Delhi	Recent advances in microwave tubes—on April, '66
10.	Dr. Saha, A.K.	IZMIRAN, Moscow, U.S.S.R.	A-2 absorption reduction techniques—on 18-5-66
		IQSY Symposium, N.P.L. New Delhi	A-2 Absorption work at NPL—on 15-12-66
11.	Sh. Singh, N.N.	Roorkee University	Heat pump cycle of air conditioning—on 25-7-66
		-do-	Gas liquefaction with special emphasis on liquefiers—on 26-7-66
		-do-	Applications of capillary tubes as restricters —on 27-7-66
12.	Sh. Tuhi Ram	IQSY Symposium, NPL	S-66 observations over Delhi—on 16-12-66
13.	Sh. Bhatnagar, V.P.	IQSY Symposium, NPL	Neutral and ionic composition of upper atmosphere—on 16-12-66

(1)	(2)	(3)	(4)
14.	Sh. Yadav, R.S.	Shri Ram Institute for Industrial Research, Delhi	Measurement of dielectric constant at microwave frequencies on September '66
		Symposium on Microwave and Millimeter waves Spectroscopy, New Delhi	Investigations on dielectric behaviour of acetone chloroform and diethyl ether chloroform mixture at microwave frequencies—on Jan., '67
15.	Shri Dube, D.C.	Symposium on Microwave and Millimeter waves Spectroscopy, New Delhi	Correlation of dielectric constants of powders and bulk of low gas materials at microwave frequencies —on Jan., '67

KRISHNAN MEMORIAL LECTURE, OPEN DAYS, SYMPOSIA, AND GET-TOGETHER AT N.P.L.

1. A symposium on International Quiet Sun Year (IQSY) was organised at National Physical Laboratory from 15th to 17th December, 1966 under the joint auspices of the Indian National Committee for IQSY and N.P.L.

2. A symposium on Microwaves, Infrared and Lasers Spectroscopy was organised from 19-1-1967 to 25-1-1967 under the joint auspices of the National Physical Laboratory and Delhi University.

3. Krishnan Memorial Lecture, "Magnetic Effects in Crystals" by Dr. S. Bhagavantam was delivered in National Physical Laboratory auditorium on 30-1-67.

4. Open days were observed on 30th and 31st January, 1967.

5. Get-Together on Thermometry between 13-2-1967 to 17-2-1967 was organized by National Physical Laboratory. The inauguration was made by Mr. F.A. Hall of Bureau of International Weights and Measure, Sevres, France.

VISITORS TO THE NATIONAL PHYSICAL LABORATORY

H.E. Mr. S.K. Romanovsky, Chairman, State Committee of the Council of Ministers of the USSR for Cultural Relations with Foreign Countries.

Professor V.M. Tuchkevich, Professor of Physics and Mathematics and Chief of the Laboratory of Semi-conductors of the Academy of Sciences, USSR.

Professor M. Balkanski, Faculty of Science, Paris University and Director of the Physical Laboratory, Ecole Nationale Superieure, Paris.

H.E. Mr. Lee Kuan Yew, Prime Minister of Singapore

Dr. H.P.R. Frederikse, National Bureau of Standards, Washington.

Professor William Paul, Harvard University, USA.

Professor J.S. Dryden, CSIRO, Sydney.

Dr. A.R. Beauilt, Plessey Computers Ltd., England.

Mr. F.J. Lehany, National Standards Laboratory, Australia.

Dr. R.E. Howard, National Bureau of Standards, Washington.

Mr. S. Bidwell, a British M.P. alongwith his wife.

3 Vice-Chancellors (Prof. Dr. Wilhelem Groth, Dr. Karl Heinz Schaefer and Prof. Dr. Wolfgang) from West Germany.

Dr. Hery Rapoporte of California.

Dr. C.H. Carlisle of London.

Dr. G.K. Taylor, UNESCO expert.

Prof. G. Varsanyi of Hungary.

Dr. Gerhard Herzberg and Dr. (Mrs.) Luise O. Herzberg of Canada.

Dr. Slavojali Harrisijaden, Director of the Laboratory for Electron Microscopy of the Medical Faculty of the University of Belgrade.

Dr. Haddara, Director General, Standard Institution, U.A.R.

Mr. Abdul Ali, Director General of Census, Royal Afghan Government.

Dr. W.G. Proctor, Director of Research, M/s Varian of Switzerland.

Dr. Linus Pauling of Central Study for Democratic Institutions, California.

Dr. Lewis M. Branscomb, National Bureau of Standards, Washington.

A:1 Pancholy, M. and Bindal, V.N., Transmission Loss Studies in Granular Materials, Acoustica., **17**; (1966), 51

A:6 Pancholy, M. and Saksena, T.K., Ultrasonic Study of Esterification Equilibria, Jour. Phy. Soc., **22**; (1967), 1110-1114.

A:9 Pancholy, M., Acoustics of the Auditorium of the Music Academy, Madras Journal of the Music Academy., **37**; (1966), 144.

A:10 Singal , S.P. and Pancholy, M., Luminescence in Liquid Irradiated by Sonic Waves, J.S.I.R., **26**; (1967), 101.

AC:1 Verma, M.R. and Rai, J., Identification of Dyes in Inks by Thin Layer Chromatography, J. American Ink Maker., **44**; (1966), 97-98. Also presented at IV International Conference on Chromatography, Brussel, 1966.

AC:2 Verma, M.R. and Rai, J., Thin Layer Chromatography of Inorganic Ions, Part I. Separation of Copper, Cobalt, Nickel, Zinc and Cadmium as their thiocyanate complexes, Current Science., **35**; (1966), 478-480. Also presented at IV International Conference on Chromatography, Brussel, 1966.

AC:5 Bhuchar, V.M. and Sen, D., Saleya Balsam as a Substitute for Canada Balsam, J. Sci. Instrument., **44**; (1967), 486.

AC:8 Verma, M.R., Agarwal, K.C. and Amar, V. K., A Complexometric Method for the Estimation of Thorium and Chromium from a Mixture, J. Chem., 5; (1967); 79-80.

AC:9 Verma, M.R. and Trehan, J.C., Analytical Studies in Basic Magnesium Carbonate and Asbestos Lagging Compositions, Chem. Age. of India *18*; (1967), 50.

BP:1 Bhide, V.G. and Date, S.K., Mossbauer Study of Intermetallic Fe_5Ge_3 System, Solid State Communications., 5; (1967), 435-437.

BP:2 Bhide, V.G., Bhasin, H.C. and Shenoy, G.K., Observation of Iron Clusters in Hydrogen Fired Fe^{57} Doped $SrTi0_3$ by Mossbauer Studies, Physics Letters, *24A*; (1967), 109-110.

BP:3 Bhide, V.G., Date, S.K., Shenoy, G.K. and Umadikar, P.H., The Mossbauer Study of Polynuclear Trivalent Iron Complexes, Physics Letters, *24A*; (1967), 91-92.

BP:4 Bhide, V.G. and Bhasin, H.C., Mossbauer Study of the SrTi03:Co^{57} System, The Physical Review., *159*; (1967), 586-593.

Elect:17 Parshad, R., Suri, S.P. and Singh, T., A Ten-Line Readout for

Decade Counter using Resistor Logic, Electronics Communicator., *I*; (1966), 3.

HP:6 Khanna, M.L., A Russian View Point on Problems in the Utilization of Solar Energy, SUN AT WORK, *11*; (1966), 3.

OPT:4 Vaidya, W.M. and Dandawate, V.D. High Pressure Mercury Discharge Lamps, J. Opt. Soc. America., *56*; (1966), 1693-1697.

OPT:6 Sastri, V.D.P. and Das, S.R. Spectral Distribution and Colour of North Sky in Delhi. J. Opt. Soc. America, , 56; (1966), 829-830.

RC:5 Ramanamurthy, Bh. V. and Kapoor, R.K., Sulphate Aerosol at Delhi in Relation with the Associated Chloride Component, J. Appl. Meteoroly., 5; (1966), 493-499.

RC:6 Sekhon, R.S. and Ramanamurthy, Bh. V., Some Characteristic Features of Hygroscopic and Non-Hygroscopic Aerosol at Delhi, J. Atmospheric Sciences., *23*; (1966), 771-777.

RC:7 Ramanamurthy, Bh. V., Roy, A.K. and Kapoor, R.K., Sources of Origin and Meteorological Importance of Hygroscopic and Ice-Forming Nuclei, Tellus XIX (1967), 1, Sweden. p. 136-142

RPU:3 Mitra, A.P., Subrahmanyam, C.V. and Jain, V.C., Multifrequency Riometers and SID Analysis, Radio Science, U.S.A., *I*; (1966), 1188.

RPU:5 Mitra, A.P., A Comparative Study of Solar Flare X-ray Measurements from Satellites and Sudden Ionospheric Disturbances, Space Science, *VI*; (1966), 558. Second Conference on direct aeronomic measurements in the lower ionosphere, Illinois, U.S.A.

RPU:7 Narasinga Rao, B.C., Control of Equtorial Spread F by the F-layer Height, J. Atmosph. Terr. Phys, England., *28*; (1966), 1206.

RPU:11 Tyagi, Tuli Ram, and Somayajulu, Y.V., Some Results of Electron Content Measurements at Delhi from Faraday Fading of S-66 Transmissions, R.P.U. (Scientific Report No. 26, June, 1966) and Radio Science, U.S.A., *I*; (1966), 1125.

RPU:13 Chandra, S. and Rangaswamy, S., Daily Response of the Ionospheric F-Region to Changes in Thermospheric Temperature, J. Geophys. Res., U.S.A., *71*; (1966), 217-225.

RPU:14 Bhatnagar, V.P. and Mitra, A.P., An Upper Atmospheric Model for Solar Minmum Condition, R.P.U. (Scientific Report No. 27, June, 1966) and J. Atmospheric Sciences, U.S.A. *23*; (1966), 233.

RPU:15 Mitra, A.P. and Mitra, N.R., R.P. U. (Scientific Report No. 28, July, 1966) and Appleton Memorial Issue, J.I.T.E., *12*; (1966), 287.

RPU:16 Somayajulu, Y.V. and Mitra, A.P., Rocket-Borne Riometer as a Technique for D-region Study, R.P.U. (Scientific Reprt No. 29, August, 1966) and Second Conference on direct aeronomic measurements in the lower ionosphere, Illinois, U.S.A. (1965), 111.

RPU:17 Mitra, A.P., Narasinga Rao, B.C. and Mahajan, K.K., Determina-

tion of Loss Coefficient and Vertical Transport Velocity in the Ionospheric F-region, J. Atmosph. Terr. Phys., England, *29*; (1967) 43.

RPU:18 Mahajan, K.K., F-Region Effects Following Two Severe Magnetic Storms over Delhi, J. Atmosph. Terr. Phys., England., *29*; (1967), 61.

RPU:19 Mitra, A.P., An Ionospheric Estimate of Nitric Oxide Concentration in D-region, J. Atmosph. Terr. Phys., England., 28; (1966). 945.

RPU:20 Chandra, S. and Rangaswamy, S., Geomagnetic and Solar Control of Ionization at 1000 km, J. Atmosph. Terr. Phys., England., *29* (1967), 259.

RPU:21 Tyagi, Tuli Ram, Electron Content Measurements over Delhi from Faraday Fading of Satellite Explorer-22 (S-66) radio transmissions, R.P.U. Scientific Report No. 32, November, 1966.

TP:17 Gupta, S.N., Sun Rules for Coupling Constants in Exact and Indian SU (6) W., Phy. Rev. *151*; (1966), 1235 .

TP:18 Gupta, S.N., Baryon-Meson Couplings in SU (6) W., Phy. Rev. *154*; (1966), 1456.

TP:19 Gupta, S.N., Some Corollaries of Goldstone's Theorem, NUOVO Cimento.

TP:20 Katyal, D.L., A New Approach to Current Algebra, Nuovo Cimento, *97A*; (1967), 839.

TP:21 Gupta, S.N., Proton-Antiproton Anhilation into Two Paus Mesons in Broken SU (6) W., Nuovo Cimento., *47A*; (1967), 915-918.

BUDGET

Head	*Actual expenditure (in lakhs)*
Pay of Officers	8.285
Pay of Establishment	13.297
Allowances and Honoraria	11.728
Contingencies	11.059
Maintenance	0.211
Chemical & Apparatus	3.599
Total Recurring	48.179
Capital	15.938
Pilot Plant	14.953
Total	79.070

STAFF

S. No.	Category	Staff in Position on 1-4-66	31-3-67
1.	Director	1	1
2.	Scientific Officers	78	86
3.	Scientific (JSA/J.T.A. and above)	105	108
4.	Auxiliary Technical	234	240
5.	Administrative and House Keeping	116	96
6.	Class IV	274	260
	Glass Technology Unit		
1.	Glass Technologist	1	1
2.	Scientific Officers	1	1
3.	Scientific Assistants	4	3
4.	Auxiliary Technical	26	31
5.	Cost Accountant	1	1
6.	Class IV	2	2
	Development-cum-Production Unit for Electronic Components and Pilot Plants		
1.	Scientific Officers	4	3
2.	Scientific Staff	18	21
3.	Auxiliary Technical	96	91
4.	Administrative	10	9
5.	Class IV	1	1

MEMBERSHIP OF THE EXECUTIVE COUNCIL

New Committee w.e.f. 2-12-66

Old Committee	New Committee
Chairman	*Chairman*
Sir A. Ramaswami Mudaliar, India Steamship House, 21, Old Court House Street, Calcutta-1.	Prof. S.N. Bose, National Professor, 22, Iswar Mill Lane, Calcutta-6.
Members	*Members*
1. Dr. D.S. Kothari Chairman, University Grants Commission, Bahadurshah Zafar Marg, New Delhi-1.	1. Dr. D.S. Kothari Chairman, University Grants Commission, Bahadurshah Zafar Marg, New Delhi-1.
2. Prof. R.C. Mazumdar Head of the Dept. of Physics, University of Delhi, Delhi-7.	2. Prof. R.C. Mazumdar Head of the Dept. of Physics, University of Delhi, Delhi-7.
3. Dr. A.K. Saha Saha Institute of Nuclear Physics, 92, Acharya Prafulla Chandra Road, Calcutta-9.	3. Dr. A.K. Saha Saha Institute of Nuclear Physics, 92, Acharya Prafulla Chandra Road, Calcutta-9.
4. Dr. S. Chandrashekhar Prof. of Physics, University of Mysore, Mysore-2.	4. Dr. S. Chandrashekhar Prof. of Physics, University of Mysore, Mysore-2.
5. Shri G.R.S. Rao Ewart Street, Bruce Street, Fort, Bombay.	5. Dr. Kartar Singh Director, Defence Research Laboratory Delhi.

6. Dr. J.N. Nanda Director, Defence Research Laboratory (Material), Kanpur.	6. Dr. G.N. Ramachandran Professor of Physics, University of Madras, Madras.
7. Shri J.C. Kapoor President & Chief Executive Officer, Air-conditioning Corporation Ltd., E-2, Gillander House, Calcutta-1.	7. Dr. R.K. Asundi Bhabha Atomic Research Centre, Modular Laboratories, 2nd Floor, Trombay, Bombay.
8. Shri B.V. Baliga Managing Director, Bharat Electronics Ltd., Jalhalli P.O. Bangalore-13.	8. Shri R.K. Gejji Industrial Adviser (Engg.), Directorate General of Technical Development, Ministry of Supply and Technical Development, Udyog Bhavan, New Delhi-11.
9. Dr. Lal C. Verman, Director-General, Indian Standards Institution, Manak Bhavan, 9, Bahadurshah Zafar Marg, New Delhi-1.	9. Dr. A.N. Ghosh, Director-General, Indian Standards Institution, Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi-1.
10. Director-General, Scientific and Industrial Research, Rafi Marg, New Delhi-1.	10. Director-General, Scientific and Industrial Research, Rafi Marg, New Delhi-1.
11. Shri M.S. Sundara, Financial Adviser to CSIR, C/o Ministry of External Affairs, Room No. 61, South Block, New Delhi.	11. Shri M.S. Sundara, Financial Adviser to CSIR, C/o Ministry of External Affairs, Room No. 61, South Block, New Delhi.
12. Dr. A.R. Verma, Director, National Physical Laboratory, Hillside Road, New Delhi-12.	12. Dr. A.R. Verma, Director, National Physical Laboratory, Hillside Road, New Delhi-12.

Non-member Secretary

Shri Lalit Mohan,
Administrative Officer,
National Physical Laboratory,
Hillside Road,
New Delhi-12.

Non-member Secretary

Shri Lalit Mohan,
Administrative Officer,
National Physical Laboratory,
Hillside Road,
New Delhi-12.

MEMBERS OF THE SCIENTIFIC SUB-COMMITTEE

New Committee w.e.f. 18-3-67

Old Committee	New Committee
Chairman	*Chairman*
Dr. A.R. Verma Director, National Physical Laboratory, Hillside Road, New Delhi-12.	Dr. A.R. Verma Director, National Physical Laboratory, Hillside Road, New Delhi-12.
Members	*Members*
1. Dr. S. Chandrashekhar Prof. of Physics, University of Mysore, Mysore-2.	1. Dr. S. Chandrashekhar Prof. of Physics, University of Mysore, Mysore-2.
2. Dr. A.K. Saha Saha Institute of Nuclear Physics, 92, Acharya Prafulla Chandra Road, Calcutta-9.	2. Dr. A.K. Saha Saha Institute of Nuclear Physics, 92, Acharya Prafulla Chandra Road, Calcutta-9.
3. Dr. Lal C. Verman Director-General, Indian Standards Institution Manak Bhavan, 9, Bahadurshah Zafar Marg, New Delhi-1.	3. Dr. A.N. Ghosh Director-General, Indian Standards Institution Manak Bhavan, 9, Bahadurshah Zafar Marg, New Delhi-1.
4. Shri J.C. Kapoor President and Chief Executive Officer, Air-conditioning Corporation Ltd., E-2, Gillander House, Calcutta-1.	4. Dr. R.K. Asundi Bhabha Atomic Research Centre, Modular Laboratories, 2nd Floor, Trombay, Bombay.
5. Dr. J.N. Nanda Director, Defence Research Laboratory (Material), Kanpur.	5. Dr. G.N. Ramachandran Professor of Physics, University of Madras, Madras.

6. Shri B.V. Baliga
Managing Director,
Bharat Electronics Ltd.,
Jalahalli P.O.,
Bangalore-13.

6. Shri R.K. Gejji
Industrial Adviser (Engg.),
Directorate General of
Technical Development,
Ministry of Supply and
Technical Development,
Udyog Bhavan, New Delhi-11.

7. Dr. Kartar Singh
Director,
Defence Research Laboratory,
Delhi.

Non-member Secretary

Shri G.D. Joglekar
Scientist Incharge,
Division of Planning and
Liaison,
National Physical Laboratory,
Hillside Road, New Delhi-12.

MEMBERS OF THE BUILDING AND FINANCE SUB-COMMITTEE

New Committee w.e.f. 18-3-67

Old Committee	New Committee
Chairman	*Chairman*
Dr. A.R. Verma Director, National Physical Laboratory, Hillside Road, New Delhi-12.	Dr. A.R. Verma Director, National Physical Laboratory, Hillside Road, New Delhi-12.
Members	*Members*
1. Secretary, C.S.I.R. Rafi Marg, New Delhi-1.	1. Secretary, C.S.I.R. Rafi Marg, New Delhi-1.
2. Architect, C.S.I.R. Rafi Marg, New Delhi-1.	2. Architect, C.S.I.R. Rafi Marg, New Delhi-1.
3. Dr. Lal C. Verman Director-General, Indian Standards Institution, Manak Bhavan, 9, Bahadurshah Zafar Marg, New Delhi-1.	3. Dr. Kartar Singh Director, Defence Research Laboratory, Delhi.
4. F.A., C.S.I.R., New Delhi.	4. F.A. C.S.I.R., New Delhi.
Non-Member Secretary	*Non-Member Secretary*
Shri Lalit Mohan Administrative Officer, National Physical Laboratory, Hillside Road, New Delhi-12.	Shri Lalit Mohan Administrative Officer, National Physical Laboratory, Hillside Road, New Delhi-12.

SUB-COMMITTEE FOR THE DEVELOPMENT-CUM-PRODUCTION UNIT OF ELECTRONIC COMPONENTS

New Committee w.e.f. 18-3-67

Old Committee	**New Committee**
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Members	*Members*
1. Dr. A. Rao Atomic Energy Establishment Bombay.	1. Shri G.R. Subramaniam Deputy General Manager, Components Division, Bharat Electronics Ltd., Jalhalli P.O. Bangalore-13.
2. Dr. Amarjeet Singh Director, Central Electronics Engineering Research Institute, Pilani.	2. Shri C.R.S. Rao Chairman—Radio Electronic Television Manufacturers' Association (RETMA), General Manager, National Ekco Radio & Engg. Co. Ltd., Mahakali Caves Road, Chakala—Andheri East, Bombay-69.
3. Representative of Director- General of Scientific and Industrial Research, Rafi Marg, New Delhi-1.	3. Dr. D.Y. Phadke Head, Technical Physics Division, Tata Instt. of Fundamental Research, Colaba, Bombay-5.

4. Financial Adviser, C.S.I.R.,
New Delhi.

5. Director,
National Physical Laboratory,
Hillside Road,
New Delhi-12.

Convenor

Shri T.V. Ramamurti
Officer Incharge,
D.P.E.C.,
N.P.L.
New Delhi.

4. Shri P.N. Deobhakta
Development Officer,
Dte. of Technical Development (DGTD),
Udyog Bhavan, New Delhi-11.

5. Dr. D.L. Subramaniam
Scientist,
CEERI
Pilani.

6. Dr. A.R. Verma
Director,
National Physical Laboratory,
Hillside Road,
New Delhi-12.

7. Financial Adviser to CSIR,
New Delhi.

8. Representative of Director-General of Scientific and Industrial Research,
Rafi Marg, New Delhi-1.

Convenor

Shri T.V. Ramamurti
Officer Incharge,
D.P.E.C.,
N.P.L.
New Delhi.

ADVISORY COMMITTEE OF RAIN AND CLOUD PHYSICS

RESEARCH UNIT

1. Shri C. Ramaswamy — *Chairman*
   Director-General of Observatories,
   Lodi Road, New Delhi-3

2. Dr. K.R. Ramanathan
   Director,
   Physical Research Laboratory,
   Navrangpura, Ahmedabad-9

3. Group Captain S. Das Sarma
   Director of Meteorology,
   Air Headquarters, New Delhi

4. Shri Baleshwar Nath
   Member, Irrigation Team,
   Committee on Plan Projects,
   (Planning Commission),
   Jam Nagar House, Block No. 12, Shahjahan Rd.,
   New Delhi-11

5. The Director
   National Physical Laboratory,
   Hillside Road, New Delhi-12

6. Shri C. Balasubramaniam
   Agricultural Meteorologist,
   Coimbatore
   (Representative of the Deptt. of Agriculture and Irrigation,
   Madras State)

7. Command Meteorological Officer,
   Headquarters Operational Command,
   Indian Air Force,
   New Delhi

8. Dr. P.R. Pisharoty
   Director,
   Institute of Tropical Meteorology,
   Poona

9. Shri A.K. Roy
Suit No. 3,
P286, Durga Road,
Calcutta

Secretary

10. Dr. Bh. V. Ramanamurthy
Officer-in-Charge,
Rain & Cloud Physics Res. Unit,
N.P.L. Building,
New Delhi

PANEL OF CONSULTANTS FOR DIVISIONS

Acoustics

1. Dr. D. Srinivasan
   Student Officer,
   National Defence College,
   Tees January Marg,
   New Delhi-11

2. Prof. Dr. Ignacy Malecki
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   Science, Poland),
   Institute of Basic Technical Problems,
   Warazawa 10,
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3. Dr. K. N. Mathur
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Basic Physics

(Low Temperature)

1. Dr. D. Shoenberg, FRS,
   Mond Laboratory,
   Cambridge,
   London.

2. Prof. Venkataswarlu
   Indian Institute of Technology,
   Kanpur.

Carbon Products

1. Dr. K. S. Chari
   Incharge,
   Designs & Engineering Section,
   Council of Scientific & Industrial Research,
   Rafi Marg,
   New Delhi-1.

2. Shri Baldev Singh
Industrial Liaison & Extension Officer,
C.S.I.R.,
New Delhi.

3. Shri B. Singh
Managing Director,
M/s. Beni Limited,
Calcutta.

4. Shri S. P. Verma
Industrial Advisor,
D.G.T.D. New Delhi.

Electronics

1. Prof. J. N. Bhar
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Radio Physics Institute,
92, Acharaya Prafulla Chandra Road,
Calcutta.

2. Dr. M. Chaudhari
Prof. of Electronics,
Birla Institute of Technology & Science,
Plani (Rajasthan).

3. Dr. B. H. Wadia,
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Ramwadi, Nagar Road,
Mile 4/5, Poona-14.

Time & Frequency

1. Dr. K. R. Ramanathan
Physical Research Laboratory,
Ahmedabad.

2. Dr. G. D. Gokarn
Director,
Over Seas Communication Service,
New Delhi.

Electricity

1. Prof. H. N. Ramachandra Rao
Indian Institute of Science,
Bangalore.

2. Prof. C. S. Ghosh
Professor & Head of the Department of
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University of Roorkee,
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3. Mr. Chester H. Page
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4. Shri A. P. Secthapathy
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Central Water & Power Commission,
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Bangalore-12.

Glass Technology

1. Shri Veda Prakash Gupta
Managing Director,
Hicks Thermometers (India) Ltd.,
Brooklands, Barlowganj,
Mussoorie.

2. Shri M. L. Joshi
Jg. Glass Industries Pvt. Ltd.,
Co-operative Insurance Bldg.,
2nd Floor, Sir P. Mehta Road,
Bombay-1.

3. Shri K. D. Sharma
Central Glass & Ceramic Research Institute,
Calcutta-32.

Heat (Standards)

1. Dr. Sadgopal
Director (Chemical),
Indian Standards Institution,
New Delhi.

2. Mr. S. P. Punj
Tech. Director,
Punj House
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3. Shri Hati Datta
The Ganga Glass Works (Pvt.) Ltd.,
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4. Shri V. Krishnamoorthy
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5. Shri D. V. Rao
Asst. Director (Cer)
Small Industries Service Institute,
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Heat and Power

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2. Dr. Sadgopal
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Indian Standards Institution,
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3. Dr. K. N. Mathur
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Instrumentation & Servicing

1. Prof. N. M. Athavale
Technical Director,
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2. Shri G. Bhattacharya
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MATERIALS
(Chemical)

1. Prof. S. Ramaseshan
   Head of the Deptt. of Physics,
   Indian Institute of Technology,
   Madras.

2. Dr. J. Gupta
   Deputy Director,
   National Chemical Laboratory,
   Poona.

3. Dr. V. T. Athavale
   Atomic Energy Establishment,
   Trombay, Bombay.

4. Shri G. V. L. N. Murthy
   Chief Chemist,
   Tata Iron & Steel Co. Ltd.,
   Jamshedpur.

Infrared Spectroscopy

1. Prof. R. K. Asundi
   Bhabha Atomic Research Centre,
   (Spectroscopy Division),
   Modular Laboratory,
   Trombay, Bombay.

2. Dr. H. A. Gebbie
   National Physical Laboratory,
   Teddington,
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3. Dr. R. Ulrich,
   University of Freiburg,
   West Germany.

4. Dr. P. S. Narayanan
   Physics Department,
   Indian Institute of Science,
   Bangalore.

5. Dr. G.K. Mehta
   Technical Director,
   Associated Instruments Mfrs. (P) Ltd.,
   New Delhi.

Mechanics

1. Prof. S.N. Ghosh
   Prof. & Head of the Deptt. of Applied Physics,
   Allahabad University,
   Allahabad.

2. Prof. N. P. W. Moore
   Prof. of Mechanical Engineering,
   Indian Institute of Technology,
   Hauz Khas,
   New Delhi.

3. Shri S.N. Mukerjee
   Director, National Test House,
   Calcutta.

4. Shri T.R. Vachha
   Director Research, Research Designs & Standards Organisation,
   Lucknow.

Optics

1. Dr. S.N. Mukerjee
   Director, National Test House,
   Calcutta.

2. Dr. P. Hariharan
   Joint Director (Research), Hindustan Photo Film Co. Ltd.,
   Ootacamund.

3. Gr. Capt. Jones
   Officer-in-Command, Air Force Hospital,
   Secunderabad.

4. Mr. P.J. Veger
   M/s. Philips India Ltd., Kalwa,
   Bombay.

Radio Science

1. Prof. K.R. Ramanathan
   Chairman,
   Radio Research Committee and Director,
   Physical Research Laboratory,
   Ahmedabad.

2. Prof. Vikram A. Sarabhai
   Chairman,
   Indian National Committee for Space Research,
   Ahmedabad.

3. Prof. J.N. Bhar
Director,
Institute of Radiophysics & Electronics,
Calcutta.

4. Prof. B. Ramachandra Rao
Andhra University,
Visakhapatnam.

5. Mr. Chaman Lal
Wireless Adviser,
Wireless Planning & Coordination Wing,
New Delhi.

Solid State Physics

1. Prof. Putcha Venkataswarlu
Indian Institute of Technology,
Kanpur.

2. Dr. N.B. Bhatt
Solid State Physics Laboratory,
New Delhi.

3. Prof. L.S. Kothari
Prof. of Physics,
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4. Dr. K. P. Sinha
Assistant Director,
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Poona.

Weights And Measures
(Standards)

1. Dr. K.N. Mathur
Scientist Emeritus,
N.P.L.
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2. Prof. Dr. R. Vieweg
(Ex-President, PTB, Braunschweig),
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3. Dr. E. Engelherd
Head, Length Section,
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Bundesallee—100,
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4. Dr. E. Hess
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Physikalisch Technische Bundesanstalt,
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5. Dr. H. Barrell
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(Testing)

1. Mr. H.C. Verma
Managing Director,
Messrs. Associated Instrument,
Manufacturers (India) Pvt. Ltd.,
New Delhi.

2. Mr. B.R. Dhurandhar
Managing Director,
Messrs Saple's Scales Mfg. Co. (Pvt.) Ltd.,
Bombay.

3. Dr. S. R. Lele
Managing Director,
Borosil Glass Works,
Bombay.

4. Mr. V. J. Joshi
Master of the Mint,
India Government of Mint,
Fort
Bombay.

5. Mr. M. V. Patankar
Director (Mech. Engineering),
Indian Standards Institution,
New Delhi.

6. Mr. V.B. Mainkar,
Director, Weights & Measures,
Ministry of Commerce,
New Delhi.

X-Ray Crystallography

1. Prof. K. Bannerji,
Indian Association for the Cultivation of Science,
Calcutta.

2. Prof. S. Chandrashekhar,
Professor of Physics,
Mysore University,
Mysore.

3. Prof. G.B. Mitra,
Indian Institute for Technology,
Kharagpur.

4. Prof. G. N. Ramachandran,
Prof. of Physics,
University of Madras,
Madras.