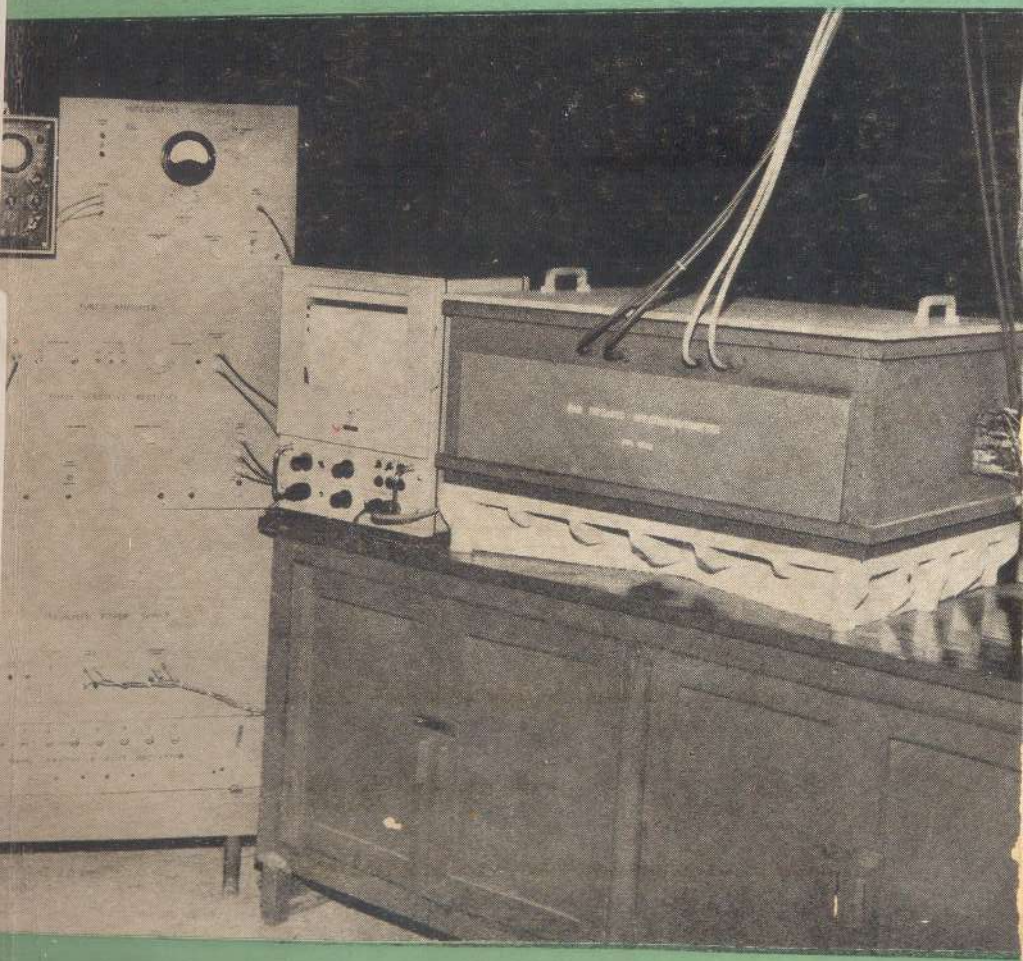
ANNUAL REPORT

1967-68



NATIONAL PHYSICAL LABORATORY

NEW DELHI-12

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 1967-68

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

During the period under review two meetings of the Executive Council were held : one on 11th September, 1967 and the other on the 19th February, 1968. These were preceded by the meetings of the following Subcommittees : (i) Scientific Subcommittee; (ii) Building and Finance Subcommittee; (iii) Development-cum-Production of Electronics Components Subcommittee and (iv) Glass Technology Unit Subcommittee.

As decided earlier, on 1st April, 1967, Rain and Clouds Physics Division was transferred to the Indian Meteorological Department.

Fig. 1 Meeting of the Executive Committee of NPL

PANEL OF CONSULTANTS FOR THE VARIOUS DIVISIONS OF THE LABORATORY

During the year under review, it was possible to convene the meetings of the following two panels :

1. Panel for Electricity Division
2. Panel for Electronics Division

The recommendations of each panel of consultants were placed before the Executive Council and are being implemented in stages.

KRISHNAN MEMORIAL LECTURE

31st January, 1968

Professor D. S. Kothari, Chairman, University Grants Commission, New Delhi, delivered the 4th Krishnan Memorial Lecture on "Nuclear Explosions" before a select gathering of scientists from educational and scientific organisations in Delhi. The lecture evolved considerable interest and in view of the pressing demand, it has been published in form of a booklet.

Fig. 2 Prof. D. S. Kothari delivering the Krishnan Memorial Lecture

NPL TECHNICAL BULLETIN

During the period under review, information regarding the projects handled by the laboratory, papers published, technical services rendered, lectures given by the NPL scientists and visiting scientists, seminars and Get-Togethers held at NPL and technical reports were published in 4 issues of NPL Technical Bulletin. The articles published in the Bulletin are being reproduced by Technical Journals and are also being given wide publicity by the press. A list of some of the important articles published in the Bulletin is given below :

1. Magnetic Effects in Crystals
2. Thermometry Get-Together at the NPL
3. Instrument Servicing at the NPL

4. Lecture-cum-Symposium on "Microwave, Laser and Infrared Spectroscopy".
5. Spectrophotometer with Double Monochromator
6. A 3000 Kgf Dead Weight Machine
7. A new Rocket Experiment
8. Studies of Light and Colour at the NPL
9. Thin Film Interference Filters
10. Film Thickness Monitor
11. Design of Optical Systems
12. Accurate Measurement of R.F. power upto Microwave Frequencies
13. Development of Waveguide Components for Microwave Applications
14. Calibration and Testing
15. Noise Menace
16. The National Physical Laboratory : Radio Talk
17. One-Ohm Standard Resistance
18. Standards at NPL : Standard of Voltage
19. Magnetic Tapes—Their Testing
20. Test and Evaluation of Electronic Components
21. Patents by NPL Scientist

SCIENTIFIC ACTIVITIES

The scientific activity of the Laboratory, as in the earlier year, has been classified under six separate categories. The progress of work done on the projects falling under the different categories is given separately. In this report only a few selected projects have been mentioned. The progress made in the inter-divisional projects, called laboratory projects and those introduced last year, are discussed below individually.

STANDARDS

During the period under review efforts on the maintenance of standards, which is a statutory obligation of this laboratory, were intensified to improve the accuracy of the existing standards and to establish some new standards, for which need is being felt. The accuracy of these standards is regularly improved by cross checking them with the corresponding international standards.

For example, in the case of electrical standards, both at the International Bureau and the National Laboratories, the precise measurements on standards are done by substitution method so that only the difference between one standard resistance or cell and another are measured. This, however, requires that the resistance or cell, with which comparisons are made, are known to that much accuracy in terms of absolute units. This is why it is necessary to maintain a bank of stable resistances or standard cells.

NPL New Delhi resistance standard has three resistances 35 years old and two resistances 15 years old and other resistances were added during the last five years. Since 1962 the maintenance of the electrical standards has been carried out and the first international comparison was done after the arrival of another three resistances during 1964.

Similarly the emf standard consisting of ten Weston Cadmium Cells has been maintained in this laboratory. The accuracy of the standards maintained at the NPL compare favourably with the accuracy with which international standards are maintained. It is our constant endeavour to improve the accuracy of the standards maintained in the laboratory and establish new standards for which need is felt by the industry. However, the maintenance of standard is both laborious and time consuming.

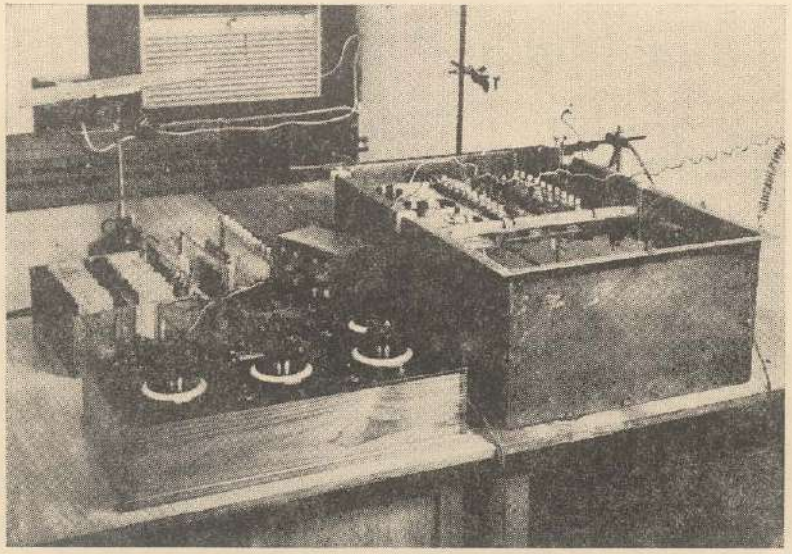

Fig. 3 Standard of E. M. F.

NATIONAL PHYSICAL LABORATORY

LIST OF STANDARDS MAINTAINED WITH THEIR ACCURACY

Physical Property	*Standard*	*Accuracy*
	Primary Standards	
Length	Metre	5 in 10^8
Mass	Kilograms	1 in 10^7
Time	Second	1 in 10^8
	Frequency	1 in 10^8
Current	Ampere	1 in 10^5
Illumination	Candella	2 in 10^3
Temperature	°K	Average 0·002 in the range of 90°K and 700°K

Physical Property	*Satandard*	*Accuracy*
	Derived Standards	
Resistance	Ohm (D.C. & A.C.)	1 in 10^6
E.M.F.	Volt (D.C. & A.C.)	1 in 10^4
	Volt (R.F.)	2 in 10^2
Power	Watt (D.C. & A.C.)	1 in 10^5
	R.F.	2 in 10^2
Force	Newton	4 in 10^5
Atmospheric pressure	mm of Hg Newton Bar	1 in 10^3
Sound pressure	Microbar dynes/sq. cm.	1 db.

DEVELOPMENTAL TESTING & CALIBRATION

The calibration and testing activities, in respect of performance, calibration and life tests of various instruments, appliances and industrial products carried out on behalf of the industry, Government agencies and Defence establishments continued as in the previous years.

During the year nearly two thousand test certificates were issued and a sum of Rs. 1,02,389·00 was realised as test fees as compared to Rs. 84,824·00 realised last year. It is significant to mention that the test fees realised this year has reached an all time peak as shown in the figure 4.

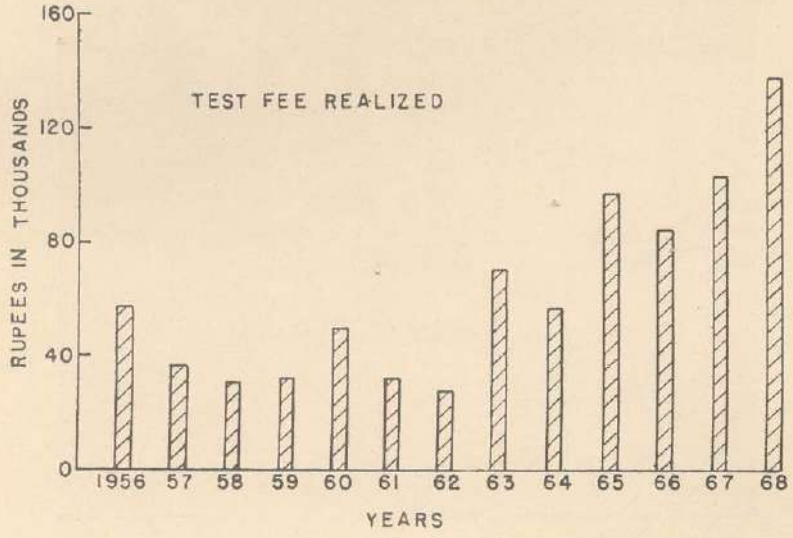

Fig. 4

APPLIED RESEARCH

SILICON

In continuation of the previous year's report, silicon tetlra-iodide was successfully cracked to obtain silicon of transistor grade purity. Six different samples, analysed spectroscopically by the Atomic Energy Establishment, Bombay, showed the concentration of the usual impurities present to be of the order of a few parts per million. Boron, which is a killer impurity was found to be less than one part per million. Nearly one hundred grams of polycrystalline transistor grade silicon has been produced.

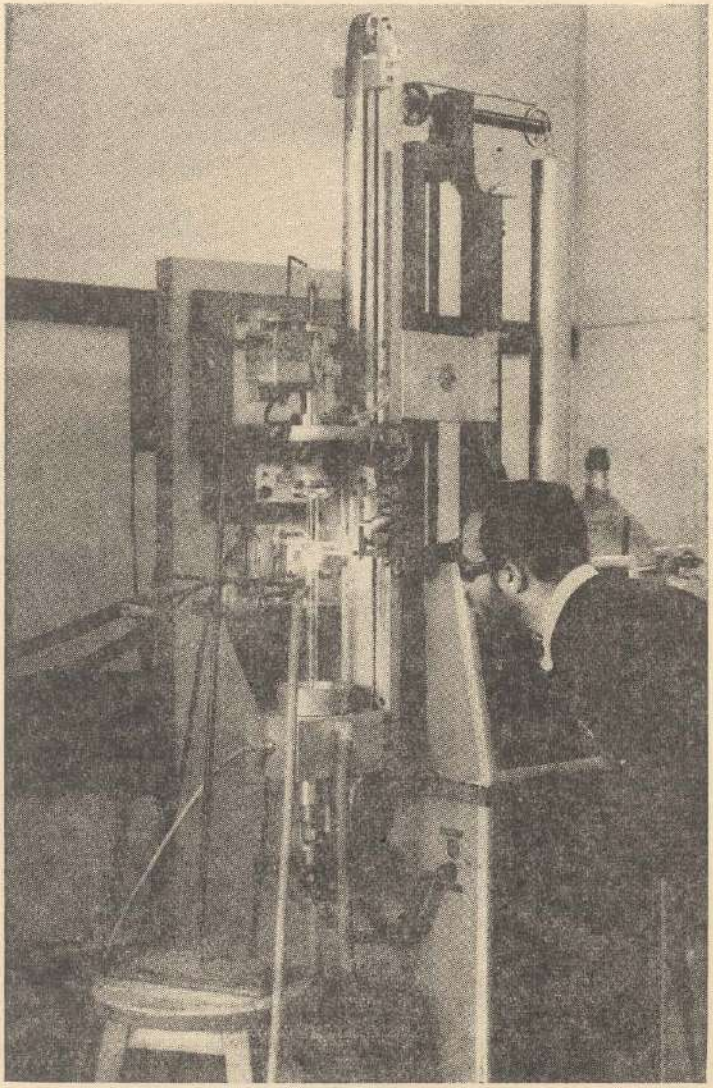

Fig. 5 Float-Zoaning of Silicon

WAVEGUIDE COMPONENTS FOR MICROWAVE APPLICATIONS

In continuation of the previous year's report, it may be stated that since the study of Microwave Engineering now forms an important part of the courses being taught to Electrical/Electronic Engineers and post-graduate Physics students, we have undertaken the supply of microwave test benches comprising of the above-mentioned components. These benches useful for research and instructional purposes are available at a cost of approximately Rs. 8,000 to Rs. 10,000 whereas the cost of imported bench is Rs. 25,000 to Rs. 30,000. A photograph of the Bragg Difraction Apparatus may be seen in Fig. 6

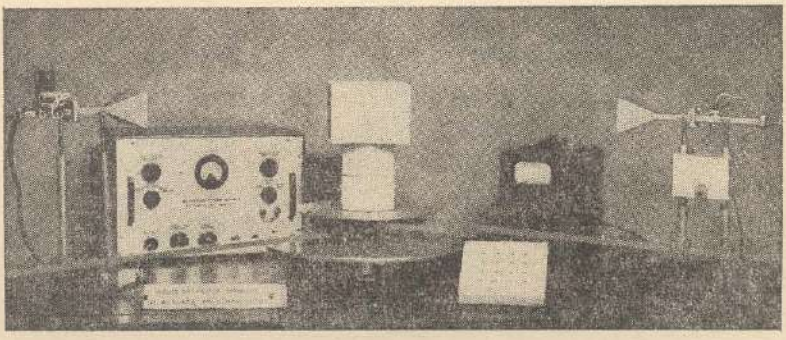

Fig. 6 Bragg's Diffraction Apparatus

20 complete X-band 3-cm microwave test benches were manufactured except the Klystrons and supplied to various universities. Of these eleven test benches were supplied to Summer Schools organized by University Grants Commission. The total cost of production of these test benches is roughly Rs. 1,80,000 thereby saving a foreign exchange to the tune of Rs. 5 lakhs.

A prize of Rs. 1,000 was awarded to Dr. Kailash Chandra, Dr. Ram Parshad and Shri V. K. Aggarwal by the Invention Promotion Board, New Delhi for their work on Broadbanding of resonance isolators on 15th August, 1967.

A training course in microwave techniques was organised by the Division of Electronics from 20th to 24th March, 1968 wherein representatives from different universities and colleges participated.

FERRITES

A very important achievement in the manufacture of short-cum-medium wave ferrite rods, which cover frequencies both in the medium and shortwave bands, has been made possible by suitably modifying the compositions and controlling the sintering cycle. In fact, it has been found

that the antenna rods made by this process are superior in many respects to the imported ones.

Fig. 7 Training Courses in Microwave Techniques

A break through has been achieved in the technology of fabrication of complicated small sized cup cores by using calcined ferrite powder as a filler with a thermoplastic resin and moulding technology. The characteristics of such products has been found to be similar to those of ferrite components made by using high pressure pressing and firing.

TESTING OF CLINICAL THERMOMETERS

Equipment set up in the laboratory for testing clinical thermometers was used by the staff of the Indian Standards Institution, New Delhi, at site during the last three months of 1967. In addition to two ISI officers, 38 persons, selected from this laboratory and ISI, were trained in using the equipment.

Till now as many as 23 processes have been handed over to the industry for commercial exploitation. The total production figures, as received from NRDC, on the NPL process, run to Rs.2·48 crores. This year's production was roughly Rs. 41 lakhs.

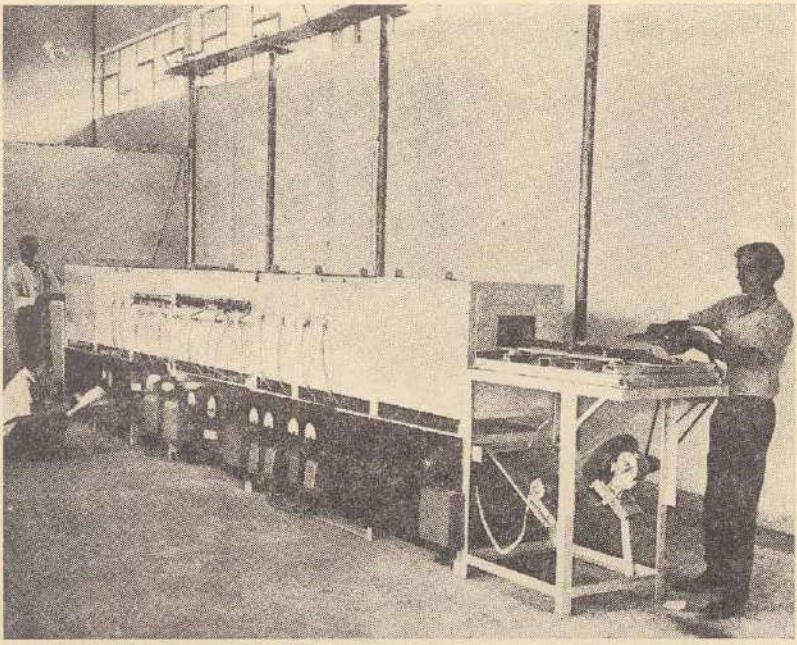

Fig. 8 Tunnel Kilu Fabricated in N.P.L.

RADIO TALK

Dr. A. R. Verma, Director, NPL, gave a radio talk on the 6th August, 1967 on "The National Physical Laboratory" with special reference to its contribution towards the industrial development of the country.

In his talk he laid emphasis on the objectives of the laboratory and described the work on calibration and testing, import substitution, environmental testing, servicing of equipment and apparatus, consultancy service being conducted by the scientists of the laboratory. He also described the pilot plants viz. electronic components, carbon products, glass equipment and microwave components and their programme of utilisation of indigenous raw materials in their manufacture. A mention was also made of the advice to the manufacturers in setting up and maintenance of the standard equipment with which to test their own raw materials and finished products and the training of their personnel for this job. These equipments and working standards used by different manufacturers should be calibrated against uniformity of production in the country.

INSTALLATION OF ELECTRON MICROSCOPE

RCA electron microscope, installed here earlier, was dismantled by the scientists of this laboratory. The complete equipment was later on installed at the Central Food Technology Research Institution, Mysore and is now working satisfactorily.

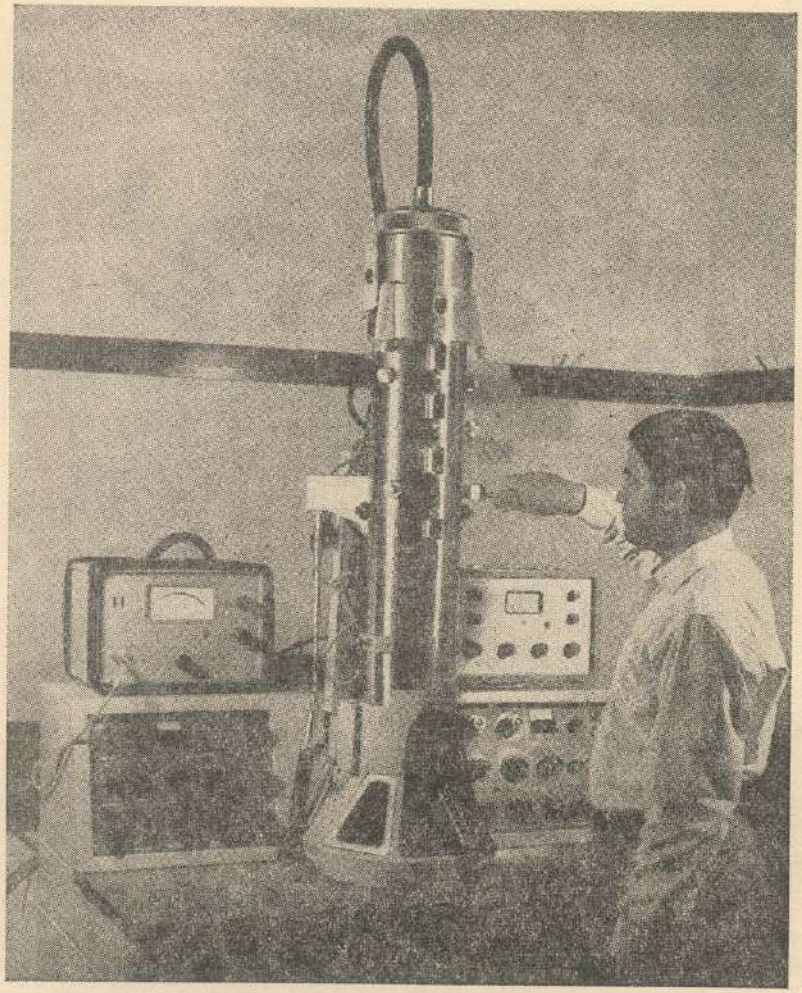

Fig. 9 Electronic Microscope

APPENDIX I

STANDARDS

Code No. and Standards	*Progress*	*Project Team*	*Ref*
1	2	3	4
ECY/ST/1 Setting up, maintenance and improvement of the Electrical Standards (a) *Resistance*	Twenty sets of readings of ten '1-Ohm' resistance standards were taken under controlled temperature at 20°C by the method of substitution for intercomparison ensuring that the values of the standards are accurate to better than one part in a million. The record of these values is being maintained. This showed that the three Tinsley resistances, purchased in 1962-63, are drifting downwards as compared to the three NPL Teddington resistance by 5 parts per million per year.	Batra, V. K., Sircar, B. & Tandan, R. K.	
(b) *Electromotive force*	Twenty-two sets of readings of the electromotive force standards, comprising of seventeen Cadmium cells, were taken under controlled temperature at 20°C, for intercomparison and measuring the values of the standards accurate to one part in a million. The record of these values is being regularly maintained. This shows that as compared to the six cells specially purchased during 1962-63 all other cells are drifting downwards.	Batra, V. K., Sircar, B. & Tandan, R. K.	
(c-i) *DC/AC Transfer standard*	Further improvements in respect of Electrostatic Voltmeter were made after getting a 20 BA Bronze shaft. The whole instrument was reassembled after	Vasishtha, S. C.	

checking the various parts. The vanes were reannealed for improved mechanical adjustments. The voltmeter was re-calibrated and thoroughly checked against an electrodynamometer for both DC and AC voltage measurements. It was found that:

(i) the difference in the voltage measurement on dc reversal has reduced and is constant throughout the range of measurement of the instrument. The instrument still gives higher deflection when positive terminal of the dc voltage is connected to the fixed sector than when negative terminal of the dc voltage is connected to the fixed sector.

(ii) the transfer error at 50 cps has considerably reduced but still exists. It is also constant throughout the range of measurement of the instrument.

(iii) the sensitivity of the instrument has slightly increased.

(c-ii) *Development of testing at* 400 *cps facilities*

It was decided to fabricate a power amplifier and a fixed frequency (400 cps) source for testing aircraft instruments (at the request of AIR INDIA).

The circuit consists of several valve stages of amplification with two power stages. At the end of the first power stage, 25 watts power is available for instrument calibration. With the addition of the second power stage, it would be possible to test instruments upto 70 watts.

1	2	3	4
	The first stage of the power amplifer has been completed and the necessary power supply has also been assembled.		
(d) *Fabrication of standard type resistors*	Eight '1-Ohm' standard resistors were fabricated during the period, raising the strength of the NPL India made 1-Ohm standard resistance to eighteen in the resistance bank. Eleven of these 1-Ohm standard resistances are complete and ready for use. The values of these resistances are very stable. One '10-Ohm' build up box has been fabricated using twelve 1-Ohm standard resistances.	Batra, V. K., Sircar, B. & Tandan, R. K.	
Elec/ST/3 Development & maintenance of Microwave & r.f. Voltage Standards (1) *Microwave Standards (Power and Frequency)*	(i) Power and frequency standards were used for calibrating signal generator, from Meteorological Department and cavity frequency meters fabricated in the laboratory under batch production of microwave components. (ii) Harmonic generator 9,000 for generating Mc/s from 3,000 Mc/s has been completed. Two high frequency transistor circuits were constructed for the v.h.f. region. The power output at present is very low, and efforts are being made to step up the power by using high power transistors.	Chandra, K. Parshad, R. Agarwala V. K. & Kataria, B. K.	
(2) *R.F. Voltage Standards*	(i) Working secondary R.F. voltage standards have already been achieved. It has been seen that, by intercomparison with laboratory standard instruments at lower and radio	R. Parshad, K. Chandra, Parminder Singh, I. M. Singh & M. R. Nagar	

frequencies, and standards in outside places, that they all intercompared accurately. This has made it possible to calibrate our wide band vacuum tube voltmeters in terms of these instruments and can be used to test industrial instruments like signal generators. Tests like these have already been performed on some industrial instruments like R.F. millivoltmeter sent to the laboratory by the industry for test.

(ii) An R.F. power standard going up to microwave frequencies has already been achieved. Efforts are being made to use this power standard to measure R.F. voltage also. For this purpose small enough thermistors are being searched, which would have lead in the axial direction. These thermistors would be mounted in coaxial R.F. systems having proper impedance matching conditions.

(iii) Three new methods of measuring R.F. voltage are being investigated and developed. They relate to opposing R.F. voltage by a standard d.c. voltage through a proper solid state diode, operation of a transistor in a saturation mode, having variable and standardised d.c. voltages applied to its collector supply, and the use of

1	2	3	4
	solid state diodes clipping techniques. Satisfactory progress has been made. The methods intercompare among themselves and use simple instruments and components available indigenously. A voltage divider is being constructed which would be frequency insensitive. It will have properly shielded RC combinations as voltage dividing elements so that RC is constant for each element. It will be used to obtain R.F. voltages of the order of few millivolts from the R.F. standard voltage, of the order of a few volts obtained from the above voltage standardising methods. Efforts are in progress to further develop a constant amplitude transistor oscillator for R.F. voltage standardisation. The oscillator was developed earlier for general applications.		
OPT/ST/1 Secondary Standards of Photometry	Intercomparison of the secondary standards of incandescent lamps was continued. A set of selected high and low pressure mercury vapour lamps, obtained from M/s. Philips, were calibrated against their standards. Tests were carried out on behalf of the ISI to determine the suitability of argon field lamps for use as miners cap lamps. A rotatable photometer was constructed for large fluorescent lamps luminaires and a number of measurements were carried out to test the suitability and accuracy of the test method.	Sarma, K. S., Dandawate, V. D. & Kailash Chand	
OPT/ST/2 Colorimetric Standards and Measurements	The double monochrometer was intended to be used for development of laboratory standards of colour temperature.	Das, S. R. & Manamohanan, S. B.	

1	2	3	4
	Due to non-availability of a sensitive thermopile and also due to the urgent need for standardizing the chromaticities of 103 ISI standards for mixed paints this work could not be continued. Measurements have been completed for 30 such surfaces using the above double monochromator.		
H/ST/1 Setting up, maintenance and utilisation of International Temperature scale. (Realisation of International Temperature unit)	1. Experimental work on the selection of suitable switches was taken up and seven tentative 3-gang switches have been built up from available materials. The results on uniformity of resistance have been very encouraging. Experimental work was also started for making sufficiently stable resistances for the bridge. The stability tests continued for about 3 months. 2. Black body furnace was designed and some parts were fabricated. 3. Semi circular cylindrical reflectors were provided on the top of 3 baths so as to improve the visibility of thermometer readings. 4. Conditions for obtaining a uniformity of temperature by the Bubbling Method have been studied in the temperature range 0° and −70°C.	Bansal, T. D., Wasan, V. P. & Sharma, M. M.	
WM/ST/1 Setting up and maintenance of standard barometer.	Further progress in the fabrication of sub-assemblies has been made. All the remaining assemblies have been completed and work on the installation as well as that on the lapping and polishing of surfaces requiring optical flatness has been started.	Prem Prakash, Om Prakash & Jain, V. P.	

The four window glasses have been polished to the required degree of flatness and parallelism. Special apparatus for the purification of mercury, which was designed earlier, has now been completed, set up and initial trials have been made.

Work on the system for measuring temperature of the mercury column to one thousandth of a degree C has also been started.

APPENDIX II

CALIBRATION & TESTING

One of the main objectives of the National Physical Laboratory is to undertake developmental testing with a view to help industry. With the rapid industrialisation of the country and particularly in view of the great export potentialities of industrial, electrical and electronic goods, it has become necessary to have an organisation to evaluate industrial product. The National Physical Laboratory has been rendering considerable aid to the industry in testing their products and advising them as to how to improve the quality of the product manufactured. This activity of the Laboratory is being constantly expanded with a view to give greater technical assistance to the industry.

The Laboratory undertakes in general type testing but in some cases it also undertakes routine testing specially for those products, for which test facilities do not exist elsewhere in the country. Test Reports, which are issued at nominal charge, help the manufacturers to assess the quality of their product and to know in which respect further improvements are called for.

The Laboratory has now been geared up to undertake testing of Radio and T.V. Receivers, cables, motors, fans, refrigerators, proving rings, temperature measuring devices, lamps and lamp fittings, microphones, etc. Extensive facilities for chemical, spectro-chemical, X-ray fluorescence, X-ray diffractometric EPR, etc. have been established to test the purity and perfection of materials. This is a silent but very valuable service to the industry.

The number of the testing and calibration jobs undertaken in the various divisions of this laboratory during this year are given in the following table. The Laboratory has realised during the year under report Rs. 1,02,668·30 by way of testing fees.

Code No. 1	*Materials* 2	*No. of items* 3
	ACOUSTICS	
A/T/1	Vibrating Machine	12
	Amplifiers	6
	Microphones	7
	Siren	2
	Fibre Boards	2
	Loudspeakers	16
	Cones	8
	Mineral Wool	16
	Tuning Fork	1 set
	Airconditioner	2
	Audiometer	2
	Sound Projector	1
	ANALYTICAL CHEMISTRY	
AC/T/1	Soil	2
	Water	25
	Oil	3
	Stay set	2
	Mirror	3
	Bolt Centres	36
	Limestone	2
	Lead Sheath	15
	Spring Steel	2
	Lustre	2
	Wax	1
	Ore	19
	Non-Ferrous Material	5
	Alloy	5
	Steel Blade	3
	Wire	4
	Zinc Coating	2
	Sulphuric Acid	5
	Rusted Equipment	2
	Stone	3
	Steel Plate	2
	Piano Hinges	3
	Miscellaneous	7

1	2	3
	APPLIED MECHANICS	
AM/T/1	Proving Rings	162
	Chain Pulley Block	8
	A.C.S.R. Conductor	4
	Polythene Pipe	3
	Hydraulic Measuring Box	2
	Compression Joint	3
	Lifting Clamps	49
	H. T. Wire	13
	M. S. Rods	52
	Tiles	6 sets
	Steel Samples	5
	Jacks	17
	Insulator Caps & Test Bars	12
	Crank Shafts	10
	Braking coupling	12
	Cubes	7
	Tapes	4
	Pressure Gauges	2
	Strain meters	8
	Machines	6
	Scales	4
	Dynamometer	15
	Mechanical Specimen	6
	Bolts	7
	Centre Bolts & Fibre Bolts	4
	Ratchet Lever Hoist	6
	Miscellaneous	26
	ELECTRONICS	
ELEC/T/1	Transistor Radio & Radio Receiver	34
	Community Receiver	3
	Miscellaneous	3
	HEAT STANDARDS	
HS/T/1	Thermometers	32
	Clinical Thermometer	23
	Thermo couple	4

1	2	3
	Glass & Mineral Wool	8
	Miscellaneous	5
	HEAT & POWER	
HP/T/1	Abel's Flash Point apparatus	8
	Pensky Viscometer	6
	Oil (Lubricating)	1
	CARBON PILOT PLANT	
CPP/T/1	Bush Block	1
	Transverse Test Machine	1
	Turbidimeter	1
	Transverse Strength Tester	1
	LOW TEMPERATURE	
LT/T/1	Domestic Refrigerator	3 sets
	Vacuum Flasks	4
	OPTICS	
OPT/T/1	Electric Lamps and Bulbs	76
	Lenses & Glasses	62
	Coating of Glass Plates	2 sets
	Gauge Clutch	7
	Lighting Fixture	18
	Miscellaneous	16
	DEVELOPMENT-CUM-PRODUCTION OF ELECTRONIC COMPONENT	
DPEC/T/1	Railway Signalling Transformer	1
	Morganite Resistance	1
	ELECTRICITY	
ECY/T/1	Calibration of DC and AC Substandard and precision measuring instruments viz. Voltmeter, Ammeter, Bridges, Standard Cells and Resistance, etc.	54
	Development testing of industrial products viz. Cables, Electric Motors, Insulated Plier, Motor, Transformer Oil, Resistance Box, Transformers, etc.	151

1	2	3

WEIGHTS & MEASURES

Calibration

WM/T/1	**Length Section:** Slip pressure and precision gauges, Sieves, Viscometers, Length measures, etc.	174
WM/T/2	**Mass Section:** Sets of weights for scientific purposes and the Weights and Measures Enforcement Departments	122
WM/T/3	**Horology Section:** Stop Watches	8
WM/T/4	**Volumetry Section:** Pipettes, Burettes, flasks, etc.	99
WM/T/5	**Hydrometry Section:** Different types of hydrometers & lactometers	75
WM/T/6	**General Testing:** Balances, Flow cups, Flash Point Apparatus, Flush Doors and Electrical appliances, etc.	360

X-RAY

X-rays/T/1	X-ray analysis of corrosion and discoloration patches
X-rays/T/2	Imperfections in large CdTe crystal and determination of the cleavage plane Miller indices
X-rays/T/3	X-ray study of ferrites and YIG
X-rays/T/4	Imperfections and growth direction determination of ZnO whiskers
X-rays/T/5	Opal-like stone, stated to be precious
X-rays/T/6	$SrTiO_3$ samples, doped with various amounts of iron
X-rays/T/7	Lanthanum aluminate and related samples
X-rays/T/8	Orientation of Si single crystal using the cylindrical Laue film and stereographic projection
X-rays/T/9	Aluminium rods, powders, silicon rods and ingots, tin, Zn, Bi and Cd ingots, alumina boules, reaction products at various stages of reduction of SiO_2, etc.

S. No.	Name of the Division	Testing fee realised, Rs.
1.	Weights & Measures	27,132·68
2.	Acoustics	4,183·85
3.	Electricity	9,379·00
4.	Optics	10,205·02
5.	Industrial Physics	236·00
6.	Heat & Power	2,231·00
7.	Analytical Chemistry	13,072·71
8.	Applied Mechanics	25,209·05
9.	Electronics	4,069·00
10.	DPEC Unit	150·00
11.	Low Temperature	6,346·00
12.	X-ray	450·00
	Total:	1,02,664·31

MISCELLANEOUS RECEIPTS

1.	Supply of Electronics Equipments	4,177·20
2.	Supply of Infrared Spectra	224·85
3.	Charges towards supply of Micro-graphs by Elec. Microscope	600·00
4.	Charges towards coating of mirrors	1,301·80
5.	Supply and repair of metal detector	2,009·30
6.	Jobs done in the workshop	2,099·06
7.	Repairs of Instruments & Servicing, etc.	3,695·00
8.	Consultancy Charges	4,122·00
9.	Supply of Carbon Products	16,092·87
	Total:	Rs. 34,322·08

APPENDIX III

DEVELOPMENTAL PROJECTS

Code No. and Project (1)	*Progress* (2)	*Project Team* (3)	*Ref.* (4)
AC/D/4 Quantitative evaluation of color changes in indicators	Absorption spectra of a series of phthaleins, viz. phenolphthalein; phenol thymol phthalein; thymol phthalein; and corresponding sulphophthaleins, viz. phenol red, cresol red, and thymol blue have been taken, the specific color discrimination, d_c/d_pH have been calculated from MacAdam Elipses and from rectilinear coordinates of colour. 4×10^{-5} (.002%) solutions were used. From this, the following observations have bee made: Phthaleins show maxima d_c/d_pH of 30-50 color steps. Sulphophthalein show two maxima d_c/d_pH 14-20 & 20-30 color steps in the acidic and in the alkaline range respectively. The study helped to understand the occurrence of the two d_c/d_pH max. found in the case of phenol red that is in conformity with other sulphophthaleins such as cresol red and thymol blue. In this series a member belonging to dihydroxy phthalein and sulphthalein is proposed to be added.	Bhuchar, V. M. & Kukreja, V. P.	
AC/D/5 Development of techniques of chemical analysis	Conditions have been standardised for dissolution of steel in $HClO_4$ (about 10 mts) and subsequent spectrophotometric determination of chromium as chromate at 445 μm	Bhuchar, V. M. & Kukreja, V. P.	

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	and of manganese after excitation with HIO_4 as permanganate is made at 520 μm. The method has been applied to analysis of various steels.		
Complexometric determination of mixture of metals	Analysis of ferrous and non-ferrous compositions is the normal function of the Division. Development of quick analytical procedures is continually pursued. Complexometric method has already been developed for Cr-Th mixtures. It is proposed to extend this to other combinations like Co-Cr and Ni-Cr.	Verma, M. R., Agarwal, K. C. & V. K. Amar	
Thiol-carboxylic acids complexes	It is a continuation of our earlier work on Thiol-acetic-benzoic acid complexes of Cr, W, U & Ni [Nature **191** (1961) 489 & ibid **194**, (1962) 835]. Consequent upon the above, the thiol-propionic acid complex of Molybdenum has been examined and its utilisation for determination of Mo assessed. Further work is in progress.	Bhuchar, V. M. & Kukreja, V. P.	
Methods for the detection of arsenic and thallium in cadmium oxide (electroplating grade)	The presence of arsenic and thallium in CdO is reported to be deleterious in the electroplating process. British Standards Specification mentions a spectrographic method; this facility may not be available in ordinary works laboratory. Modified Gutzeit method for the arsenic and polarographic method for the thallium have been investigated and the methods have been found to be satisfactory. A modified complexometric method for the estimation of cadmium is also being investigated.	Verma, M. R. & Gangopadhyay	

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Detection of adulteration in Henna	This problem arose out of the deliberations of I. S. Convention at Chandigarh. Coaltar dyes are reported to be mixed with Henna. Preliminary work on the spectrophotometric method for the estimation of Lawsone of thin layer chromatographic method for the detection of extraneous dyes in Henna has been worked out.	Verma, M. R., Rai J.	
Chromatographic method for the detection of argemone oil adulteration in vegetable oils.	Argemone seed resembles mustard seed. Oil from the former seed is reported to be deleterious to human health and its presence has to be checked in edible oils particularly in mustard oil. A thin layer chromatographic method has been developed for detecting the presence of argemone oil adulteration. The method is applicable for detection of as low as 0·1% adulteration.	Verma, M. R., Rai J. & Asha Ram.	AC: 17
AM/D/1 Design and fabrication of the 3000 kgf dead load testing machine	NPL report ST.1, entitled 3000 kgf Dead Weight Machine describing the machine, has now been published.	Das Gupta, M. K. & Sharma, R. S.	
AM/D/2 Design and fabrication of abrasion testing machine.	A report entitled 'Abrasion Testing Machine' has been printed.	Das Gupta, M. K. & Nayar, R. K.	
AM/D/3 Design and fabrication of photoelastic bench.	The photoelastic bench has now been fabricated. The lens system has been completed. The fabrication of the collimating lens has been completed. The bench has been tested and gives satisfactory performance. The fabrication of the projection system could not be taken in hand since the optical glass has not been made available by the CGCRI.	Agarwal, B. K., Das Gupta, M. K. & Agarwal, A. K.	

Salient features of the photoelastic bench:

The photoelastic polariscope is an instrument, which uses polarised light for determining stresses in loaded structures and machine parts.

The bench is required by all engineering colleges and research laboratories engaged in design and testing work. The bench that has been designed and fabricated at the National Physical Laboratory has the following special features.

1. The analyser and the polariser can be rotated simultaneously correct to 1 degree.
2. The quarter wave plate can be conveniently thrown out of the field whenever desired.
3. A ring with suitable graduations has been provided to measure fractional fringe orders directly.
4. The bench can be adapted to both two and three dimensional photoelastic work. For three dimensional studies the universal loading frame is removed and a tank substituted in its place in which stands a tilting stage. The tilting stage has provision for holding a frozen slice. The slice can be rotated about one of the principal stress directions thus facilitating oblique incidence measurements.
5. A microscope has been provided to make point by point measurements in the model.

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AM/D/4 Design and fabrication of Carlson strain meter	The detailed report on the working of the instrument is ready and is under publication.	Das Gupta, M. K. & Agarwal, B. K.	
AM/D/5 Hydrostatic extrusion of metals and alloys (generation and utilisation of high pressure)	(i) Extrusion dies for rods and solid gears have been fabricated in EN 26 steel. The circular and rectangular rods and finned rods have been extruded in pure aluminium. The extruded sections give an excellent surface finish. (ii) Design for a tetrahydral anvil press, which is capable of generating pressures of 1·2 million psi has been completed.	Agarwal, B. K., Agarwal, A. K. & Das Gupta, M. K.	
	D.P.E.C. UNIT		
DPEC/D/1 *Permanent magnet ferrites*	Further development work has been done in improving the BH Max product by presintering at sintering temperatures by the addition of barites (mineral barium sulphate) a naturally occurring mineral, to enhence the magnetic property. Unoriented magnets using mineral ferric oxide with 5% clay has also given satisfactory results when sintered at lower temperatures.	Ganapathy, C. V., Gupta, S. C. & Aftab Ahmed	
Oriented Magnets	Experiments on pressing hard ferrites in a magnetic field by the use of low voltage high current source of DC supply are in progress.		
DPEC/D/2 Soft Ferrites *Short-cum-medium wave ferrites*	Further development work has been conducted on improving the properties of the short-cum-medium wave ferrites by carrying out the following investigations: (i) A composition utilizing Manganese Zinc ferrites with the addition of Nickel and Cobalt.	Ganapathy C. V., Govindaswamy, G. Narayanan K., Khanduja, R. S., & Kalsi, H. S.	

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	(ii) A Nickel Zinc Cobalt ferrite with its iron content below stoichiometric value. (iii) Nickel Zinc Cobalt ferrite with iron about stoichiometric ratio. The latter two have given encouraging results. The first one is yet to be tried to get optimum results with comparatively higher porosity, which will give higher Q and correspondingly high permeability.		
Manganese ferrites	Further large scale experiments on standardizing the process of manufacture of Manganese Zinc ferrites are continuing. One of the significant finding is that to obtain both the high permeability and high Q' particle size, presintering and sintering temperatures have all to be controlled so that the rods have certain amount of porosity. These experiments are giving encouraging results and the processes controlling the parameters are being standardized. A new raw material source for ferrites in general, including the magnetic ferrites, has been located, which has a purity of 96-97% and the price approximately half that of the mineral iron oxide, which is normally being used now. A high pressure hydraulic extrusion machine has been designed and built for extrusion of rods having high densities.	Ganapathy, C. V., Gupta, S. C., Govindaswamy, G., & Smt. Ramadevi	
Microwave ferrites	Large batches of microwave ferrites of the X-band in different shapes and sizes were made for use in microwave benches, which were fabricated in	Ramamurti, T. V., Ganapathy, C. V., & Gupta, S. C.	

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	the laboratory. Nearly 30 benches were fabricated and all the microwave ferrites were made and supplied.		
IF Cores & E Cores	Two formulations have been developed having the following permeabilities: NPL 3-1 300 NPL 2 640 The first is suitable for IF cores and is superior to the iron dust cores that are generally used at a frequency of 450 Kc/s. The second is suitable for 'E' cores for audio transformers and have been tried in small size 'E' cores for transistor radio receivers with encouraging results.	Narayanan, K., Kalsi, H. S., Smt. Ramadevi & C. V. Ganapathy	
Memory Cores	One of the small automatic presses with a 3 tonne capacity has been modified for pressing Memory Cores in quantities and dies have been fabricated for this press, which has a production capacity of nearly 24,000 pieces in 8 hrs. Large quantities of Memory Cores have been pressed and batch samples have been sent to BARC, Bombay and to IIT, Kanpur, who are experimenting with the building of Memory Planes using indigenously available memory cores.	Ganapathy, C.V. & Gupta, S. C.	
DPEC/D/3 *Piezoelectric Ceramics*	A composition modifying the Barium titanate lead zirconate by the addition of certain rare earth oxides have given piezoelectric bodies having high density. The material can stand higher voltage and regular batch experiments are being done to assess the properties. Patents are being filed.	Ramamurti, T. V., Ganapathy, C. V., Menon, T. R. K. & Narayanaswamy, N.	

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DPEC/D/4 Technical Ceramics *Pyrolytic Carbon Film Resistors*	Large batches of carbon film resistors have been made, which have been finished into complete resistors. These have undergone tests in the environmental testing section and the results obtained are encouraging except for the coating for moisture resistance. The matter is receiving our immediate attention. Since the process involves plating the ends and soldering the leads, the noise factor was quite low and it is expected that the reliability of the resistors will be high. Some enquiries have been received for getting the know-how for the process and this matter is being looked into.	Shiv Saran, Rangarajan, S. & Ramamurti, T. V.	
Ceramic tracks for variable carbon resistors	The economics of the process of making carbon tracks for volume controls using a ceramic substrate is under study. Further experiments on processing ceramic bodies by isostatic process for the large capacity press is in progress.		
DPEC/D/5 Professional Ferrites (high permeability ferrites)	Further work on the development of the professional ferrites has resulted in our being able to produce sample, which are very close to the 3B7 of the Philips samples in practically every characteristic except in permeability, which is at present about 80% of what is required. Further experiments are being conducted to see that we could get large batch samples without much variation in the parameters. The various factors, which govern the characteristics, are being studied.	Ramamurti, T. V., Ganapathy, C. V., Gupta, S. C., Khanduja, R. S., Santokh Singh, Ved Singh, Nair, N. R. & Khurana, B. S.	

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DPEC/D/7 High Temperature & low temperature thermistors.	The Railways, who had originally initiated the programme, have not decided as to the type of endurance tests that have to be done till recently. It is only now that an agreement on the type of endurance tests has been arrived at and samples are now being prepared for subjecting to endurance tests.	Ramamurti T. V., Nair, N. R., Md. Izar Alam, V. N. Sharma, Smt. Ramadevi & Ganapathy, C. V.	
DPEC/D/8 Volume control tracks Carbon Composition Resistors	One commercial firm has been granted a licence to produce carbon composition resistors and potentiometers, as they showed their willingness to seek NPL know-how. Drawings for all the mechanical parts for edge volume controls have been prepared and quotations have been obtained from manufacturers for the mechanical piece parts. It is expected that orders will be placed during the year for the metal parts and the assembly and development on tracks and volume control is expected to be started.	Ramamurti, T. V., Nair, N. R. & Md. Izar Alam	
DPEC/D/9 Silver Paint (conducting cement)	A new conducting silver paint (using araldite and hardner separately) for room temperature curing has been developed. This has got applications, where it is not possible to heat the components, after applying the conducting paint, for curing the resin. This has been used in composite piezoelectric ceramics. Orders have been received from BARC, NAL and other organisations.	C. V. Ganapathy & Khullar, S. M.	
Elec/D/1 Design development and fabrication of prototypes of 10 cm reflex klystrons	1. The shrinkage in Ni-matrix cathodes after sintering could not be eliminated. Now these cathodes, pressed in the disc form, would be mechanically fixed on the Ni-sleeve.	Chandra, K. & Arora, T. R.	

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	Dies for pressing these cathodes have been designed and fabricated. Pressing of the cathode discs is in progress. 2. A new pump has been fitted to the induction furnace. The modified jig for making disc seals is under test. 3. The disc cathodes are being pressed for the double gap klystron also. The tube would be tested with these cathodes under preparation. 4. Fixing of the tungsten grids on the O.F.N.C. copper discs has been perfected.		
Elec/D/2 Design, development and fabrication of microwave components, materials and systems.	1. Complete test bench for X-band (8·2 to 12·4 KMC) has been fabricated and tested. It comprises of 27 different microwave components (Annexure I). Some 'C' band (15·8—8·2 KMC) have also been fabricated. 2. The proposal for batch production of 20 test benches was approved by the Executive Committee. Final orders for supply of test benches have been received from nearly two dozen universities, colleges and research institutes. 3. Batch production has been started and 20 complete test benches have been supplied to various universities. Eleven test benches have been supplied for Summer Schools organized by University Grants Commission. Total cost	Chandra, K., Parshad, R., Agarwala, V. K., Bhatnagar, H. M. & Kataria, B. K.	

of 20 test benches fabricated is Rs. 1,80,000 thereby saving a foreign exchange of the order of Rs. 5,00,000.

4. Resonance isolators for post and telegraph department as per their specifications are still under development. C.G.C.R.I. has been requested to supply us alumina slabs to be used as low loss ceramic material. Our own samples of TiO_2—glass have not proved very satisfactory for low loss isolators. Some more samples are being prepared.

5. One 'T' circulator for X-band has been designed, constructed and tested. It is to be used as iso-circulator, which means that it can be used as isolator as well as circulator. Some more work is still to be done.

6. A report on these activities was presented at the Defence Electronics Seminar held at Hyderabad in August '67.

7. A prize of Rs. 1,000 was awarded to Dr. K. Chandra, Dr. Ram Parshad & Shri V. K. Agarwal by Invention Promotion Board for their work on Broad-banding of resonance isolators. The award was announced on 15th August, 1967.

ANNEXURE I

List of Microwave components fabricated for X-band Test Bench.

1. Klystron mount.
2. Padding attenuator (3, 6, 10 db).
3. Variable attenuator (0 to 30 db).
4. Broadband isolator.
5. Three port 'Y' junction circulator.
6. Frequency meter.
7. Multihole directional coupler (3, 10, 20 db).
8. Slotted section.
9. Probe with tuner.
10. Waveguide detector mount with tuner.
11. E-H tuner.
12. Slide screw tuner.
13. E-plane tee.
14. H-plane tee.
15. E-plane bend.
16. H-plane bend.
17. E-H tee.
18. Matched termination.
19. Movable short.
20. Waveguide horns.
21. Waveguide pieces.
22. Waveguide twists.
23. Cross directional coupler.
24. Co-axial to waveguide adapter.
25. Waveguide flanges.
26. Klystron power supply.
27. Waveguide stands.

Code No. and investigation	*Progress*	*Team*	*Reference*
1	2	3	4
Elec/D/4&5 Electronic circuits and instrumentation	1. The working of a transistor multivibrator having variable collector and base voltages and variable-base resistances was investigated and the optimum working conditions for a VCO (Voltage Controlled Oscillator) were determined. A report on this work has been prepared. 2. Circuit conditions for operating a number of transistors in parallel have been investigated. As the country does not yet produce high power transistors, the paralleling will make it possible to use the indigenously produced devices for high power operation. An experimental 10 watt audio amplifier has been made, by using transistors, each having an output of ½ watt. A report on the work has been prepared. 3. Using the technique of parallel transistor a set up is being assembled for running small voltage ac motors with variable speed. The work has general applications in industry and physics instrumentation. At present a power output of about 28 watts could be attained. 4. Circuit of a reversible counter has been completed, in which it is possible for the subtrahend to be greater than the minuend. In the counter two scales are provided one having plus algebraic sign and the	Parshad, R. Suri, S. P. Singh, S. K. A. C. Parbhakar & Gautam C. B. L.	

other negative. Which scale has to be used at a particular instant is determined by a direction sensor, which has been developed for operation with a binary quinary decade counter developed earlier.

A report on this work has been prepared.

5. Monostable and free-running multivibrator circuits have been developed, which have very long off-on timings. Timings of order of ½ hour in optimum conditions have been reached, whereas conventional circuits hardly give a time greater than one minute. Further developmental work is in progress.

6. A temperature-independent, constant frequency free running multivibrator has been developed for 50 cycles and 1000 cycles. This circuit can form the basis of inexpensive instruments yielding constant frequencies.

Instrumentation

1. Prototype of klystron power supply was made. Based on this work twenty power supplies were constructed on a production basis for supplying microwave bench and its accessories to universities and other educational institutions. Some parts in the supply (like vacuum tubes) are still foreign. Efforts will be made to

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	make the supply completely from indigenous sources. 2. Transistorised traffic control equipments have been developed. Previously, the equipments used relays and gas tubes. Circuitry has been developed, which uses transistors and zener diodes. Problems of self-starting and prevention of false triggering have been overcome. Based on these and earlier techniques, the Licensees of NPL on Sequential Switching Devices (Traffic control and other devices), the Control and Switchgear Co. has installed a number of traffic control units, multi-phase, two phase, Pedestrian push-button devices, blenking lights at various places in Amritsar. 3. An instrumentation of burglar alarm for an industrial firm has been developed and supplied. 4. A direct deflection type frequency meter has been completed. It can measure frequencies upto 500 kcs and is useful for quick and comparatively accurate determinations of frequency. 5. Work was initiated on the construction of a counter-type frequency meter and different parts of its circuit are being assembled.		
Elec/D/7 Effect of magnetic field on diode and transistor operation	Work published earlier had indicated that external magnetic field at p-n junction increases the built-in potential. To verify this statement, depletion layer	Parshad R. & Mehta S. C.	

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	capacitance values for various diodes of germanium and silicon, at various magnetic fields was measured. In silicon there is no change in capacitance with magnetic fields, while in germanium there is a definite change. Efforts are being made to explain the results.		
H/D/1 Prototype calibration equipment for glass thermometers.	Series of equipments, developed during 1965-1966, was used for testing in the N.P.L. The details of this equipment were published and discussed in the Get-together on Thermometry held at NPL during February, 1967. Some thermometer manufacturers have since then built up their own equipment, either exactly like ours or with certain modifications. Some of these thermometer comparators have been adopted as Pointing Baths by the manufacturers. The I.S.I. specification for methods of calibration of thermometer is considering the adoption of these equipments as a whole.	Bansal, T. D., Wasan, V. P. & Sharma, M. M.	
H/D/2 Clinical thermometers	1. The Shaking Down Machine was redesigned and fabricated. Its speed can now easily be controlled by the use of stabilized dc whereas the principle of construction remains the same. 2. The Accelerometer has been completed and installed. It only needs graduation. Heating wires were laid along the two walls of the room to enable an ambient temperature of 33°C to be maintained with sufficient safety.	Bansal, T. D., Wasan, V. P. & Sharma, M. M.	

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	Testing The ISI has used the equipment at site from September to December, 1967, for testing clinical thermometers. *Training* Thirty eight persons from ISI and NPL were trained for using the equipment in addition to two ISI officers. *Instruction Manual* An Instruction Manual has been written for use of the equipment and running a scheme of testing. Two copies of this Manual were provided to ISI and one to the NPL Library.		
H/D/4 *Investigations to recommend the convection co-efficient of heat transfer under steady state free convection in Indian conditions.*	Empirical study of known data for single horizontal cylinder had been developed earlier. The paper has been accepted for publication in the Indian Journal of Pure and Applied Physics.	Bansal, T. D. & Chandna, R. C.	
HP/D/1 Drying of coal fines obtainable during coal washings by the utilization of Solar Energy	Earlier arrangement for heating air with solar energy were described, viz. by blowing air with an electrically driven fan through the bundle of tubes of the heat exchanger-cum-reservoir coupled to two solar water heaters and across a motor car radiator with a centrifugal pump and a fan commonly used in an automobile. The amount of heat transferred from hot water to air in the shell-and-tube heat exchanger and the temperature of the outgoing air were estimated under forced convection conditions. Now the design data for heating air under free or natural con-	Khanna, M. L.	

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	vection conditions and utilizing solar energy has been completed. The temperature of out-going air has been estimated by considering various parameters, viz. flow rate and temperature of in-coming air, temperature of incoming water, length and diameter of tubes, etc. The data presented will greatly help in arriving at the final design of the shell and tube heat exchanger to be used for space heating of living room. Three papers on the subject, mentioned earlier, have been published and the Indian Patent No. 99523 has been accepted.		HP: 7,8,9
*IP/D/2 Process Carbons	Process carbons of sizes varying from 12 mm to 22 mm were processed with emphasis on the consumers' reports. The factors responsible for high consumption and dense smoke were studied. Improvements were effected by adjusting the composition and the process variables.	Joglekar, G. D., Kapur, S. K. & Verma, C. L.	
*IP/D/3 Process Carbons for High Intensity	Process carbons of sizes varying from 8 mm to 11 mm cored and copper-plated are under development. These are used in Survey of India and other Government departments for cartographic work. So far these grades are imported. A few batches were processed and samples sent for trials and tests.	Joglekar, G. D., Kapur, S. K. & Verma, C. L.	
*IP/D/4 Pressure Sensitive Carbon Discs	Tablet making machine was set up and die was designed to suit the purpose. Effect of impregnants on transverse strength of the product was studied. Samples were submitted to Defence authorities for trial.	Joglekar, G. D. & Datta, K. K.	

MATERIALS DIVISION

Silicon and Semiconductor Devices (Laboratory Project)

M/D/5

(a) *Preparation of Semiconductor grade silicon:*

During the year under report, tetra-iodide has been successfully cracked. It has been possible to obtain silicon of transistor grade purity. An analysis of six different samples, supplied by us to the Atomic Energy Commission (Spectroscopy Division) revealed that none of the following impurities was greater than a few parts per million.

Sb, Fe, Cu, Ni, Mn, B, Be, Bi, Mg, Pb, Cr, Sn, Al, Ag, V, Ti

Boron, which is a killer impurity and is very difficult to remove even by zone refining, was found to be less than one part per million. During the year we have removed all the teething troubles and have now streamlined the production of transistor grade purity silicon. During the period of the report one hundred grams of polycrystalline transistor grade silicon was produced.

Jain, G. C., Gupta, P. K., Amar, V. K., Iyengar, T. R. G., Soni, G., Menon, V. G. & Sastry V. D. P.

(b) *Casting, Fusing and Zone Refining of Silicon Rods:*

Techniques developed earlier for casting silicon into rods of various diameters, were modified and perfected to obtain consistency in results. Rods of various diameters and lengths have now been cast from silicon.

(c) *Fusing of Silicon Rods:*

The technique, developed earlier for fusing of silicon rods, has now been perfected. Last year we were using commercial grade silicon, while this year transistor grade silicon has been used. With high purity of transistor grade silicon the problems in fusing are of a complicated nature on account of its much higher resistivity.

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(d) *Zone Refining of Silicon Rods*:	Now that rods of high purity silicon have been cast. Attempts are being made to fuse single crystal seed to these rods. Thereafter single crystal rod will be zone refined.		
(e) *Fabrication of Silicon Devices:*	Last year we were getting ready to start work on silicon devices. Furnaces were fabricated in the laboratory. Multiple diffusion of impurities in semi-conductors has been carried out. The control multiple diffusion is the heart of all semi-conductor devices. The problem, which now exists, is awaiting the arrival of thermal compression die bonder and ultrasonic wire bonder.		
M/D/2 Development and Physical Study of Phosphors	Work has mainly been concentrated on the activation of imported zinc and cadmium sulphides with silver to be eventually used for black-white television screen material. Two different materials are used for these television screens. The silver activated zinc sulphide provides the blue component and the mixed zinc sulphide and cadmium sulphide phosphors activated with silver provides the green yellow component. The blue component material has been successfully prepared in the laboratory. Work on the yellow component is in progress.	Agrawal, J. P.	
M/D/4 Instrumentation for measuring consistency of butter	Further studies with the torsion viscometer revealed that at the low stresses prevailing in torsion viscometer the working of butter is not complete and hence the comparison between different butter samples cannot be done under identical working condition. A new design based	Chari, S. S. & Awasthi B. R.	

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	on Stormer's principle was made, which will give higher stresses so that the working of the sample may be complete and hence comparison becomes adequate. This instrument is being fabricated in the laboratory.		
OPT/D/3 Optical test methods based on interferometry	A prototype of the inverting interferometer for testing objectives has been designed and is under construction. A prototype of a Fizeau cum inverting Fizeau inteferometer is under design. A multiple beam Fizeau interferometer has been set up and is in use for measuring the thickness of thin films. A simple reversing prism has been designed and fabricated for use in precision measurement of fringe shifts. The performance of the prism as a function of the fringe visibility and fringe irradiance, is being evaluated.	Sen, D. & Puntambekar, P. N.	
OPT/D/6 Development of infrared spectrometers	(a) The prototype of the cheap infrared grating spectrometer for the region 1-3μ is still under construction. The optical drawings are complete and have been tested. Mechanical drawings of a few components have been completed and passed on to the workshop. Some of the components have already been fabricated while the others are in hand. Drawings of the other components are being prepared.	Saksena, B. D. & Agarwal, K. C.	
	(b) A high resolution infrared grating spectrometer for the region 1-3μ is under construction. Its components are under fabrication in the workshop.	Saksena, B. D., Agarwal K. C. & Pahwa, D. R.	

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	All the mirrors have now been obtained and are being assembled to get a good optics for the instrument. Arrangements for mounting the grating are being refined and finalised; a synchronous motor for rotating it has been ordered and is expected soon.		
	(c) The electronics and the optics of the Far Infrared mesh Fabry-Perot spectrometer was built by Dr. R. Ulrich of the University of Freiburg. After receiving the Golay cell with the diamond window, further work was started to put the instrument into working condition. Dr. F. Siebert from the same university joined our group to assist the work. Atmospheric water vapour absorption spectrum has been recorded in the range 180-360 μ. The instrument has been found working quite satisfactorily except the fact that some unwanted radiations towards the high wavelength side were present due to second order effect of unfiltered radiations. To avoid this optics of the instrument is being modified to provide better filtering. Besides this automatic sample changing mechanism is being introduced so as to have the sample and the reference beam in the optical path alternatively for one minute. The work is in	Saksena, B. D., Siebert, F., Pradhan, M. M. & Pahwa, D. R.	

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	progress and the spectrometer will soon be ready for recording the spectra.		
	(d) An alternate detector (triglycine-sulphate) is being prepared to be subsequently used in place of Golay cell. Triglycine-sulphate (TGS) material and single crystals of the appropriate size have been prepared. A suitable water bath to maintain the TGS plate at its Curie temperature has been designed and is expected to be ready soon. An appropriate amplifier is also being fabricated.	Saksena, B. D., Agarwala K. C. & Pahwa, D. R.	
	(e) After receiving a flash lamp from the University of Freiburg further work on ruby lasers was started. A condenser bank of 550 μF capacity comprising of about 150 condensers and 2500 volts was installed. A special type of air core inductance 100 microhenry having 5·6 miliohm resistance capable of allowing upto 2000 amps current was made. A trigger circuit was made to supply trigger voltage of 15,000 volts.	Saksena, B. D., Siebert, F. & Pradhan, M. M.	
	*The equipment was tested with a ruby laser (supplied to us by Dr. Gurs of West Germany) which was found to emit red light at a threshold potential of 1300 Volts.		
OPT/D/7 Precision Optical Component Development	During the year a number of components were made for various divisions of this laboratory as well as for outside parties. A	Sen, D. & Grover, C. P.	

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	few of the items prepared are listed below: 11 optical flats of 1/8 wavelength accuracy; 7 beam dividers; 6 plane mirrors of 1/4 wavelength and 7 spherical mirrors 1/4 wavelength accuracy for use in infrared spectrometer; one laser tube; one test plate for inverting interferometer of 1/10 wavelength accuracy.		
OPT/D/9 Spectrochemical Analysis	A number of experiments were carried out to pin-point the conditions under which measurable intensities at low ppm. for a number of elements of interest in Silicon Project could be obtained. In this connection, Cathode layer, superposition and split-burn techniques were tried and the conditions under which they could be best utilized were determined. About twelve samples have been analysed spectrographically. Some advice on the spectrochemical procedures and use of certain equipment was given to the Asst. Chief Chemist, Hindustan Zinc Ltd., and Okhla Industrial Training Institute, New Delhi. Quantitative analysis of different elements in a sample of petroleum coke has recently been completed.	Sh. V. D. P. Sastri, & S. Manmohanan	
OPT/D/10 Design and development of optical systems	33 more optical systems have been designed including objectives for enlargers, telescopes, levels and binoculars. An inexpensive, 35 mm filmstrip projector made to NPL design, is now available in the market. Several prototypes of eyepieces and microscope condensers, made by the industries to NPL design were received for testing. Studies have been made on the	Ram Prasad	

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	primary aberrations of two lens systems used in eyepieces and the results have been reported.		
*OPT/D/11 Gas Lasers	A small vacuum coating apparatus was fabricated for trial preparation of high reflection dielectric mirrors for laser resonator systems. Mirrors were successfully made giving up to 99% reflectance with practically no absorption. A gas filling and purification apparatus giving a vacuum of better than 10^{-6} torr. were fabricated. An ionization gauge control circuit was built for use in this vacuum filling system. A laser tube has been made along with the Brewsters angle windows and the resonator mirrors. The assembly of the He-Ne laser is in progress.	Das, S. R., Sen, D., Puntambekar, P.N. & Grover, C. P.	
TF/D/1 Thin Film Devices NDM Filters	Metal dielectric—Metal thin film interference filter consists of a sandwitched layer of (half wavelength thick) dielectric between two highly reflecting surfaces. Complete technical know-how has been developed for the preparation of these filters in the visible range of the spectrum. The filters have been put to test as regards the effect of temperature and humidity and it has been found that without any deterioration in their performance the filters can withstand a temperature of 70°C and humid atmosphere up to 80%. Techniques have been successfully developed for sticking the filters with canada balsam to a protective blank glass plate. The size of the filters is $1\frac{1}{2}'' \times 1''$ and are mounted in $2\frac{1}{2}''$ dia. bakelite mount. These filters have been supplied to some institutions viz. Delhi College of	Bhide, V. G., Shah, V. V., Sen, D., Sharma, S. K., Suri, S. P., Malhotra, G. L., Sharma, D. C., Pantambekar, P. N. & Panwar, V. S.	

Engineering, Sardar Patel University, Vidyanagar Post-Graduate College, Modinagar, Lady Hardings Medical College, New Delhi, etc., and the reports obtained are satisfactory.

Narrow band all dielectric filters

As a next step to the metal-dielectric-metal filters the technique for the preparation of more sophisticated narrow band pass all dielectric multilayer filters has been developed. In these filters the high reflecting metal surfaces of the MDM filters are replaced by a stack of alternate high and low index quarter wavelength thick dielectric layers. The spacer layer is again half wavelength or integral multiple of half wavelength thick layer. To prepare such filters an evaporation unit of 30 cm diameter with optical monitoring device and rotating substrate holder was designed and fabricated. Keeping suitable geometry of the two evaporation sources for high index ZnS and low index (MgF_2) dielectrics, few filters with 5,6,7 & 8 layers were made. An examination of these filters showed that the variation of the peak transmission wavelength over a filter area of $2{\cdot}5 \times 3{\cdot}5$ cm was not more than 25 A.U. The characteristics of these filters are given below:

Type of filter	Spacer	Peak Transmission wavelength	Transmission at peak wavelength	Half width A.U.
5-s-5	MgF_2 Ist order	5461	99%	150
6-s-6	Zns Ist order	5461	87%	130
6-2s-6	Zns 2nd order	5461	94%	80
7-s-7	MgF_2 Ist order	5461	85%	65
8-2s-8	Zns 2nd order	5461	75%	35

These measured values are close to those reported in literature for similar filters. The adherence of the films with the glass substrate and the keeping property under normal laboratory conditions, have been found satisfactory.

High reflection coatings.

Work on all dielectric high reflection coatings useful in interferometry and lasers was initiated using a small glass evaporation unit with 10 cm diameter and 30 cm high chamber. Several multilayer mirrors of seven, nine and eleven alternate layers of MgF_2 and ZnS were successfully prepared and showed uniform coatings over $2{\cdot}5 \times 2{\cdot}5$ cm area. The R & T values at the monitoring wavelength were found to be:

	R	T
9 layer coatings	95%	3·6%
11 layer coatings	99%	1%

These values as well as their spectral transmission are close to those reported in literature for similar mirrors.

Polarising beam divider.

A polarising beam divider was made by cementing one 13 layer mirror between two high angle prisms. It gave about 99% polarisation to the transmitted beam and about 90% polarisation to the reflected beam. Further work on polarising beam dividers will be taken up after a suitable technique is developed for monitoring the thickness of oblique incidence.

Thin film resistors

Thin film resistors are prepared by depositing nichrome on cylindrical substrates made of ceramic or glass. For this

purpose the existing vacuum coating unit was modified to incorporate a planetory gear system, in which the substrate holder as a unit rotates about the central axis with a speed of 50 rpm and each cylindrical substrate rotates about its own axis at a speed of 200 rpm. To achieve better adhesion and reproducible characteristics of the resistor, a furnace has been designed to maintain the ceramic substrates at 350°C during the process of deposition.

After depositing the film, desired value of the resistor is adjusted by partially removing, the film material in a spiral form using a grooving machine. Resistor in the finished form is obtained by putting brass caps with lead wires at the ends of the ceramic rod and finally by giving a protective layer of epiomite. TCR values for such resistors is found to be roughly 150 ppm on an average. These have withstood satisfactorily accelerated and longterm humidity tests.

Electronic film thickness monitor and controller

Improvements were made in the design of the electronic circuit for film thickness monitor and a new water cooled quartz crystal holder was also designed and fabricated.

The crystal holder consists of a double walled brass box having two separate compartments, where the reference crystal and the sensor crystal (each of 6 M c/s AT cut) are housed. Each compartment carries a cylindrical teflon piece with a rectangular through hole to house the crystal assembly. The quartz crystals are sandwitched between

two stainless steel plates, the lower ones having $\frac{1}{4}''$ dia. openings for the deposition of the film. The sandwitched crystal is spring loaded, the pressure being adjusted by screwing a central disc. The central rod and the side strip serves as two insulated electrodes for the quartz crystal. During the deposition of the film one of the crystal is shielded and the other is exposed to the vapour beam.

The AT cut quartz crystal has roughly zero temperature co-efficient in the temperature range of $-20°C$ and $60°C$. However, provision is made to operate the crystal at a uniform temperature by circulating water through the holder.

The electronic control unit consists of two identical transistor oscillators, a mixer stage and a pulse analogue frequency meter.

During the process of deposition of the film, the frequency of the crystal exposed to the vapour beam decreases as the film builds up and the beat frequency is a measure of the actual mass deposited. The instrument is calibrated for copper, silver and aluminium films. The observed change in beat frequency with the material thickness (determined by optical method) of the deposited film is found to be linear up to 30 Kc/s change in beat frequency, which corresponds to about 19000 A.U. film thickness for aluminium.

The performance of the instrument has been found to be very satisfactory. One unit has been supplied to the Indian

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Institute of Science, Bangalore and a few more orders for the supply of these units are in hand for execution.

In addition to the thickness monitor a controller has also been developed, which shuts off the evaporation source power at a predetermined value of the film thickness. The instrument has worked very satisfactorily.

Patent has been filed for the film thickness monitor and controller and the technical know-how of the process is being passed on to NRDC for its release to the industry.

APPENDIX IV

RESEARCH INVESTIGATIONS

(*) New Investigations

Code No. and investigation	*Progress*	*Team*	*Ref.*
1	2	3	4
A/R/4 Sound absorption by wedge of indigenous materials (for use in anechoic room)	With the data obtained up to the end of the preceding year, which included all the likely available materials, it was decided to make a choice of the material for use in the anechoic room. About this time a new variation of fibreglass, the bonded fibreglass, was put on the Indian Market by M/s Fibreglass Pilkington. As a preliminary, absorption co-efficient of this material was measured in thicknesses 25 and 50 mm and densities of 16, 24, 32 & 48 kg/m^3. From these measurements 50 mm thick material with 48 kg/m^3 density was chosen for study in detail. One meter wedge of this material was found to give a lower cut-off frequency of about 80 c/s at a comparatively lower cost. It was, therefore, recommended to obtain this raw material for treatment of the anechoic room.	Pancholy, M., Chhapgar, A.F. & Bansal, S. C.	
A/R/7 Study of steels by ultrasonics	Each of the eight different types of steels selected for the study were cut into samples of suitable size totalling in number to 300. In each case different heat treatments such as annealing, normalising, isothermal austenitizing	Pancholy, M. & Shrawan Kumar	

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	and hardening were imparted in box furnaces at 2-3 temperatures above the corresponding point to obtain variation of grain size in the microstructures produced. After preliminary metallographic examination and hardness measurements heat treatments were repeated in fresh samples in certain cases in salt bath furnace or by reducing the austenitizing time to eliminate the decarbonisation observed in the previous work. Final metallographic examinations have been carried out in about 100 samples after the required degree of lapping and polishing of the surfaces to ascertain whether the spectrum of microstructure variation in grain size and the phase rejection at the grain boundaries correspond to the chemical composition and the heat treatment given.		
A/R/8 Efficiency of Sirens	(i) To control the directivity of radiation experiments were conducted initially using a small battery operated siren and an exponential horn. It was observed that there was 6-9 dB increase in sound pressure level along the axis. As a next step a multicellular horn has been designed to load each slot on the siren head. This horn has been fabricated and is under study. (ii) The air power of the siren has been estimated by connecting to the inlet a duct of known cross-sectional area and estimating the velocity of the intake air current using pilot tubes.	Pancholy, M., Bindal V. N. & Davinder Singh	

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	From measurement of the electrical input power, blower air power and sound output power it is observed that for a 5 H.P. siren the typical air power is equivalent of 1000 watts and the sound output power is 200-300 watts. These results correspond to a blower efficiency (ratio of the air power to the electrical input power) of about 30% and an overall efficiency (ratio of the sound power output to the electrical input) of about 7% or less. Experiments are in progress to study the effect of horn leading on the individual slots on the sound output. The results of air power measurement suggesting a 30% efficiency were conveyed to the NAL to seek their opinion as to whether they consider this figure adequate and whether they would like to undertake work to improve the blower designed. NAL have stated in reply that they have on hand problems of relevance to the aircraft industry only and have suggested that the matter may be referred to CMERI, who are working on allied problems. The matter has accordingly been referred to CMERI.		
A/R/9 Sonoluminescence	Studies on the following lines were conducted: (1) Degree of luminescence in water and 12 organic liquids under similar conditions. (2) Effect of variation of temperature on luminescence. (3) Variation of luminescence with intensity of sound field.	Pancholy, M. & Sidkey, M. A. (UAR guest worker)	

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	(4) Luminescence in liquid mixtures. (5) Luminescence in aqueous solutions of different concentrations of salts such as sodium sulphite, sodium nitrate, calcium chloride, etc. (6) In order to verify as to whether luminescence in water is due to hydrogen peroxide luminescence has been studied in water in presence of reducing agents such as ferrous sulphate, sodium nitrate, hydroxyamine, hydrochloride and sodium metabisulphite.		
AC/R/9 Method for the estimation of fluorides	(i) Calcium fluoride is precipitated at pH 5 with calcium chloride. Filter pulp is used as the collector for the precipitated calcium fluorides. This mode avoids the use of calcium carbonate as the collector and its subsequent interference in the gravimetric determination. The calcium fluoride obtained according to the modified method, can be ignited directly and weighed. (ii) Volumetrically the soluble fluorides can be titrated with thorium nitrate using alizarin S as indicator. The end point is normally not sharp. In our modified procedure, thorium fluoride that precipitates during titration is filtered out just near the end point. The titration of the filtrate is completed. Thus the end point becomes very sharp and repeatable.	Verma, M. R., & Rai J.	AC: 13

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	The two modified procedures yielded consistant results for flouride in determination of soluble fluorides and silico-fluorides.		
ECY/R/1 Survey and investigation of electrical insulating materials	During the year under review the following studies were conducted: (1) *On phenol formaldehyde laminates* (i) Effect of thermal ageing on dissipation factor. (ii) Surface resistivity and surface breakdown at room temperature. (iii) Dissipation factor at 1 KC after one year's exposure to humid atmosphere (95 to 98% R.H.). (iv) Surface resistivity after various hours of exposure to humid atmosphere. (v) Surface breakdown after 15 days' exposure to humid atmosphere. (vi) Dissipation factor at 1 KC of samples (iii) above after one, two months' exposure to room atmosphere. (2) *On Tryphane (A kind of Rayon)* (i) Dissipation factor and dielectric constant at 1 KC. (ii) Volume and surface resistivity and electric strength and surface breakdown at room temperature (3) *On Formica.* (i) Dissipation factor and dielectric constant at different frequencies.	Dhar, R. N.	

(ii) Volume and surface resistivity, electric strength and surface breakdown strength at room temperature.

(iii) Dissipation factor at 1 KC after two days' immersion in water.

(iv) Dissipation factor and surface resistivity after exposure to humid atmosphere for different periods (95-98% R.H.).

(v) Surface breakdown after 15 days' exposure to humid atmosphere.

(4) *On Micanite*

(i) Dissipation factor and dielectric constant at 1 KC.

(ii) Volume and surface resistivity, electric strength and surface breakdown strength at room temperature.

(5) *On Vulcanized Fibre Board*

(i) Volume and surface resistivity and electric strength at room temperature.

(ii) Dissipation factor at 1 KC after 3 months' exposure to humid atmosphere (R.H. 95-98%).

(iii) Dissipation factor at 1 KC of above samples after one and two months' exposure to room atmosphere.

(6) *Teflon-Fluon*

(i) Dissipation factor and dielectric constant at 1 KC.

(ii) Volume resistivity and electric strength at room temperature.

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	(7) *On PVC* (i) Dissipation factor at 1 KC after one year's exposure to humid atmosphere (R.H. 95-98%). (ii) Surface breakdown strength and surface resistivity at room temperature. (8) *Polythene Polystrene* (i) Electric strength at room temperature. (ii) Dissipation factor at 1 KC after one year's exposure to humid atmosphere (R.H. 95-98%).		
	Basic Physics Division		
BP/R/1 Investigation of electric and magnetic properties of solids using Mössbauer effect	Mössbauer studies of $SrTiO_3$: Fe^{57} system was undertaken along with the EPR and magnetic susceptibility investigations so as to resolve the discrepancy between the EPR and Mossbauer studies. These studies have conclusively shown that iron enters the lattice substitutionally at Ti^{4+} site in its high-spin ferric state and is usually associated with a charge compensating oxygen vacancy. On firing these samples in hydrogen, the quadrupole split spectrum of Fe^{3+} associated with an oxygen vacancy transforms into a Zeeman split spectrum with hf field and isomer shift characteristic of iron metal indicating the formation of colloidal iron. These colloids exhibit superparamagnetism. Vacuum firing of the original air-fired samples reduces part of the Fe^{3+} ions to Fe^{2+} ions due to the creation of more oxygen vacancies. A series of experiments were performed to detect the various	Date, S. K., Bhasin, H. C., Tambe, B. R. & Bhide, V. G.	BP:8

stages, through which atomically dispersed Fe^{3+} is converted into coloidal iron on hydrogen firing and vice-versa. These series of experiments have shown that hydrogen firing is necessary to produce metal colloids in the lattice and these colloids are formed at and above the temperatures at which lattice starts to reduce. A detailed paper embodying the results has been accepted for publication in the Physical Review.

The Mössbauer study on Al_2O_3:Fe^{57} system has been undertaken in order to determine the charge state of iron ions in the lattice, as the stoichiometry of the lattice is changed by giving variety of heat treatments. The results on the reduction of Fe^{57}:Al_2O_3 system in hydrogen atmosphere indicate the formation of metallic iron clusters yielding characteristic hf split spectra. On firing in air, these clusters are first converted to Fe_2O_3, which subsequently dissolves in the lattice to give normal Fe^{3+} at Al^{3+} sites. Vacuum firing, however, merely tends to stabilize the Fe^{2+} state in addition to the normal Fe^{3+} state. A paper embodying all these results has been accepted for publication to Physical Review. BP:7

To investigate paramagnetic hf effects in Mössbauer spectroscopy, the study on Fe^{57}; SnO_2 has been carried out for three different concentrations of iron and for different temperatures. For low concentration of iron, the hf effects are clearly observed in Mössbauer spectra. With increasing concentration

of these paramagnetic ions, the Mössbauer spectra show usual unrelaxed quadrupole split doublet. The variety of heat treatments of Fe^{3+} in SnO_2 have the same effect on the charge state of iron ions as observed for iron in aluminium oxide. The results are being analysed and prepared for publication.

Electronic properties of Fe and MgO are being studied with Mössbauer effect. This is a specially useful technique for this study, since it allows the observation of microscopic properties, as against bulk properties in other technique. As a result it has been made possible to see iron in paramagnetic, superparamagnetic, ferromagnetic, anti-ferromagnetic states. Thus practically the whole range of magnetic interactions is obtainable for iron in MgO. The phenomenon of radiation induced valence change for iron is also being studied. The reaction $Fe^{2+} \rightarrow Fe^{3+}$ has been observed as a result of irradiation with X-rays. The effect of X-ray irradiation on vacancy associated Fe^{3+} and isolated Fe^{3+} is now under study.

BP/R/2
X-ray
Spectroscopy

The fine structure appearing on the high energy side of X-ray K-absorption edge of yttrium has been investigated using a 400 mm Bent crystal spectrograph. Yttrium metal, in addition to our previously studied complexes of yttrium, has been investigated. The position of the principal K-absorption edge for metallic yttrium is at 726.32 x.u., indicating that it is at a lower energy side than that for

Bhat, N. V., Rambhad, K. R. & Bhide, V. G. BP:5

Y^{3+} ion in aqueous solution and compounds. This is due to the fact that considerable mixing of 4d, 5s and 5p bands takes place. These studies are substantiated by the soft X-ray emission studies of Holiday. The fine structure of X-ray K absorption edge of metallic yttrium has been interpreted in the light of Hayasi's theory. The structure appearing closer to the main edge seems to arise through the collective oscillations of valence (conduction) electrons.

The fine structure for five yttrium compounds, viz. Y_2O_3, YCl_3, $Y(NO_3)_3$, $Y_2(SO_4)_3$ and $Y(OH)_3$ was reported in J. Chem. Phys. 48, Apr. 1968. This structure was analysed using Lytle's theory. The bond lengths have been computed using this analysis.

The comparison of these results with X-ray diffraction data shows that the agreement is indeed fairly good and that the X-ray absorption edge fine structure can be effectively used to calculate the interatomic distances. BP:6

A paper embodying these results is under publication in the Journal of Chemical Physics. The study of X-ray K-absorption edges of second transition series elements was extended to the case of niobium, which is of particular interest, as it can exist in various valence states. A preliminary study of niobium metal and its few compounds showed that the X-ray K-absorption edge shifts to high energy side with increasing valency. The fine structure

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	in the case of potassium and lithium niobate has been studied. An attempt is being made to correlate these studies with the ferro-electric properties of these substances.		
BP/R/5 Study of elementary particles and their interactions *Baryon Mass Splittings in an SU(6) XO(3) quark model (in collaboration with Delhi University)*	A paper, describing the work conducted, has been published.	Katyal, D. L., Bhasin, V. S. & Mitra, A. N.	BP:20
BP/R/6 *Dispersion sum rules for baryon compton scattering*:	Work was completed and a paper has been published.	Vaishya, J. S.	BP:21
BP/R *Super convergence sum rules for the pro-* $\pi + N \rightarrow \rho + N$	Work has been completed. The theoretical results were in agreement with those obtained experimentally.	Vaishya, J. S.	
BP/R/8 *D-Wave Quark-Quark forces and baryon multiplets*:	The energy spectra of baryons and their resonances is examined and d-wave quark-quark forces within the three quark model. The model is an extension of the one proposed earlier by A. N. Mitra. The main results are: (i) A realisation of $\underline{56}$ states of $L^P = O^+, 2^+$ & 4^+ alongwith $\underline{\underline{70}}$ states of $L^P = 1^+$ and 3^+ (ii) The 56 representation of $L^P = 1^-$ and 3 and $\underline{70}$ representation of $L^P = 2^-$. (iii) One gets an energy formula of the type $E_L = \overline{E}$-const x γ_L for the cen-	Katyal, D. L.	

tral mass of a given L^P multiplet, where $\bar{E}$ is the ionisation energy of the quark-diquark system, and is appreciately higher than the corresponding limit with s-wave forces.

A paper has been accepted for publication in Nuovo Cimento.

BP/R/9
Super convergence relations for meson-meson scattering:

Superconvergence sum rules for pseudo scalar-tensor meson elastic scattering have been obtained. It has been found that saturation by low lying one-particle intermediate states, in general, is poor. A paper has been published in Physical Review.

Vaishya, J. S. BP:22

*BP/R/11
Current Algebra, unsubtracted dis-person relations and radiative decays of strange mesons (in collaboration with Delhi University):

Analysing the matrix elements related to the decays $K^+ \to l^+ + \nu - \gamma$ and K^+L $K^+ \to \pi^\circ + l^+ + \nu + \gamma$ under the assumptions of (i) equal-time-computation relations and (ii) unsubtracted dispersion relations, we obtain a Fubini type sum rule between weak K-decay form factors, meson-meson couplings and photo-meson couplings. Because of lack of knowledge about strange axial-vector (Q) couplings, we use partially-conserved-axial-vector-current (PCAC) hypothesis to eliminate such couplings and thereby obtain a sum rule between pseudo-scalar meson decay constants (F F), K-decay form factors $[f_+(0)]$ and VVP and VPγ-couplings. The sum rule obtained is in agreement with the experimental data. A paper has been published in the Physical Review.

Vaishya, J. S. BP:23 & Gupta, K. C.

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*BP/R/12 *S-wave quarks and baryon resonances (in collaboration with Delhi University)*:	An s-wave model of quark-quark forces is examined in details in the context of a three-quark treatment of baryons and their resonance using para-statistics. The model, which is an extension of one proposed recently by one of us (A.N.M.) gives attractive kernals for ($\underline{56}$, even)$^+$ and ($\underline{70}$ (odd)$^-$ states in an [SU(6), L^P] classification, in agreement with Dalitz classification of such states upto the first few L excitations. One also obtained an energy formula of the type $E_L = E - \text{const}\ \eta^{-L}$ ($\eta < 1$) leading to an ionization energy 'E' for a quark-di-quark system. The theoretical and experimental implications of these results are discussed. A paper has been published in Nuclear Physics.	Katyal, D. L. & Mitra, A. N	BP:24
*BP/R/13 *Strong decays of higher baryon in a quark model (in collaboration with Delhi University)*:	An SU(6)×0(3) model of Baryons, which had earlier been used Mitra and Ross for the evaluation of the strong decay widths of negative parity ($\underline{70}$, 1) baryons, is now extended to higher-lying baryonic states assumed to belong to the ($\underline{56}$, 2^+) and ($\underline{70}$, 3^-) representations, as Regge recurrences of the super-multiplet transitions are examined. For the transition ($\underline{56}$, 2^+)→($\underline{56}$, 0^+) the results are in broad agreement with experiment as well as those of $SU(6)_W$ and previous quark-model calculations. For the transition ($\underline{56}$, 2^+)→($\underline{56}$, 2^+) and ($\underline{56}'$, 2^+)→($\underline{70}$, 1^-), appreciable widths are predicted for several experimentally observable states, the first type being geometrically related to $N^* N \pi$ coupling	Katyal, D. L. & Mitra, A. N.	BP:25

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	constant, and the second type being shown to involve a symmetry transition of only one unit (from symmetric to mixed symmetric wave functions). The results are also given for transitions from (70, 3^-) states. A paper has been published in the Physical Review.		
*BP/R/14 *Current algebra, vertex functions and decay widths of K*, Q and ϕ mesons*	On mass-shell current algebra technique has been developed for treating three point functions of currents like $< T [A^a\mu (x), A^i_v (y), (V\lambda^i, (o))] > o$ where $A\mu$ and $V\mu$ are currents of chiral SU(3) × SU(3) algebra. The results have been utilised of Q, K* and ϕ mesons. Energy dependence of Kl_3-decay form factors has also been obtained. A paper has been published in the Physical Review.	Vaishya, J. S. & Gupta, K. C.	BP:26
*BP/R/15 *Structure - dependent axialvector form factors in charged pion radiative decay.*	The structure-dependent axialvector form factor of charged pion radiative decay $\pi^+ \rightarrow l^+ + \nu + \gamma$ recently investigated by Das, Mathur and Okubo in the soft pion limit $q^\pi \rightarrow o$ has been re-examined in the framework of "Hard pion" calculation method of Schnitzer and Weinberg. In this way the explicit energy dependence of the form factor, which may be checked experimentally by studying the detailed energy spectra of photons and leptons, is obtained. The result of the present investigation has been compared with that of the previous authors and also with the present available data. A paper has been published in Physical Review.	Vaishya, J. S.	

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*BP/R/16 *Multiple scattering effect in quark model for non-leptonic decays of hyperons (in collaboration with Delhi University)*:	The non-leptonic hyperon decays have been investigated taking scattering of the emitted meson with the remaining quarks within the baryons into account. While rescattering does not affect S-wave decays appreciably, it helps a great deal in explaining the p-wave decays. The decays are also calculated and the ratio $R=\Omega\rightarrow\Lambda K/\Omega\rightarrow\Xi\pi$ is found to be much better in agreement with experiments than in the impulse approximation. A paper has been submitted for publication in Nuclear Physics.	Katyla D. L., & Ravinder Nath	
*BP/R/17 Current algebra and Ke_4 decay from factor (in collaboration with Delhi University).	Ke_4 decays are considered with the frame-work by SU(3) $\times$ SU(3) algebra. An effort has been made to obtain the momentum dependence of the axial vector form factor involved in these decays. To achieve this, we work with zero mass external pions (p^2, $q^2\rightarrow o$) p and q being the four momenta of the two pions unlike the soft pions (p, $q\rightarrow o$) incorporated in earlier algebra calculations of Ke_4 decays. Further, we use the recently developed on-mass shell three-point functions through our analysis. We also make an estimate of the weak amplitude term involving K and Q meson poles and the scaler term involving the σ meson. In this way, we obtain momentum dependent Ke_4 decay from factors. These are used to calculate the dipion energy spectrum, decay rates and the vector form factor. The fair agreement with the experimental data shows indirectly small s-wave final state inter-actions. Our calculation brings out nearly that the Ke_4	Vaishay, J.S., Dutta, R. & Gupta, K. C.	

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	decay form factors have significant momentum dependence. A paper has been published in Physical Review.		
LT/R/1 Thermal magnetic & transport properties of metals and alloys at low temperatures.	*Study of torsional and young's modulii of thin metallic rods at low temperature.* One platinum resistance thermometer (Capsule type) has been constructed for use in this experiment. The thermometer was calibrated at the steam point and triple point of water. It has now been incorporated in the cryostat for temperature measurement in the study of torsional and young's modulii of thin rods and is on test for its response in the cryostat.	K. D. Baveja	
LT/R/2 Specific heat measurements at low temperatures.	The specific heat apparatus was further improved by removing some glass section and replacing it with metallic one. The system was checked for leaks and a few trial runs were conducted on the apparatus, when some difficulty was experienced in isolating the calorimeter thermally from the bath. Efforts were made to overcome this difficulty. By making slight improvements in the specific heat apparatus the apparatus was found to be working satisfactorily. Measurements on the specimens of Bi, Bi-Sn and Bi-Pb are in progress.	J. S. Dhillon & R. G. Sharma	
	Tests conducted on the copper double-walled evacuated vessels of 5 litres capacity showed that soldering joints on the inner spheres of the vessels cracked after it had been filled with liquid air three or four times. To make the metallic Dewars withstand such thermal shock,	J. S. Dhillon & B. D. Jakhwal	

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	the design of rims of the hemispheres was changed and necessary alterations carried out. The Dewars were then resoldered. The Dewars were evacuated, sealed and tested. The evaporation rate of liquid air was satisfactory keeping in mind that the stainless steel tube used as a neck for the inner sphere of of the Dewar was a little bit too thick, as the thin walled tube of this material was not available in the market. One of these vessels has been sent to the Physics Department of University of Baroda and the other is in regular use in the Division.		
LT/R/3 The de Hass-van Alphen Effect	Main cryostat and glass Dewars were made. As the large electromagnet developed some fault (shorting of coils) and remained idle for over six months, no further progress could be made.	J. S. Dhillon & Y. S. Reddy	
LT/R/4 Theoretical study of fermi surfaces	A 1-dependant potential was constructed and its effects on band-structure are under study.	R. Sundaram.	
LT/R/5 Electrical and thermal conductivities of dilute magnetic alloys and ferrites at low temperatures	The electrical resistance of alloys of copper containing 0·5, 0·3, 0·2 and 0·1 atoms per cent of manganese was measured from liquid air upto room temperature. The electrical magneto-resistance of these rods was measured at a few magnetic fields at liquid helium temperatures. The heat conductivity of copper alloys containing 0·5 and 0·013 atoms per cent manganese was measured at liquid helium temperatures and also in the range of liquid nitrogen and the room temperature. The heat conductivity of a specimen of copper containing 0·4 atoms	M. S. R. Chari & N. S. Natarajan	

per cent of manganese was measured at liquid helium temperatures, at zero field and four other values of the external magnetic field.

The heat conductivity of a specimen of silver containing 0·02 atoms per cent of manganese was measured at liquid helium temperatures at zero field and three other external magnetic fields.

These investigations were undertaken with a view to understand the effect of dilute magnetic impurities on the transport properties of simple metals. Results obtained showed that, in the liquid helium region, the electron mean free path for heat transport is much shorter than that for electrical conduction. Consequently, the Lorenz number drops down significantly below the normal Sommerfeld value. This is attributed to the inelastic scattering of the conduction electrons at the magnetic impurities, whose ground state degeneracy has been lifted by the exchange field.

At temperatures slightly above the resistance minima, the electrical resistivity of these alloys shows a quadratic temperature dependence instead of the usual fifth-power dependence, expected from intra-band phonon scattering. This is reminiscent of the resistivities arising from selectron scattering from d-transition electron paramagnons in nearly ferro-magnetic transition metals like palladium. The paramagnon-induced s-s transitions in the paramagnetic state arise here from the spin-flip part of the s-d exchange interaction.

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LT/R/7 Hall effect and magneto-resistance in iron whiskers and in silicon.	The cryostat for Hall effect and magneto-resistance studies in iron whiskers was assembled. To check its performance preliminary tests were carried out. These studies have been undertaken with a view to understand the low-temperature anomalies in the temperature variation of the 'ordinary' and "extraordinary" Hall coefficients in iron whiskers observed by Dheer (Phys. Rev. **156**, 637,1 967). An apparatus for routine measurements of Hall effect and magneto-resistance of silicon in the temperature range 80°-300°K was set up and measurements of resistivities of samples, supplied by Materials Division, were carried out.	Dheer, P.N. & Chatterjee, H. K.	
LT/R/8 Topology of d-bands in transition metals including s-d Interaction.	The d-wave contribution to the matrix elements of the pseudo-potential was separated. The phase shift was obtained in two different energy regions, one at the resonance energy and the other at energies much larger than the resonance energy. The secular equation was transformed into a form containing s-d hybridization matrix element, d-band width and the hybridization matrix element were estimated for copper and nickel. The calculated values agree fairly well with those obtained from other considerations. Having thus obtained an in-sight into s-d interaction in the non-magnetic case, s-d interaction in the magnetic case has been taken up for study using Greens functions. A course of ten lectures on Green's functions and applications to	R. Sundaram	

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	solid state was delivered in the Basic Physics Division.		
LT/R/9 Magnetic susceptibility measurements	The main cryostat for susceptibility measurements (77° to 320°K) was designed and fabricated. The A.D.L. electromagnet was brought to working condition. A field controller was rigged up and used with the electromagnet. The temperature range was covered by a temperature controller with a stability of (0.1°C).	V. G. Bhide, R. G. Sharma & Y. S. Reddy	
	Measurements were taken on ferric complexes viz. Ferric Benzoate, Ferric Malate, Ferric Formate and Ferric Citrate in the temperature range (77° to 300°K) at seven fields ranging from 3 KOe to 13 KOe.		
	Susceptibility measurements were made on artificially produced isolated-clusters in Al_2O_3: Fe_2O_3 and Al_2O_3: Cr_2O_3 systems at different field strengths (3 KOe to 13 KOe) and different temperaturs (77° to 320°K). The 1/x versus 'T' plot shows negative Weiss constant '0' approaching to zero with dilution. μ^{eff} value in both the systems is found to increase with dilution approaching 'free on value' as expected. A total of more than 30 samples and 10 concentrations for each system were prepared and their susceptibilities were measured.		
	Calculations for evaluating the exchange for interaction term in both the systems are in progress.		
OPT/R/2 Gas discharge studies.	The presence of oscillations in voltage and intensity was detected in a 60-cm long low pressure mercury discharge,	Das, S. R. & Dandawate, V. D.	

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	operated as a ripple free DC. The frequency and the velocity of the positive and negative moving striations were determined. The effect of pressure on these factors is under investigation.		
OPT/R/4 Studies on daylight.	The data collected for Bombay has been obtained and processed. Paper on the typical spectral distribution for tropical daylight has been published in the Journal of the Optical Society of America, while the data on 1961 solar eclipse has been published in the Journal of Planetary and Space Sciences.	Das S. R., Sastri, V. D. P. & Manmohanan, S. B. OPT:22 & 23	
SSP/R/2 Study of high temperature properties of metals.	Recently, there has been much interest in the thermal conductivity of transition metals. The data on cobalt have been badly lacking. Preliminary work data on cobalt rods have been obtained. Some new problems were encountered while measuring the thermal conductivity of cobalt, since resistance of cobalt is more strongly dependent on temperature than that of nickel or other metals. Some further modifications in the Jain and Krishnan Method were introduced to make the method suitable for cobalt. Spectral emissivity measurements are being extended further in the intra-red region. Preliminary work has shown that like tungsten the spectral emissivity of both cobalt and nickel becomes dependent on temperature at two different wavelengths respectively.	Jain, S. C. Verma, N. S.	
SSP/R/3 Study of colour centers in Ionic crystals.	(a) In additively colored highly pure H and 'pure' B Crystals (background impurity concentration <1 ppm and $>$ 10 ppm	Jain, S. C. Mahendru, P. C. Parashar D. C. & Sootha G. D.	

respectively) quenched from 300°C in dark a colloidal band is formed. The peak position (730 μm) and half-width (0·25 eV) of the band do not change with heat treatment in dark in the H crystals. In B crystals the colloidal band has a larger half-width (0·30 eV) and moves to longer wavelengths on heating the crystal to higher temperatures. F band decreased and X band in the H crystals at 700-710 μm and the Scott 'R' band in the B crystals at the same wavelengths are formed on quenching the crystals from 150° to 250°C in light. Most of the X centers and some of the Scott 'R' centers are converted to colloidal centers at 300°C. The colloidal band in H crystals and the composite colloid and 'R' band in B crystals move rapidly to longer wavelengths and increase in half-width on heating the crystals to higher temperatures in light. The shift to longer wavelengths is due to the increase in colloidal particle size in the H crystals heated in light and due to the formation of highly composite centers in the B crystals. A narrow symmetrical ESR line due to colloidal centers superimposed on ESR line due to F centers is observed in crystals containing colloids. The line is Lorentzian in shape, has a half-width of 2·5 gauss and a g value of 1·9998. This value of g agrees with the theoretical value obtained theoretically by Beinenstock and Brooks for potassium metal conduction electrons neglecting "polarization correction" and including the Hartree terms. A rough upper limit of 700 atoms on the size of the colloidal parti-

cles is obtained by the observed symmetrical shape and half-width of the CESR line. The X and the Scott 'R' centers do not give any ESR absorption. In the B crystals only a small fraction of the absorption under the "colloidal band" is found to be due to colloidal particles. Even in the H crystals, a part of the optical absorption under the "colloidal band" is due to residual background impurity present in the crystal. No colloids are formed in crystals containing large concentrations of Ba^{2+} or Cd^{2+}. X band does not influence the electrical conductivity, Scott 'R' band suppresses the conductivity by a large factor and colloids enhance the conductivity at higher temperatures. The results show that the colloidal nature of the centers, investigated by Scott and associates, is essentially correct and contradictory results were obtained by subsequent workers, because it is not possible to understand the effect of light and background impurity on the optical absorption bands by optical measurements alone.

(b) The absorption under the 'M' band in KCl is found to be due to two different centers, designated as M_S and M_H centers. At room temperature, the peak position of the M_S and M_H bands are near 835 and at 820 μm respectively. The M_S band is generated along with the M_H band by bleaching the additively colored crystal by white light for times shorter than 15 minutes and then decays on increasing the time of bleaching, leaving only the M_H band. If

a crystal containing M_H and a large M_S band is heated, the M_S band decays and disappears at 70°C again leaving behind the M_H band, which is stable upto 120°C. The X band is formed at 120°C and increases upto 280°C in optically bleached KCl crystals. The conductivity of the colored crystal is influenced by several factors. The F aggregate centers and colloids act as donors and give rise to excess electronic conductivity. On the other hand, aggregation of cation vacancies with F centers and impurities suppresses the conductivity by a large factory. The plot of the ratio $\sigma c/\sigma n$ (σc is the conductivity of the colored crystal and σn of the identical uncolored crystal) as a function of temperature shows three interesting regions. M_S centers act as donors with an ionization energy of about 1·0 eV in the first region between RT and 100°C and give rise to a large excess electronic conductivity. A peak in the $\sigma c/\sigma n$ vs temperature plot is obtained at 60°C due to this excess conductivity. Appreciable excess conductivity due to M_H centers could not be observed. R and N centers contribute to the conductivity near room temperature. In the second region 150°-300°C, the ratio $\sigma c/\sigma n$ becomes less than unity in crystals containing background or deliberately doped divalent impurity. The effect is more pronounced and the ratio $\sigma c/\sigma n$ becomes very small ($\sim$0.02) if the crystals are optically bleached before or during the heating process. These results are similar to those observed by Ingham

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	and Smoluchowski in irradiated NaCl crystals. It is found that first the F centers combine with the impurity vacancy pairs and thermally stable aggregate of the divalent metal ion, F center and cation vacancy is formed. As the impurity vacancy pairs are used up, equilibrium between the pairs and free vacancies and impurity ions is disturbed and the free cation vacancy and divalent impurity combine to form new impurity vacancy pairs. Both the first and the second reactions are of second order. The energy of activation for the first reaction is ~0.4 eV, it is faster than the second reaction and decay of centers is controlled by this reaction. The activation energy for the second reaction controlling the decrease of conductivity is close to the energy of migration of a cation vacancy. In the third region 300°—500°C, the large excess conductivity is observed, if the crystal contains colloids.		
SSP/R/4 Study of optical electrical and other properties of thin films.	Measurement of electrical resistance has been extended to palladium films in the thickness range 40-100A°. The temperature coefficient of resistance for palladium is found to be positive even for the thinnest films. The measurement of Hall effect for palladium films is in progress.	Jain S. C. & Jain, V. K.	
SSP/R/5 Physical properties of and irradiation effect on ionic crystals and semiconductors.	The peak positions, half-widths and oscillator strengths of Cd (and Zn) bands in KBr and other uncolored alkali halides are given. In uncolored KBr, Cd introduces three optical absorption bands at 202 μm, 215 μm and 280 μm respectively. The new bands, D_1	Jain, S. C. Jain V. K. & Krishan Lal.	

and D_2, at 250 μm and 285 μm respectively are observed in the irradiated KBr:Cd crystals. The growth of absorption coefficients F and M at the peaks of F and M bands respectively was studied as a function of radiation dose. The value of S in the relation $M=S F^2$ is suppressed by a factor 100 in crystals containing more than 20 ppm of Cd. In these crystals M band cannot be produced even by optically bleaching the F band. The second stage growth of the F band is also suppressed considerably by the Cd impurity, which supports the view that the second stage F centers are necessary for the formation of M centers. The D_1 and D_2 bands observed in X irradiated crystals are absent in the additively colored crystals.

In the crystals colored additively at 460°C an ultraviolet band at 330 μm and a band at 750 μm are observed in addition to the F band. The F band can be converted to the 750 μm band by optical or partial thermal bleaching of the crystal. In a crystal colored at 560°C the 750 μm band is absent and only the 330 μm band and a very stable F band are present. On heating the crystals to 600°C, the 330 μm band, F band and 750 μm band disappear and a new band at 300 μm appears. The crystal containing the 300 μm band shows an EPR absorption line with Lorentzian shape and a *g* value of 1·987 and enhanced conductivity above 500°C. These results suggest that the centers responsible for this band are metallic colloidal

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	particles of Cd. The equilibrium concentration of F centers in crystals doped with 28 ppm of Cd and colored additively at 560°C is 20% less than that in a pure crystal. At 560°C the rate of diffusion of F centers in the Cd doped crystals is less by a factor 5, as compared to the rate in a pure crystal and is less by a factor 50, as compared to the rate of diffusion of 330 μm band centers.		
SSP/R/6 Measurement of ultrasonic attenuation, internal friction and elastic constants of metal and alloy single crystals.	(1) Papers on thermoelastic internal friction and thermoelastic stresses of hexagonal group of metals have been prepared.	Dayal, C. R.	
	On the basis of these calculations it is concluded that :—		
	(a) The longitudinal modes exhibit damping and dispersion; while the transverse modes are unmodified and unperturbed.		
	(b) Damping coefficient has a linear temperature dependence and is independent of the thermal conductivity coefficient along the c-axis for a very long cylindrical specimen.		
	(c) The thermal stresses, consisting of two contributing parts, first to ensure satisfaction of the boundary conditions i.e. freedom from mechanical stresses and the second, depends on the spatial and temporal functional dependence of the heat sources and sinks.		

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	(d) Stresses exhibit linear variation on the temperature gradient impressed on the plane surface $z=o$ of the cylinder. (2) Operative finalization of the cryostats for the measurement of elastic constants ultrasonic attenuation in single crystals at liquid air, liquid nitrogen temps. (3) Single crystal growth of low melting point metals.		
X/R/1 X-ray studies of solid solutions and phase transformations in semiconductor materials.	Further work during the year on compositions Bi_4S_3Te and Bi_4S_2Te corresponding to the minerals grunlingite and joseite respectively has revealed these to be mixtures of the phases Bi_2S_3 and Bi. It was expected that under conditions of high pressure and temperature, the single phases of above compositions could be prepared. However, preliminary experiments with the existing high-pressure equipment have not been successful. X-ray work on the single phase $Bi_2S_{1\cdot25}Te_{1\cdot75}$ has been continued and on the basis of photographs from well-crystallised material, the space group has been confirmed as $R\bar{3}m$, with no indication of superlattice formation. In order to find the distribution of the atoms perpendicular to the basal plane of the layer structure, one dimensional Fourier analysis of the 001 amplitudes has been carried out. These were obtained from the basal reflections on a-axis zero level photographs, and the Loreniz, polarization and absorption corrections were applied to the microphotometered	Ali, S. Z, & Kundra, K. D.	

intensities. The relative heights of the peaks due to S (at the origin of unit cell) and Te (at 0·120°C distance from the base) are being interpreted in terms of the possible statistical distributions of S and Te in the layer packed with the sequence Te-Bi-S-Bi-Te. The phase with composition $Bi_2S\ Te_2$ has also been prepared for comparison with $Bi_2S_{1\cdot25}\ Te_{1\cdot75}$, and the accurate lattice parameters are given below:

Composition	a_0 (*A*°)	c_o (*A*°)	*Remarks*
$Bi_2S_{1\cdot25}Te_{1\cdot75}$	4·22	29·52	a_o determined from 30·0, and other high angle reflections by the Straumanis method, and c_0 by extrapolation.
Bi_2STe_2	4·25	29·59	Same as above.

Apart from differences in the lattice parameters, the Seeback co-efficient and electrical conductivity at room temperature for the two compositions also show differences.

X-ray study of In Se. Further work has been carried out on very slowly cooled ingots. Carefully chosen platy blocks from such an ingot were used for density determination. The average experimental value at room temperature is 5·59 g/cc while that calculated on the basis of our previously reported a_o and c_o values and 4 InSe molecules per unit hexagonal cell is 5·453 g/cc. The actual composition is thus not stoichiometric and can be expressed by the formula $In_{1\cdot05}$ Se. The disagreement between the lattice parameters and the space group, determined by other workers, was reported earlier. We regarded our space group $P6_3/mmc$ as tentative and have re-examined the (okt) reflections

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

for systematic absences. Apart from this, microphotometric intensity measurements of the 00l reflections (on a-axis zero level photographs) have been done. The intensity of these and other spots is beset with difficulties due to the plastic deformation and other faults in very soft crystals. However, one or two crystals showing the least deformation were chosen for finding the distribution of the In and Se atoms perpendicular to the basal (cleavage) plane. The 00 l amplitudes, obtained after correction of the intensities for the Lorentz, polarisation and absorption factors, have been used for a one-dimensional Fourier analysis, the signs having been determined on the basis of the special atomic positions in P 6_3/mmc. It has been found that two sets of In and Se positions in this space group give good reliability factors but unacceptably close atomic approach in one or the other place. The final assignment of the space group and re-determination of the signs of the amplitudes of basal reflections (from tilted crystal rotation photographs) is being done. More accurate lattice parameters are also being determined from high angle α_1 α_2 doublets.

RPU/R/3
Satellite Radio Beacon Studies.

(i) Satellite transmission of Explorer-22 and 27 recorded at 20,40 and 41 Mc/s.

(ii) Electron content values for the period Jan. 1967 to June 1967, calculated from S-66 records and sent to NASA for exchange.

Rao, B. C. N. & Tuhiram.

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	(iii) Electron content values for the period June 65 to October 65 calculated from BE-C records and exchanged. (iv) Time lag in the occurrence of Q-T points at two different frequencies explained theoretically on ray theory. (v) Electron content measurements at Delhi have been compared with similar studies at several other stations. Electron production rate has been calculated from BE-C records around sun-rise hours. The results were presented at RTRC symposium at NPL held on 13.9.67.		
RPU/R/4 A Rocket borne Riometer payload for D-region.	Records of the first test flight have been received and are being analysed to yield electron density profiles and electron temperature in D-region. Preliminary circuits for Lyman Alpha and probe experiment are being tested. The second payload at NPL is being modified according to the new circuit finally adopted for the first one. The modified payload is intended to be flown from Thumba.	Rao, B. C. N. & Avadhanalu, M. B.	
RPU/R/6 Riometers.	Cosmic radio noise observations were carried out to study the normal ionospheric absorption and to use as solar flare patrol. Final values of the normal ionospheric absorption at 20 and 30 Ms/s for the years 1964-65 have been obtained and sent to the World Data Centres for exchange of the Data.	Sarma, S. B. S. S., Mitra, A. P., Sharma, M. C. & Juneja, S. L.	

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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 hour-intervals, when the sun is active. It is intended to fun the equipment continuously by turning the antenna always towards the sun, for which a synchronous motor and a proper reduction gear system (which reduces the speed of revolution by 1-5 million times) are needed. The results obtained by this equipment are published every month in Solar and Geophysical Data services.	Rao, M. N. M. & Kushwah, D. S.	
RPU/R/9 Rocket and Satellite Studies of the Ionosphere	Mr. N. R. Mitra, a guest worker from Bhagalpur University, was awarded Ph.D. degree by Banaras University for his thesis on 'Ion Kinetics in the lower Ionosphere' The work is being continued, Some computations have been made with the help of a computer programme about height distribution of Ion Production in the upper atmosphere. An ion composition model for the F-region and the topside ionosphere, during night time, has been constructed with the various available information.	Mitra, A. P., Saha, A. K., Bhatnagar, V. P., Jain, V. C. & Chakrabarty, D. K.	
RPU/R/10 Study of F-layer effects with frequency deviation and phase anomalies (PL-480 Project)	This project has been extended for another three years up to May 1970 with the availability of additional funds. AVLF phase equipment has been received on loan from ESSA and is being put into operation. The dopplometer equipment has been running satisfactorily at the field station of the university of Calcutta. Sudden frequency deviation effects with flares have	Mitra, A. P., Saha, A. K., Subrahmanyam, C. V. & Vashist, A. R. S.	

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	been referred to RPU/S/2 for solar Geophysical Data series publication. Mr. C. V. Subramanyam was awarded Ph.D. Degree by Delhi University. He was partly supported by this project.		
RPU/R/11 Low and VLF Radio Wave Propagation	Recording of integrated atmospheric radio noise at 75 Kc/s is stopped and in its place 236 Kc/s transmission from a Russian station is being recorded. Stabilized H. T. and L. T. supplies are applied to the Marconi and BEL receiver, which resulted in improved constancy of the gain over long periods of time. Raw data is being extracted out of the chart records for further analysis.	Ramanamurthy, Y. V.	
RPU/R/12 Development of Radio Forecasting and service techniques	Charts and instructions for using E layer circuits were prepared on the request of Post & Telegraphs Department Engineers and have been supplied to them. The preparation of a manual for using both E & F layer paths is in progress. Work on major modifications of regular F layer prediction procedures has not progressed satisfactorily mainly due to the absence of adequate staff. Mrs. Aggarwal had been away to USSR for four months during this period. Work on formulating procedure for starting some kind of a short-terms forecasting system has been initiated. The solar flare effects detected by these equipments are being reported in Solar Geophysical Data published by RRC.	Saha, A. K., Aggarwal, S. & Jain, V. C.	

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*RPU/R/15 Satellite Telemetry Receiving System (New Investigation)	Attempts are being made to get on loan some equipment. The aim of this peoject is to receive raw data of measurements made by several satellites through the reception of telemetry signals. The project is of a continuing nature after successful initiation.	Raddy, B. M. & Bhatnagar, V. P.	
CG/R/3 Study of whisker growth in crystals	Whiskers of 'Pure' and 'Spectroscopically pure' cadmium grown in vacuum of the order of 10^{-6}mm Hg and in an inert gas atmosphere were studied. Deliberate introduction of spectroscopically pure tin and lead, as impurities, was tried in some cases. Tin did promote whisker growth, but not through VLS mechanism, whereas lead remained inactive. The direction of growth was mainly observed to be <1210>. Occasionally new directions of high index orientations were detected. All Cd whiskers studied were found to be imperfect. The studies of imperfections were carried out with Laue technique, combined with microfocus X-ray source. It was found that the imperfections varied much along the lengths and sides of the whiskers. Cases were also detected, where the structure of whiskers got drastically simplified towards the tip. Single twist around the growth axis of the whiskers was not found, but curvatures of the planes, inside the whiskers, were commonly observed. They varied from several tenths to several tenths of the centimetre. Even very perfect looking whiskers showed some substructure (splitting of diffraction spots into doublets, mainly in the	Peneva, S. K.	

non-quatorial reflections). It was found experimentally that the apparent simplicity of the equatorial layer spots is not a lattice property, but is due to the geometry of the reflection itself.

The structure of several kinked whiskers was also studied. It was found that change of the growth direction is always correlated with far bigger disturbances in the lattice. Kinking was observed some times as (1) a continuation of the more perfect part of the crystal; (2) as a secondary crystal formation; and (3) as a big concentration of imperfections in particular part of the whiskers body and continuation of the growth in another, more favourable growth direction.

Bigger information about the localisation and character of existing imperfections were found through X-ray studies of annealed whiskers. Comparison of the photographs before and after annealing yielded information about the way different imperfections have moved due to the heat treatment.

A paper entitled "X-ray Investigations on the growth of Cd Whiskers" by Ajit Ram Verma and S. K. Peneva has been accepted for presentation at the Second International Conference of Crystal Growth, Birmingham, England, to be held in July, 1968 and covers part of the experimental results mentioned above.

Detailed calculations on the the geometry of the X-ray diffraction by a stationary crystal, when a point X-ray source is

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	used, were performed. It is a method of finding out the shapes of the diffracting planes through the shapes of their corresponding Laue spots. The paper entitled "Study of Shapes of Diffracting Planes by X-ray Laue Technique" by Krishan Lal and S. K. Peneva has been sent for publication in the Journal of Applied Physics.		
DNPL/R/8 Recoded as CG/R/4 High pressure X-ray apparatus for studying structural transformations	In continuation of the previous report, the less penetrating copper radiation has been replaced by the more penetrating molybdenum radiation. A new film holder to suit our requirements has been designed and fabricated. To facilitate further work on high pressure X-ray studies, a clamping system to clamp the high pressure camera alongwith the film holder, has also been designed and fabricated. This set up enables us to replace the X-ray films conveniently, without disturbing alignment etc. It has been found by calculation that lithium hydride, which is to be used as X-ray window for high pressure work, transmits X-rays to about 85% in the present system and by using a suitable platinum wire collimation the background on the film has been reduced. Further improvements are in progress.	Joginder Singh & Kapoor, Y. M.	
IP/R/1 Micromeritics	Study of electrical resistance of carbon rods was continued. Some experimental studies were carried out on tortuosity function of porous media. A new method to determine monolayer capacities of adsorbates was found. A complete review on the methods of measurement of	John, P. T. & Bohra, J. N.	

particle size of industrial powders was written. A study on Harkins and Jura method for the determination of surface area was made. Proper suspending liquid for $MgCO_3$, ZnS and CdS were determined by experimental methods.

1	2	3	4
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Code No. and Project	*Projects*	*Team*	*Ref.*
1	2	3	4
	(1) Carbon Projects		
IP/PP/1 Development of projector and process-carbons	(a) A few batches were processed for further improvement and other studies regarding consumption, current and light characteristics.	Joglekar, G. D., Kapur, S. K., Verma, C. L. & Mrs. Sundaram Rajeswari	
	(b) Production batches of process carbons were handled. The carbons were extruded and baked and more than 11,000 carbons were sold. The production of the plant was increased with same equipment and man-power by studying the processing units and having TIME M O T I O N STUDIES. The processing and baking wastages were further reduced.	Joglekar, G. D., Kapur, S. K. & Verma, C. L.	
	(c) The study of indigenous raw materials was continued for process carbons and other carbon products. The raw materials supplied by the manufacturers vary considerably and this effects the finished product.	Joglekar, G. D., Kapur, S. K. & Verma, C. L.	
IP/PP/2 Design and fabrication of industrial equipment	The baking capacity of the furnaces was increased further by using bigger containers up to 28 in. and by modifying the design and construction of the furnaces. The stress was laid on reducing the baking time	Joglekar, G. D. & Kapur, S. K.	

1	2	3	4
	without effecting the quality and efficiency of the products to be baked.		
	(2) D.P.E. C. Unit		
DPEC/PP/1&2 Soft Ferrites	The experimental production of medium wave ferrites using manganese is continuing as planned and the limited orders that are accepted are being met regularly. The plant is now producing roughly about 1 tonne per month of ferrite antenna rods and IF cores. Improvements in processes in increasing the Q value without affecting the permeability has been applied for larger batch production.	Ramamurti, T. V., Ganapathy, C. V. & others.	
High Pressure Extrusion Machine	A hydraulic extrusion machine will be in operation very shortly. This will help in achieving the higher pressures required for the above processes especially high densities.		
A process for complex shapes & screw cores	A process has been evolved for complex shapes for making screw cores by using a thermoplastic resin, in which pre-sintered ferrite powder is used as a filler. The thermoplastic resin filled powder can then be moulded into complex shapes in a standdard type of thermoplastic moulding machine. Experiments are being conducted to produce the Japanese type of dumbel core and cup cores by this process.		
	By pre-sintering the ferrite composition at higher temperature and mixing with non-prefired material in a 50:50 ratio, a uniformly finished product with high permeability and good 'Q' are being made. By this method it has been possible to reduce the number of pre-firings.		

1	2	3	4
	Furnace capacity has been doubled.		
DPEC/PP/3 High permeability ferrites (Professional ferrites)	Necessary duplicate sets of floating type of dies and tools, controlled atmosphere furnace with higher capacity have been made. Some essential machines for grinding and lapping have been acquired as well as hydraulic presses of higher capacity. Parts of the tunnel kiln, which was ordered from Germany, has been received and the refractories for the furnace are being procured from local sources. Arrangements are being made for fabricating the metal shell. Two presses of special type, which can be used both for making pot cores as well as TV jokes and deflection coil formers has been ordered and they are expected in the coming year.		
DPEC/PP/4 Hard Ferrites	Small batch production of hard ferrites has been going on and we have supplied 28,040 pieces to various institutions/ industries. During the year two of our licencees, M/s Matchwel Electricals and Elpro International, sent their engineers for training to NPL. Matchwel Electricals have produced successfully oriented magnets in their factory. M/s Elpro International, whose engineer got training only a few months back, have applied for expansion of the capacity of their factory and hope to be in production in a a year as soon as they are given the licence for expansion and necessary foreign exchange for import of essential equipment.	Ramamurti, T. V., Ganapathy, C. V. & others.	
DPEC/PP/5 Machinable Ceramics	Ministry of Home Affairs and the INPL have asked NPL to produce coil formers of different shapes and sizes, which has		

1	2	3	4
	been undertaken and already 292 pcs have been supplied to both. Enquiries have been received from Civil Aviation, AIR and a few other organizations for assembly of Ceramics and these are being studied.		
DPEC/PP/7 Silver Paint and Silver Cement	We have supplied till date 3,200 gms to various organisations.		

Year	*Production*	*Sales*	*Sales Value*	*Royalty Amount @ 2½% of Sales*
(1)	(2)	(3)	(4)	(5)
1. M/s. Bharat Electronics Ltd (Ceramic Capacitors)				
1967-68	32,89,709 Pcs.	33,87,398 Pcs.	6,70,335.26	16,758.38
2. M/s. **Manilal Mohanlal & Co. (Silver Mica)**				
1967-68 (Capacitors)	1,996 Pcs.	1,20,071 Pcs.	33,712.98	842.82
(Plates)	11,33,500 Pcs.	11,04,500 Pcs.	1,21,855.25	3,046.38
3. M/s. Indian Telephone Industries (Silver Mica)	1,00,33,077 Nos.	internally consumed	11,18,924.49	27,973.11
4. M/s. Semi Conductors (Soft Ferrites)	2,16,152 Nos.	1,43,223 Nos.	66,254.87	1,656.37
5. M/s. Morris Electronics (Soft Ferrites)	—	—	8,74,504.00	21,863.00
6. M/s. Caledonian Jute Co. Ltd. Mills (Ceramic Rods for Carbon Resistors)	3,87,450 Pcs.	33,400	5,235.00	130.88
7. M/s. Micro Ceramic Private Ltd. (Ceramic Rods for Carbon Resistors)	3,05,500	2,17,000 Nos.	34,450.00	861.25
8. M/s. Beni Ltd. (Carbon Brushes & Rods)	9,730.575	11,642.475 kgs.	2,28,282.73	7,989.88

DEPARTMENTAL PRODUCTION & SALES

1.	Railway Signal Magnets	1,35,598	2,11,835.02
2.	Porcelain Rods	7,28,774	76,100.60
3.	I. F. Cones & Tubes	1,008	3,644.96
4.	Piezoelectric Bodies		
5.	Ferrite Pot Cones	557	3.342.00
6.	Trimmer Bases	9,65,112	26,868.80
7.	Hard Ferrite (Magnets)	25,109	12,810.40
8.	Process Carbons		

GLASS TECHNOLOGY UNIT

The Unit played a very active part in the various fields of Scientific Glass and Vacuum Techniques. It continued its manifold services to Research & Industry in all the fields of Glass Techniques and Vacuum Techniques. A large number of complicated glass apparatus were fabricated and supplied to the Universities and Research Organisations as well as Medical Institutes and Industry. A few requests from the Defence Establishments were also met for the supply of special apparatus and equipments required by them.

Some of the important apparatus and equipments supplied are listed below:

1. Dewar Flask for liquid nitrogen, air & helium
2. McLoad gauge
3. Vacuostat
4. Mercury filling system for thermometers
5. Double distillation apparatus
6. Continuous and electrically operated coil inside the flask type special distillation apparatus
7. Continuous double distillation apparatus
8. Triple distillation apparatus
9. Mercury pipettes for testing of buytrometers
10. Suspended level viscometers
11. Specific gravity bottles
12. Special quartz apparatus for Material Division
13. Glass electrodes
14. Conductivity cells
15. Homogenizers
16. Automizers
17. Cryostellate for eye operations
18. Micro syringe with micrometer arrangements
19. High vacuum stop cocks of various types of Stalogmeters
20. Standard ground glass joints
21. Sulphur determination apparatus
22. Ghee testing apparatus
23. Glass sprayers
24. Glass to metal seals and vacuum jacketed silvered colomuns, a number of other glass and quartz apparatus such as micropipettes A grade, etc. This Unit have recently fabricated a few more

special equipments like double wall silvered fractionating coloumns for DRL, Kanpur. Micro-hydrogenation equipments for ASRCT, Bangkok (Thailand), sintered separating special funnels for IIT, New Delhi, discharge tube for University of Gorakhpur, Warburg manometer for M.S. University of Baroda, Baroda, conductivity cells, platinum electrodes, etc.

The Unit produced equipments worth Rs. 2.100 lakhs, during the year under review.

We have received three candidates from Thailand under Colombo Plan, who are at present undergoing 3 years' Practical Training course in Scientific Glass and Vacuum Techniques.

Reconditioning of Mercury Arc Glass Rectifiers Bulbs

There is a heavy demand for the reconditioning of glass rectifier bulbs. A large number of rectifiers were reconditioned and put into operation again for the following firms:—

1. M/s Usha Forgings & Stampings, Faridabad.
2. M/s Western Railway, Bombay.
3. M/s Calcutta Electric Supply Co., Calcutta.
4. M/s Calcutta Tramways Co., Calcutta.
5. Speciality Papers Ltd., Vapi.
6. Regional College of Engineering, Srinagar.

We have also fabricated a few new glass rectifiers of small capacity for the following firms:

1. M/s Usha Forgings & Stampings, Faridabad.
2. M/s Universal Electricals Ltd., Calcutta.
3. M/s Jai Engineering Works, Hyderabad.

Following firms have been advised by the Glass Technologist:—

1. M/s Indian Drugs and Pharmaceuticals Ltd.
2. M/s Mohan Breveries, Ghaziabad.
3. M/s Dholpur Glass Works Ltd., Dholpur.
4. M/s Lite Engineering Co., Kanpur.
5. Hi-Tech Ltd., Dholpur.

Special Achievements

We have fabricated an apparatus called 'Cryostellate' for eye operations for Maulana Azad Medical College, New Delhi and it is likely to have a large demand from the medical institutes, as it is understood that this has been found to be very useful by Maulana Azad Medical College, New Delhi for performing cataract operations.

The Unit have accepted a few high voltage water cooled Diode and Triode Valves for reconditioning from M/s Usha Forgings & Stampings, Faridabad.

SERVICE TO INSTITUTIONS/INDUSTRY

Radio & Science Division

Code No. and Problem	*Service/Advice*	*Reference*
1	2	3
RPU/S/1 Regular Ionospheric Soundings and True Heights	Routine round the clock soundings of the ionosphere at 15 min. intervals continued satisfactorily. Routine hourly scale data were provided for radio propagation services (RPU/S/2). Weekly summary data were sent (on request) to interested people in India and abroad. Selected records were specially scaled and reduced to true heights with an electronic computer programme and given to other laboratories on request and for the project RPU/R/4 on satellite radio beacon studies.	Saha, A. K., Venkatachari, R., Jain, V. C. & Chakrabarty, D. K.
RPU/S/2 & RPU/S/3 Solar Geophysical and Propagation Data Services	Being in-charge of the ARWC, this project was responsible for the dissemenation of warnings about solar and geophysical events (being received in the form of geoalerts and URSIGRAMS) to all the scientific and research organisations in India. Radio propagation data services were provided on a regular basis to the radio traffic organisation in India (e.g. AIR, OCS, Defence, P&T) and abroad in the following form: (i) through regular dissemination of basic ionospheric data (RRC-A Series, Part I).	Mitra, A. P., Reddy, B. M., Subrahmanyam, C. V., Jain, V. C., Aggarwal, S., Malhotra, P. L., Deshpande, S. & Mendiratta, R. L.

1	2	3
	(ii) through regular dissemination of solar and geophysical data (RRC-A Series, Part II).	
	(iii) through predictions (6 months in advance) of radio propagation conditions over Asia and part of Europe.	
	(iv) through special predictions of radio propagation conditions for the border area (NEFA and LADAKH).	
	(v) through ATA broadcast at 1500 hrs. I. S. T. daily given after editing the solar geophysical and geomagnetic data received from various observatories in India.	

INSTRUMENTATION & SERVICING

While the servicing of sophisticated instrument from NPL itself and other CSIR laboratories and Medical Institutions continued as the main activity of this section, inquiries concerning Instrumentation—i.e. Instrument application, Instrument specifications for particular uses, Instrument availability of relative merits of Instruments of different makes, showed an upward trend. The inquiries were handled mostly on a personal discussion level and the bulk of inquiries were from Government departments, who look upon us as a "Specialist" facility for a variety of information.

The second article of the series "Instrument Designs—a commentary", consisting of critical comments on the design and performance of four imported instruments—the AVO meter, the vitascope, Ultrasonic Flat Detector and a Flame Photometer was written and is due to be published in "Instruments India". Another article on "Medical Instrumentation and the NPL" is due to appear in the proceedings of "The first Bio-medical Engineering Symposium—India". The illustrated monthly "SPAN" printed a feature article "A Clinic for Ailing Instruments" concerning our Instrumentation activities and as a result there were inquiries from all over the country about specific problems.

Instruments Serviced (of NPL) (45 Instruments)

Power supplies, Oscillograph, Spectrophotometer, Crystal Calibrator, Helium Analyser, Multimeter, Foxboro Timer, *p*H meter, Oscillator, Luxmeter, Tesla Coil, Terra ohm meter, Electronic Temperature Controller Time Switch, Quadrant Electrometer, etc.

Instruments Serviced (From Outside Institutions) (50 Instruments)

Microtome, *p*H meter, Audiometer, Photo-Electric Colorimeter, Flame-photometer, Eye machine, Nefluorometer, Spectronic 20, Micro Astrup, Synoptophore, Microscope, Ultrasonic Flaw Detector, Electrocardiograph, Automatic Muffle Furnace, Sound Lever Meter, Vitascope, Histokinette, Blood Pressure apparatus, Thermohygrograph, Electro-Stimulator, etc.

Instrumentation Problems answered (54)

(a) I S I MEETINGS

S. No.	*Name of the officer*	*Name of the committee*	*Place & date of meeting*
1	2	3	4
1.	Sh. M. K. Das Gupta	Sluice Valves Sub-Committee BDC 3 : 5	Calcutta 12.5.67
2.	Sh. G. D. Joglekar	1. ETDC 11/P2	Bombay 18.9.67
		2. ETDC 11/P6	Bombay 19-9-67
		3. ETDC 11/P7	Bombay 19-9-67
		4. ETDC 11/P-2.11	Bombay 20/21-9-67
		5. Indian Standards Convention	Chandigarh 25/30-9-1967
3.	Sh. K. S. Sharma	1. Electrical Lamps and Accessories Sectional Committee ETDC: 23	Bombay 10/12-8-67
		2. Illuminating Engg. Sectional Committee ETDC: 45	New Delhi 17/19-10-67
4.	Sh. R. K. Tandan	1. Electrotechnical Division Council ETDC	New Delhi 29-2-68
5.	Dr. Ram Parshad & Sh. T. V. Ramamurti	1. Electronic Equipment Sectional Committee ETDC:24	New Delhi 29/30-9-67
6.	Dr. Ram Parshad & Sh. V. N. Sharma	1. Helmets Sub-committee BDC 22:5	New Delhi 14-12-67
7.	Dr. M. Pancholy	1. Acoustics Committee ETDC:27	Delhi 25-7-67
		2. Panel for Hearing Aids ETDC 27:P:4	Bombay 23-10-67
		3. Panel for Tapes & Tape Recorders: ETDC:27:P:5	Bombay 24/25-10-67
		4. Acoustics Sectional Committee	Bombay 26-10-67

1	2	3	4
8.	Dr. A. F. Chhapgar	1. Cinematographic Equipment Sectional Committee	Delhi Nov. 1967
9.	Sh. M. R. Verma	1. Inks & Allied Products CDC:13	Calcutta 24-10-67
10.	Sh. Prem Prakash	1. Dairy Products and Laboratory Apparatus	Secunderabad 28/29-6-67
		2. Screw Threads Tolerances and Gauging Practices Committee	Bangalore 9-8-67
		3. Optical & Mathematical Instrumental Committee	Madras 15-9-67
11.	Dr. Kailash Chandra	1. Cables, wires and waveguides for Telecommunication Equipment Sectional Committee ETDC : 42	New Delhi 22-12-67

(b) MISCELLANEOUS MEETINGS

1.	Sh. G. D. Joglekar	1. Singal & Tele. Comm. Research Sub-Committee	Lucknow 24-8-67
		2. Mechanical & Electrical Engg. Sub-Committee	Lucknow 24-10-67
2.	Sh. Prem Prakash	1. Committee for Amendments to modern Weights & Measures (Enforcement Act)	Calcutta 28/30-9-67
		2. Advisory Committee on National Test House	Calcutta 28/30-9-67
3.	Dr. M. L. Pancholy	1. Advisory Panel of Efficiency of Buildings	Roorkee 15/16-12-67
		2. Auditorium Acoustics Committee of I.I.P., Dehradun	Dehradun 27/28-12-67
4.	Sh. T. V. Ramamurti	1. Working Group of the Electronics Committee	Bombay 24-11-67
5.	Sh. Om Parkash	1. Cell for Design and Development of Instruments	Delhi 11-9-67
6.	Sh. T. D. Bansal	1. Table Glass Blowing Industry—Discussion of	New Delhi 17-1-68
7.	Dr. L. A. Ramdas	1. Indian National Committee for the International Hydrological Decade	Hyderabad 26-12-67
8.	Dr. S. C. Jain	1. Physical Research Committee	Waltair 23/24-2-68

GUEST WORKERS

Sl. No.	*Institution*	*No.*	*Placement Division*
1	2	3	4
1.	Indian Institute of Technology, Kanpur	2 1	Electronics DPEC
2.	Banaras Hindu University, Varanasi	11 2	Electronics Materials
3.	Punjab Engineering College, Chandigarh	4 1 2	Electronics DPEC R.P.U.
4.	M.M.H. College, Ghaziabad	1	Solid State Physics
5.	Delhi College of Engineering, Delhi-6	6 2 1 1	Electronics Workshop DPEC Materials
6.	Jadavpur University, Calcutta	2	Electricity
7.	Madras Institute of Technology, Madras	2 1	Electronics DPEC
8.	Motilal Nehru Regional Engg. College, Allahabad	2 2	Workshop Mechanics
9.	J.K. Institute of Applied Physics, Allahabad	3	Electronics
10.	Thappar Institute of Engg. Technology, Patiala	9 2	Electronics DPEC
11.	Birla Institute of Technology and Science, Pilani	1	Electronics
12.	Women's Polytechnics, Delhi	2	Electronics
13.	M.B.M. College, Jodhpur	1	Electronics
14.	Roorkee University, Roorkee	1	Electron Microscope
15.	All India Institute of Medical Science, New Delhi	1	Electron Microscope
16.	Agra University, Agra	1	Heat
17.	Govt. Polytechnic, Kota	1	Workshop

1	2	3	4
18.	Defence Science Laboratory, Delhi	1	Solid State Physics
19.	Saugar University, Saugar	1 2 2	Library Solid State Physics Optics
20.	Indian Institute of Technology, Delhi	8 7 1	Electronics Materials Electricity
21.	Govt. Polytechnic, Jabalpur	1	Library
22.	Govt. Science College, Jabalpur	1	Library
23.	National Institute of Education, New Delhi	2 4	Materials Basic Physics
24.	Hindustan Steel Ltd., Durgapur	2	Electron Microscope
25.	Deccan College, Poona	1	Acoustics
26.	Madhav Engg. College, Gwalior	1	Materials
27.	Hindu College, Sonepat	1	X-rays
28.	Central Electronic Engineering Research Institute, Pilani	1	Election—Microscope
29.	Agra College, Agra	1	-do-
30.	Central Food and Technological Research Institute, Mysore	1	-do-

NPL LIBRARY

The total number of additions to the Library during the period 1st April, 1967 to 31st March, 1968 was 2341.

The total number of accessioned publications in the Library upto 31st March, 1968 was 60357.

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.

APPOINTMENTS AND PROMOTIONS

Shri R. K. Tandon promoted as Scientist E with effect from 1-1-1966.

Shri O. P. Kulsreshtha promoted as Scientist E with effect from 20-7-1966.

Dr. (Mrs.) S. Z. Ali promoted as Scientist E with effect from 13.2.1968.

PATENTS FILED AND ACCEPTED

1. "Improvements in or relating to the manufacture of Soft Ferrites" by C. V. Ganapathy, S. C. Gupta, G. Govinda Swamy, K. Narayanan and T. V. Ramamurti.
2. "A process for obtaining a machineable ceramic body" by Shiv Saran, S. Rangarajan and T. V. Ramamurti.
3. "Solar Heating device" by Dr. M. L. Khanna and Dr. N. M. Singh.
4. "Dielectric loaded waveguide type broad band-E-plane Ferrite Resonance isolators for microwave frequencies" by Dr. Kailash Chandra, Dr. Ram Parshad and Vijay Kumar Aggarwal.

KRISHNAN MEMORIAL LECTURE

Krishnan Memorial Lecture, "Nuclear Explosions", by Professor D. S. Kothari was delivered in the National Physical Laboratory auditorium on 31st January, 1968.

HONOURS AWARDS

1. Dr. V. G. Bhide has been elected as a Fellow of National Institute of Sciences, India.

2. Sh. D. G. Joglekar was awarded the Fellowship of Indian Standards Institution.

3. Dr. K. N. Mathur was awarded the Fellowship of Indian Standards Institution.

4. Dr. S. R. Das has been elected a Fellow of the Institute of Physics, London.

5. Drs. Kailash Chandra, Ram Parshad and Sh. Vijai Kumar Agarwal have been awarded Rs. 1000.00 by the Invention Promotion Board for the development of the process "Dielectric-loaded waveguide Type Broad Band-E-Plane Ferrite Resonance Isolators for Microwave Applications".

6. C. V. Subramanian was awarded the degree of Ph.D. by the University of Delhi on the thesis "Ionospheric Effects of Solar Flares".

7. V. P. Bhatnagar was awarded the degree of Ph.D. by the University of Delhi on the thesis "Neutral, Electronic and ion composition in the Earth's upper atmosphere for solar minimum condition".

8. G. D. Sootha was awarded the degree of Ph.D. by the University of Delhi on the thesis "Optical, Electrical and ESR Investigations of Colloids and other Colour Centres in pure and doped KCL and LiF Crystals".

9. V. K. Jain was awarded the degree of Ph.D. by the University of Delhi on the thesis "Electrical and Optical properties of Additively Coloured Highly pure and Doped KBr and NaCl Crystals".

10. S. N. Gupta was awarded the degree of Ph.D. by the University of Delhi on the thesis "Symmetry breaking effects in strong interaction process".

11. S. K. Sharma was awarded the degree of Ph.D. by the University of Agra on the thesis "Study of Structural Transformation of Vacuum Evaported Thin Alloy Films by Electron Diffraction".

12. M. V. Joshi was awarded the degree of Ph.D. by the University of Bombay on the thesis "Frequency converting circuits using Transistors".

FOREIGN DEPUTATIONS

DR. A. R. VERMA	Attended the 56th Session of the International Committee of Weights and Measures at France (Paris) from 6th to 16th October, 1967.
DR. S. C. JAIN	Visited U.S.A. from 14-5-67 to 16-7-67 for discussion with authorities at the National Bureau of Standards regarding PL-480 Project and also delivering lectures, etc.
DR. M. S. R. CHARI	Visited West Germany and Holland under the Indo-German Exchange Programme.

CULTURAL AID AND TRAINING PROGRAMME

1. Shri V. P. Wasan: To Canada for training in the field of "Heat and Solid State Physics" under the Colombo Plan.

2. Dr. P. C. Mahendru: To France (Paris) for specialised training under Indo-French Technical Cooperation Agreement.

3. Sh. S. V. Gupta: To France (Paris) for training in the field of Maintenance of Standards of Mass and derivation of various related standards under the Indo-French Technical Cooperation Agreement.

4. Sh. M. M. Bindal: To France & U.K., for training in the field of Moire Fringe Technique to strain analysis under the Indo-French Technical agreement and Agreement between CSIR and British Council for the Exchange of Scientists.

5. Mrs. Santosh Agarwal: To U.S.S.R. for training in the field of Radio Propagation Prediction Systems used in U.S.S.R. particularly short term forecasts on solar and geophysics phenomena under the Indo-USSR Cultural Exchange Programme.

6. Sh. V. K. Batra: To Canada for training in the field of Maintenance and Derivation Electrical Standards (Electricity) under the Columbo Plan.

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

8. Sh. Mustafa Ahmed Sidkey: Researcher from U.A.R. working on Senoluminescence under the agreement for Scientific and Technical Cooperation between India and U.A.R.

9. Sh. Tamas Ungar: Researcher from the Institute for Experimental Physics, Eotvas University, Budapest, Hungary, working on *X-ray Spectroscopic Studies of Metals and Alloys* under the Indo-Hungarian Cultural Exchange Programme.

10. Dr. Fritz Siebert: Working as an Expert in Infra-red Spectroscopy under the agreement with the German Academic Exchange Service.

11. Sh. Songwuthi Kanjanpabou:
12. Sh. Tanu Pangpanich:
13. Sh. Sukhum Punnasata:

} From the Applied Scientific Research Corporation of Thailand are receiving training in the field of Glass Technology under the Colombo Plan.

Training Course

A training course in microwave techniques was organized from 20th March to 24th March 1968. The following universities and colleges participated in this programme :

1. University of Delhi, Delhi.
2. Andhra University, Waltair.
3. M.S. University of Baroda, Baroda.
4. University of Saugar, Saugar, M.P.
5. Birla Institute of Technology and Science, Pilani.
6. Nagpur University, Nagpur.
7. University of Gauhati, Gauhati.
8. Sri Venkateswara University, Tirupati.
9. Ram Narain Ruia College, Bombay.
10. J.V. College, Baraut (Meerut).
11. Kerala University, Cochin.
12. Sardar Patel University, Vallabh Vidyanagar.

These organizations along with many others were supplied complete microwave test benches fabricated at N.P.L.

LECTURES BY VISITING SCIENTISTS

Sl. No.	*Name*	*Institute*	*Subject and Date*
1	2	3	4
1.	Prof. R. A. Gross	Plasma Physics Lab. Columbia University, U.S.A.	Physics of strong shock waves : 6-4-1967
2.	Dr. Ing. Claus Reuber	Fritz-Haber Institute of the Max-Plank-Gassel Shaft, Berlin	Phot ocapacitive properties of II-VI compounds 24-4-1967
3.	Dr. Kochler	Phillips Res. Labs.	Cryogenics 3-5-1967
4.	Dr. P. Greguss	Ultrasonic Res. Lab. Hungary	Ultrasonic Holography 27-5-1967
5.	Dr. S. C. Mathur	Marshall Space Flight Centre, U.S.A.	Conduction Mechanism in Organic-Semi-Conductors 31-5-1967
6.	Mr. R. N. Morse	CSIRO, Australia	Comfort cooling & uses of Solar energy 7-6-1967
7.	Prof. J. Gallaway	University of California, U.S.A.	Localised Defects in Semi-conductors 29-7-1967
8.	Dr. R. A. Slradteng	Oxford University, U.K.	Magnetic Field Effects in Semiconductors 14-8-1967
9.	Dr. R. A. Slradteng	Oxford University, U.K.	Cyclotron Resonance in Ge, Si and III-V compounds 16-8-1967
10.	-do-	-do-	De Haas-Submkov effect in InSb. Low Temp. Magneto-resivkana & Helicon studies of HgTe 17-8-1967

1	2	3	4
11.	-do-	-do-	Resonant Scattering of electrons by optical phonons in GaAs & Cd Te 18-8-1967
12.	Prof. Yash Pal	T.I.F.R., Bombay	i) The primeaval fire ball whisper of the creation of the universe 12, 13 & 14-9-1967 ii) Three research papers 20-9-1967
13.	Dr. D. D. Hughes	Visiting Professor, Indian Institute of Technology, Kanpur	1. Applications of Super Conductivity 19-10-67 2. Materials for Super conductivity Magnets 20-10-1967
14.	Prof. Harry F. Meiuer's	Associate Professor of Physics Rensselaer Polytechnic Institute, Troy, New York	18-11-1967
15.	Dr. W. R. G. Kemp	National Standards Laboratory, Sydney, Australia	Industrial Development of Scientific Instruments in Australia 24-11-1967
16.	Dr. P. N. Tiwari	I.I.T., Delhi	Activation Analysis 5-12-1967
17.	Dr. V. P. Duggal	Delhi University	Quantum Size Effects in Thin Films 6-12-1968
18.	Dr. Govind Behari Lal	Former President of Science Writers Association of the United States, America	Science & Freedom 11-12-1967
19.	Dr. Inderdev	Institute Fur Augewandte Physik Unisity of Korlsruhe	Growth of ZnS Crystals 23-12-67

1	2	3	4
20.	Madam V. V. Zhdanova	Candidate of Physics Mathematical Science, USSR	Thermal expansion of Semi-conductors with Diamond & Zinc-blande Stometeries 12-1-1968
21.	Dr. Alladi Ramakrishnan	Director, Institute of Mathematical Science, Madras	Some of the most recent work on the Dirac Theory, Higher Spin Equations & Feynomon formalion 14-2-1968
22.	Prof. H. Pick	Vice President of the German Science Association	1. Electronic Structure of Natural Hydrogen in Alkalata Halides 27-2-1968 2. Optical Properties & Phonon Scattering of OH in KCI & KBr
23.	Dr. Berkewitz	Head, Coal Research Division of the Research Council of Alberata, Canada	Reaction between carbons & discharge generated excited H-Species 18-3-1968

PAPERS PUBLISHED

A:7 Pancholy, M. and Bindal, V. N., Acoustical Propagation Parameters of Dry Sand, Ind. Jour. Pure & Appld. Physics, **5**, (1967) 295.

A:11 Pancholy, M. and Saksena, T.K., Ultrasonics Relaxation Study of Ionic Dissociation Equilibria in Salts and Complexes, Acoustics, **18**, (1967) 5.

A:12 Pancholy, M., Chhapgar, A.F. and Singal, S.P., Noise Survey, in Calcutta, Jour. sci. & industr. Res., **26**, (1967) 314.

A:13 Pancholy, M., Joga, Rao, H., Chhapgar, A. F., and Davinder Singh, Acoustics of Revindra Bharathi, Hyderabad, Jour. Inst. Engineers, **47**, (1967) 427.

AC:10 Verma, M.R., Trehan, J.C. and Dabas, M.S., Chemical analysis of asbestos cement compositions: Zement Kalk Gips, No. **7** (1967) 302-3.

AC:11 Verma, M.R., Amar, V.K. and Gangopadhyay, N., Volumetric method for the assay of Ferrous Oxalate, Ind. J. Chemistry, **5**, (1967) 581.

AC:12 Verma, M.R. and Gupta, P.K., Colour measurements in products of plant origin: I.S. Convention, Chandigarh, Sept. 1967: DOG S-1/10.

AC:13 Verma, M.R. and Rai, J., Gravimetric and volumetric methods for the determination of fluorides—a re-examination of the problem, Ind. J. Chemistry **9**, (1969) 178.

AC:14 Verma, M.R., Spectrophotometric methods developed in Division of Materials Analysis at NPL, Institution of Metals, Annual Meeting Tatanagar, January, 1968.

AC:15 Verma, M.R. and Rai, J., Paper and thin layer chromatographic methods for the separation and identification of members of gold groups, J. Less Common Metals **15**, 237 (1968).

AC:16 Verma, M.R. and Gupta, P.K., Paper chromatographic method for the separation and identification of Ti, U, Th & Zr. as their thiocyanate complexes, Current Science **37**, (1968) 194.

AC:17 Verma, M. R., Jitendra Rai and Asha Ram, Thin layer chromatographic method for the detection of adulteration of vegetable oils with argemone oil, O.T.A. Bulletin (In press).

AC:18 Bhuchar, V.M. and Kukreja, V.P., Rapid spectrophotometric determination of small amounts of iron in Nickel, Aluminium, Zinc & Copper: Ind. J. Chem., **5**, (1967) 562.

AC:19 Bhuchar, V.M. and Mrs. Padma Narayan, Spectrophotometric determination of copper, nickel and iron in presence of each other and its application to the rapid analysis of cupronickles, Ind. J. Chem. **6**, (1968) 534.

BP:5 Bhide, V.G. and Bhat, N.V., The X-ray K absorption edge of Yttrium in some Yttrium Compounds, J. Chem. Phys. **48**, (1968) 3103.

BP:6 Bhide, V. G. and Bhat, N. V., The Fine Structure X-ray K absorption Spectrum of Yttrium, J. chem. phys. **50**., (1969) 42.

BP:7 Bhide, V.G. and Date, S.K., Mossbauer effect for Fe^{57} in Al_2O_3 effect of variety of heat treatment, Phy. Rev., **172**, (1968) 345.

BP:8 Bhide V.G. and Bhasin, H.C., Mossbaur Study of the $SrTiO_3$; Fe^{57} System, Phy. Rev., **172** (1968) 290.

BP:10 Baveja, K.D., Dynamic Method of Measuring Torsional Modulus of Elasticity, Jour. Scientific Instr., **39**, (1962) 145-147.

BP:10 Baveja, K.D., Dynamic Method of Measuring Young's Modulus of Elasticity, Jour. Scientific Instr., **41**, (1964) 662-665.

BP:10 Natarajan, N.S., Atomic heat of quartz at liquid helium temperatures: Ind. J. Pure & Appl. Physics, **5**, (1967) 372.

BP:10 Chari, M.S.R., The intrinsic electronic thermal resistivity of iron; Seventh Conf. on thermal conductivity, National Bureau of Standards, Gaithersburg, Maryland, Nov. 1967.

BP:11 Chari, M.S.R. and Natarajan, N.S., Fabrication of small wire resistors to be used as thermometers at liquid air temperatures, Thernometry Symposium, NPL 1967.

BP:12 Chari, M.S.R. and Natrajan, N.S., Thermal Conductivity of a poly-crystalline rod of nickel-zinc ferrite at liquid helium temperatures: Nuclear Physics and Solid State, I.I.T. Kanpur, (1967).

BP:13 Chari, M.S.R., The electrical and thermal resistivities of iron: Physica Status Solidi (Germany), **19**, (1967) 169.

BP:14 Natarajan, N.S. and Chari, M.S.R., The anomalous thermal conductivity of dilute silver-manganese alloys at helium temperatures: Phys. Stat. Sol., **21**, (1967) K 127.

BP:15 Chari, M.S.R., Electrical and magneto-resistances of carbon resistors at low temperatures: Ind. J. Pure & Appl. Physics, **5**, (1967) 482.

Elect:12 Yadav, R.S., Parshad, R. and Dube, D.C., Determination of Dielectric Constant of Liquid Air at Microwave Frequencies, Ind. Jour. Pure & App. Phys. **4**, (1966) 428.

Elect:13 Parshad, R. and Mehta, S.C., Effect of Magnetic Field on the V-I Characteristics of Solid State Diodes, Ind. Jour. Pure & App. Phys., **5**, (1967) 23.

Elect:14 Malhotra. G.L., Parshad, R., Verma, B.S., and Sharma, S.K., Fabrication of Tellurium Thin Film Transistor, Ind. Jour. Pure & App. Phys. **5**, (1967) 30.

Elect:17 Parshad, R. and Suri, S.P., A Binary-Quinary Decade Counter Using Resistance Logic, Electron Eng., Dec. (1966).

Elect:19 Parshad, R., Mehta, S.C. and Singh, G., Negative Effect of Magnetic Field on the life-time of Minority Carriers in Solid State Diodes, Ind. Jour. Pure & App. Phys. **5**, (1967) 490.

Elect:20 Parshad, R. and Jain, V.K., Some Simple Transistor Multivibrator Circuit of Constant Frequency Output, Jour. I.T.E., **13**, (1967) 59.

Elect:21 Parshad, R. and Mehta, S.C., Effect of Magnetic Field on the Current Amplification Factor of Junction Transistors., Ind. Jour. Pure & App. Phys. **5**, (1967) 165.

Elect:22 Yadav, R.S. Dube, D.C. and Parshad, R., Investigations on Dielectric Behaviour of Acetone-Chlorform and Diethy ether-chloroform mixtures at Microwave Frequencies, Ind. Jour. Pure & App. Phys. **6**, (1968) 10.

Elect:23 Chandra, K., Parshad, R., and Agarwal, V.K., 'Broadbanding of waveguide junction circulators'. Jour. I.T.E., **13**, (1967) 145.

Elect:24 Jain, P.C. and Chandra, K., Laser and its application, Science Reporter, (1967).

Elect:25 Agarwal, V.K., Chandra, K. and Parshad R., 'Broadband Microwave Ferrite Devices: Isolators and Circulators', Invention Intelligence, **3(1)**, (1967) 4.

Elect:26 Chandra, K., Parshad, R., Kumar, R.C. and Agarwal, R.K., Measurement of impedance at microwave frequencies using directional coupler and adjustable short, Proc. I.E.E.E., **114**, (1967) 1653.

Elect:27 Chandra, K., Parshad, R., and Kumar, R.C., 'Synchronous Operation of reflex klystrons under square wave, pulse and frequency modulation', Jour. I.T.E., **14** (1968).

Elect:28 Bhagyalakshmi, K., Dielectrics—A review, students' journal, **8** (1967) 262.

HP:7 Khanna, M.L. and Singh, N.M., Industrial Solar Drying, Solar Energy, **11**, (1967) 87.

HP:8 Khanna, M.L., Drying of materials with Solar Energy, Chem. age of India, **18**, (1967) 509.

HP:9 Khanna, M.L., Design data for Solar heating of air, using a heat exchange and storage system, Solar Energy, **11**, (1967) 142.

HP:10 Khanna, M.L., Development of prototype solar water heater, Research & Industry, **11**, (1966) 145.

HP:11 Khanna, M.L., Present status of Solar Energy utilisation—A review, Invention Intelligence, **3(4)**, 5-15 (Nov., 1967).

HP:12 Khanna, M.L., The present status of demineralization of saline water, Paper presented at the symposium on 'Problems of Indian Arid Zone', 23rd Nov. to 2nd Dec., 1964. Jodhpur, organised jointly by Ministry of Education and UNESCO, New Delhi.

HP:13 Khanna, M.L., Solar still, 2nd Annual Supplementary Volume, 'Encyclopaedic Dictionary of Physics', Pergemon Press Ltd., London (1967) p. 332-336.

HP:14 Khanna, M.L., Recent developments in use of solar energy, 3rd Annual Supplementary Volume, 'Encyclopaedic Dictionary of Physics' Pergemon Press Ltd., London (1968) p. 375-82.

IP:6 John, P.T., and Sekhon, R.S., Oil extrusion and constant pressure head methods to determine surface area of granular carbon-powders, Carbon, **5** (1967) 281.

IP:7 John., P.T. and Bohra, J.N., A modified equation for pore-volume and area distribution in finely divided and porous-materials. J. Phy. Chem. **71**, (1967) 4041.

IP:8 John, P.T., Significance of particle size in relation to industry. Ind. Chem. Manufacturer, (1967) 19.

IP:9 John, P.T. and Sethon, R.S., Methods of Measuring vapour pressure of water and other liquids. J. sci & industr. Res., **27** (1968) 50.

OPT:5 Das, S.R., Recognition of Signal Colors by a different set of color names, J. Opt. Soc. Am., **56**, (1966), 789.

OPT:8 Joshi, K.C., Sastri, V.D.P. and Parthasarathi, S., Absolute transition probabilities, Oscillator Strengths and Electron Transition Moment for the first Negative System of CO^+, JQSRT, **6**, (1966), 215.

OPT:10 Joshi, K.C., The forbidden bands of $a^1\text{-}\times$ system of N_2, J. Atmos. Terr. Phys., **28**, (1966), 521.

OPT:11 Joshi, K.C., Parthasarathi, S. and V.D.P. Sastri, Vibrational transitional probabilities of the first Positive System of N_2, JQSRT, **6**, (1966) 205.

OPT:12 Parthasarathi, S., Sastri, V.D.P. and Joshi, K.C., Electronic transition moment variation of the CN Violet System, JQSRT, **6**, (1966), 903.

OPT:21 Sen, D. and Puntambekar, P.N., Shearing interferometers for testing corner cubes and right-angle prisms, App. Opt., **5**, (1966), 1009.

OPT:22 Sastri, V.D.P. and Das, S.R., Typical Spectral Distributions and colour for Tropical Daylight, J. Opt. Sec. Am., **58**, (1968), 391-398.

OPT:23 Sastri, V.D.P., Spectral Irradiance and Colour of Sky at Delhi during the Solar Ecplipse on 15 February, 1961, Planet. and Space Sci., **16** (1968) 647.

OPT:24 Ram Parshad, Primary Aberrations of Two Lens Systems of Ramsden Type, Ind. J. Pure & App. Phys., **5**, (1967) 405.

OPT:25 Ram Parshad, Primary Absorations of two-lens systems of Huygenian type, Ind. J. Pure & Appl. Physics **5** (1967).

OPT:26 Gardiner, J, Boynton, R.M. and Das, S.R., J. Super-Summation of Photopic Adapative Effects, etc., J. Opt. Soc. Am., **56**, (1966), 538.

OPT:27 Gardiner, J., Boynton, R.M. and Das, S.R., Interaction between Photopic Mechanisms, J. Opt. Sec. Am., **56**, (1966), 1775.

OPT:28 Boynton, R.M. and Das, S.R., Efficiency resulting from spectrally distributed mixtures of Stimuli, Science, **154**, (1966), 1581.

OPT:29 Sen, D., Double Passed Interferometers, Bull. Opt. Soc. of India, **1(2)**, (1967) 19.

OPT:30 Ram Prasad, Design and development of optical components in India, Indian Manufacturer, 1966 Annual Number, p. 99.

OPT:31 Ram Prasad, Sasta Film Strip Projector, Vigyan Pragati **16**, (1967), 268.

OPT:32 Ram Prasad, NPL's contribution in Rationalisation & Standardisation of optical instruments, Eleventh I.S.I. Convention, Chandigarh, 1967, Dec. S-4/9.

OPT:33 Ram Prasad, Optical Glass Se Lens Nirman, Vigyan Pragati, **16,** (1967) 185.

OPT:34 Ram Prasad, Designing of Optical Instruments, Instruments India, October 1967, **2(10)**, (1967) 17.

OPT:35 Joshi, K.C., The ν and β systems of NS, Zeit. fur Phys. Chem., **56**, (1967) 173.

OPT:36 Joshi, K.C., Relative band strengths and r-centroids for the $B^{13}\Sigma_u - X^1\Sigma_g^+$ system of nitrogen, Nature, **212**, (1966), 1459.

OPT:37 Joshi, K.C., The $C^2\Sigma_u \pm X^2\Sigma^+$ system of $^{15}N_2^+$, Proc. Phys. Soc., **87**, (1966), 561.

OPT:38 Joshi, K.C., Potential Energy Curves for the $C^2\Sigma^+_u$ and $X^2\Sigma_g^+$ states of N_2, JQSRT, **6**, (1966), 211.

OPT:39 Joshi, K.C., The Emission Spectrum of NS molecule, Zeit. fur Phys., **19**, (1966), 126.

RPU:22 Tyagi, Tuhi Ram, Electron content measurements over Delhi from Faraday Fading of satellite explorer 22(S-66) Radio Transmissions, RPU Sci. Report No. 33, May, 1967.

RPU:23 Tyagi, Tuhi Ram, Satellite Beacon Studies of the Ionosphere Over Delhi, RPU Sci. Report No. 34, August, 1967.

RPU:24 Bhatnagar, V.P., Daytime Ion composition in the height range of 150-1500 Km for solar minimum condition, RPU Sci. Report No. 35, August, 1967.

RPU:25 Rao, B.C.N., Effects of East-West Horizontal drifts on the diurnal variation of electron density in the equatorial F-region, RPU Sci. Report. No. 36, August, 1967.

RPU:26 Rao, B.C.N., Electron density distribution in the bottomside F-region of the equatorial ionosphere, RPU Sci. Report No. 37, August, 1967.

RPU:27 Tyagi, Tuhi Ram and Bhatnagar, V.P., Time lag in occurrence of Q-T point of Faraday rotation records at widely spaced frequencies, RPU Sci. Report No. 38, October, 1967.

RPU:28 Tyagi, Tuhi Ram and Mitra, A.P., Some geographic and geophysical aspects of electron content measurements from satellite Radio Beacon Transmissions, RPU Sci. Report No. 39, February, 1968.

RPU:29 Chakrabarty, D.K., Jain, V.C. and Saha, A.K., Height distribution of Ion production function in the upper atmosphere, RPU Sci. Report No. 40, February, 1968.

RPU:30 Mitra, A.P., Space Research in India, RPU Sci. Report No. 41, March, 1968.

RPU:31 Bhatnagar, V.P., Nocturnal Ion composition in the height range of 200-1000 Km. for solar minimum condition-II, RPU Sci. Report No. 42, May, 1968.

RPU:32 Reddy, B.M., Lakshmi, D.R. and Brace, L.H., Response of the 1000 Km ionosphere to magnetic storms, RPU Sci. Report No. 43, June, 1968.

RPU:33 Saha, A.K., Deviative absorption in F. layer, J. Atmosph Terr Phys., **29**, (1967) 1261.

SSP:6 Jain, S.C., Goel, T.C. and Chandra, I. Thermal and electrical conductivities and spectral and total emissivities of nickel at high temperatures, Physics letters **24A**, (1967) 320.

SSP:7 Chandra, Ramesh, Howard, R.E. and Jain, S.C., Electrical Conductivity and Hall Effect in Thin Vanadium Films, J. Appl. Phys., **38**, (1967) 4092.

SSP:8 Chandra, Ramesh, Howard, R.E. and Jain, S.C., Electrical Properties of Thin Titanium Films, Ind. J. Pure & App. Physics, **5**, (1967) 397-400.

SSP:9 Jain, S.C. and Radhakrishna, S., Optical Centers in Alkali Halides, Part I—Electron Excess Centers and Colloidal Centers, J. sci. & industr. Res., **26**, (1967) 283-288.

SSP:10 Jain, S.C. and Radhakrishna, S., Optical Centers in Alkali Halides, Part II—Z-Centers, J. sci. & industr. Res. **26**, (1967) 324-329.

SSP:11 Jain, S.C. and Sootha, G.D., Electrical and Optical Properties of Titanium Doped Lithium Fluoride Crystals, Phys. Stat. Sol., **22**, (1967) 505.

SSP:12 Lal, K., Dielectrical properties of interstitial impurity Cation in Alkali Halide Crystals, Phys. Stat. Sol., **22**, (1967) 141.

SSP:13 Jain, S.C. and Lal K., Study of the Dielectric properties of Cobalt Doped Sodium Chloride Crystals, Proc. Phys. Soc., 92, (1967) 990.

SSP:14 Jain, S.C. and Jain, R.K., Electron paramagnetic resonance absorption and other physical properties of chromium oxide and other crystals containing chromium as impurity. Presented at the International Symposium on Anistropy in Single Crystal Refractory Compounds, Dayton, Ohio, USA, June, 1967 Procs. the Symp. (In Press).

SSP:15 Radha Krishna, S., Relaxation phenomena due to vacancies in the Second Neighbours, Ind. J. Pure and App. Physics, **5**, (1967) 497.

SSP:16 Mahendru, P.C. and Mitra, Ved., A study of F centers and thermo-lumine-scene in Mn Doped KCl Crystals. Presented at the Convention of the Physical Research Committee (CSIR) held on Feb. 21-24, 1968 at Waltair.

SSP:17 Jain, S.C. and Parashar, D.C., Concentration of vacancies in NaCl grown from the melt and from the solution. Presented at the International Conference on Crystal Growth, Boston, Mass, USA, June 20-24, (1966).

SSP:18 Jain, S.C. and Mahendru, P.C., Study of formation of defects in Alkali Halides by Ionising Radiations. Presented at the International Conference on Luminescence, Budapest, Hungary (1966).

SSP:19 Jain, S.C., and Goel, T.C., Thermal conductivity of Metals at High Temperatures. Method I: Nickel, Brit. J. Appl. Phys. (InPerss).

SSP:20 Jain, S.C. and Sootha, G.D., Optical, ESR and electrical studies of colloidal and F Aggregate Centers in highly pure KCL. Crystals. Part I. Colloidal Centers, Phy. Rev., **171** (1968) 1075.

SSP:21 Jain, S.C. and Sootha, G.D., Optical, ESR and electrical studies of colloidal and F Aggregate Centers in highly pure KCl Crystals. Part II. F-Aggregate Centers, Phy. Rev., **171** (1968) 1083.

SSP:22 Jain, S.C., Mahendu, P.C. and Sootha, G.D., Evidence of two types of M. Centers in highly pure KCl Crystals., J. Phys. & Chem. & Solids **29** (1968). 2072-75

SSP:23 Jain, S.C., and Jain, V.K., Optical and Thermal Stability, half widths and oscillator strengths of F-Aggregate Bands in highly pure KBr Crystals, Journal of Physics C (Solid State Physics),, London (In Press).

SSP:24 Mehendru, P.C. and Mitra, Ved., Optical and electrical properties of Mn Doped KCl Crystals, Ind. J. Pure & Appl. Phys., **6** (1968) 350.

SSP:25 Jain, S.C., Sootha, G.D. and Jain, R.K. Optical, ESR and electrical studies of Colored KCl Crystals Doped with Cadmium, Journal of Physics C (Solid State Physics), London. (In Press).

TF:1 Sharma, S.K., Verma, B.S., Prashad, R., and Malhotra. G.L., Heating effects on thin films capacitors, Ind. J. Pure & Appl. Phys., **5**, (1967) 434.

TF:2 Sharma, S.K. and Jain, V.K. The preparation of InSb films, Solid State Electronics, **11**, (1968) 423.

TF:3 Parshad, R., and Sharma, S.K., Physical basis of a mechanism of hysteresis in phase transformations. Ind. J. Pure & Appl. Phys., **6**, (1968) 207.

BP:20 Katyal, D.L., Bhasin, V.S. and Mitra, A.N., Baryon Mass splittings in an SU(6) XO(3) quark Model, Phy. Rev. **161**, (1967) 1546.

BP:21 Vaishya, J.S., Dispersion sum rules for baryon compton scattering, Nuovo Cimento, **51**, (1967) 536.

BP:22 Vaishya, J.S., Superconvergence sum rules for meson-meson scattering, Phy. Rev., **166**, (1968) 1822.

BP:23 Vaishya, J.S., and Gupta, K.C., Current algebra, unsubstracted dispersion relations and radiative decays of strange mesons, Phy. Rev. **165**, (1968) 1996.

BP:24 Mitra, A.N., and Katyal, D.L., S-wave quarks and baryon resonances, Nuclear Physics, **B5**, (1968) 308.

BP:25 Katyal, D.L. and Mitra, A.N., Strong decays of higher baryons in a quark model, Phys. Rev., **169**, No. 5, (1968).

BP:26 Vaishya, J.S., and Gupta, K.C., Current algebra, Vertex functions and decay widths of K, Q and φ mesons, Phy. Rev. **170**, No. **5**, (1968).

BUDGET

Head		*Actual Expenditure (in lakhs)*
Pay of Officers		8.810
Pay of Establishment		13.054
Allowances and Honoraria		13.235
Contingencies		8.602
Maintenance		0.266
Chemical and Apparatus		5.432
Total Recurring		49.399
Capital	7.129	25.240
Pilot Plant	18.114	

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New Committee w.e.f. 14-2-1968

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