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JOURNAL OF WEIGHTS AND MEASURES

40 PAISE

ABBREVIATION FOR METRIC UNITS

(1) DECIMAL MULTIPLES AND SUB-MULTIPLES

Prefix	Value in Terms of Unit	Abbreviation
Kilo	1,000	k
centi	0·01(10^{-2})	c
milli	0·001(10^{-3})	m
micro	0·000 001(10^{-6})	μ

(2) WEIGHTS

Denomination	Value	Abbreviation
tonne	1,000 kg	t
quintal	100 kg	q
kilogram	1 kg	kg
gram	1 g	g
milligram	1 mg	mg
carat	200 mg	c
(3) CAPACITY		
kilolitre	1 000 l	kl
litre	1 l	l
millilitre	1 ml	ml
(4) VOLUME		
cubic metre	m^3	m^3 or cu m*
cubic centimetre	cm^3	cm^3 or cu cm*
cubic millimetre	mm^3	mm^3 or cu mm*
(5) LENGTH		
kilometre	1 000 m	km
metre	1 m	m
centimetre	1 cm	cm
millimetre	1 mm	mm
micron	1/1 000 mm or 10^{-3} mm	μm
(6) AREA		
square kilometre	1 000 000 m^2	km^2 or sq km*
square metre	1 m^2	m^2 or sq m*
square centimetre	1 cm^2	cm^2 or sq cm*
square millimetre	1 mm^2	mm^2 or sq mm*
(7) LAND MEASURE		
are	100 m^2	a
hectare	100 a	ha
centiare	m^2	ca

*Both these abbreviations are current, but the first set should preferably be used. The former abbreviation is used more commonly internationally than the latter.

Rules for Abbreviations :

(1) Do not make any change, such as addition of 's' to indicate plurality *e.g.*, write 1 kg. 10 kg. 20 g.5 g, 10 t, 20 ml, 271, 165 km, 2 mm, 100 cm^3, 66 km^2.

(2) Do not capitalize the abbreviations. For example, do not write 1 Kg, 2 Kg, 20 MM, 50 MM; the right way is to write 1 kg, 2 kg, 20 mm, 50 mm, etc.

(3) Do not use any other abbreviations except those given above.

metric measures

(JOURNAL OF WEIGHTS AND MEASURES)

DIRECTORATE OF WEIGHTS & MEASURES
MINISTRY OF COMMERCE

Vol. 8 JANUARY 1965 (PAUSA 1886) No. 1

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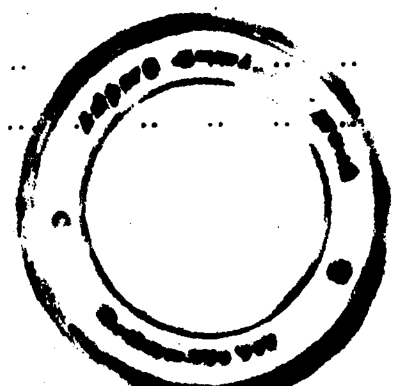

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metric measures

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Ninth Conference of Controllers

THE Ninth Conference of Controllers of Weights and Measures was held in Shillong on 30 and 31 October 1964. Shri V. B. Mainkar, Director of Weights and Measures, Ministry of Commerce, presided. Controllers of Weights and Measures of the States and Union Territories and representatives of the National Physical Laboratory (NPL), Indian Standards Institution (ISI) and Ministries of Commerce, Finance and Information and Broadcasting attended the Conference.

Welcome

Shri G. Sarmah, Controller of Weights and Measures, Government of Assam, welcomed the delegates to the Conference. He indicated the progress made by Assam in the adoption of the metric system and the work done by his Organization.

Passing Condolence Resolution

The Conference passed a resolution of condolence on the passing away of our great Prime Minister, Shri Jawaharlal Nehru and Shri H. C. Dasappa, Union Minister for Industry and Supply. The delegates stood up in silence for two minutes in respect for the memory of the departed souls. The following is the text of the condolence resolution :

'This Conference of Controllers of Weights and Measures would like to record its deepest sorrow at the sad demise of our great Prime Minister, Shri Jawaharlal Nehru who devoted his whole life to the betterment and unity of his country and peace in the world. It was due to his progressive outlook that the formidable reform of the weights and measures of this vast country by the adoption of the metric system was made possible. This Conference, therefore, mourns the passing away of the pioneer whose vision and farsightedness integrated the country in the field of weights and measures'.

'This Conference also records its deep sorrow at the untimely death of Shri H. C. Dasappa, Union Ministry for Industry and Supply'.

Inaugural Speech

Shri Moinul Haque Choudhury, Minister for Agriculture, Government of Assam, extended a hearty welcome to the delegates.

He said that the Chief Minister of Assam was to have inaugurated the Conference, but as the Chief Minister could not return to Assam due to important meetings in Delhi, he was inaugurating the Conference. The Chief Minister, Shri B. P. Chaliha, however, had sent a message to the Conference which he read out. The following is the text of the message :

'I was indeed very glad to learn that the 9th All India Conference of Controllers of Weights and Measures would be held at Shillong this time. I was looking forward for the privilege to associate myself with this Conference. But owing to important State business it has become imperative to delay my departure from Delhi and I cannot return to Shillong in time to attend the Conference for which I am very sorry. I have requested my Colleague, the Minister for Agriculture to convey my apology to the Conference for my absence. Standardisation of weights and measures in a vast country like ours is very necessary, and, I hope, those who are assigned this important work would be able to discharge their responsibility successfully.

I wish the Conference all success'.

The Minister, in his inaugural speech, said that the importance of weights and measures in daily life did not need stressing. Yet till India attained Independence, very little was done to improve the chaotic condition of weights and measures prevalent in the country. He emphasised that the duty of a responsible Government was to see that no false weights or measures were used and that in every transaction the buyer received the correct quantity of goods and the seller received the correct value for his goods. This needed standardisation of the system of weights and system had been introduced in the country according to a phased programme and its use had now become compulsory in almost every field. The success of enforcement had been due to the complete co-operation of the people, the trade and others. He pointed out that it was not so easy to change the mental habits of the people, and he called upon the Conference to consider what further

M. H. Choudhri, Minister for Agriculture, inaugurating Ninth All India Conference of Controllers of Weights and Measures in Shillong on 30 October 1964.

measures which had been done by the adoption of the metric system throughout the country. Earlier misgivings in the minds of people about the change-over had now been allayed by the success achieved in the introduction of the new system. The Standards of Weights and Measures Act, 1956 had laid down a period of 10 years for the change-over. During the last 8 years, the metric steps would be necessary to complete the reform in this respect.

In Assam, considerable progress had been made during the last two and a half years of effective enforcement. As there were no manufacturers of weights and measures in the State, large quantities of weights and measures had to be brought from outside the State to meet the internal demands. Even now, there

was not enough capacity for manufacture in the State. However, weights and measures were being made available to the public at reasonable prices. Publicity had been arranged for the reform. The change-over and the enforcement had been smooth and without opposition from any quarter. There had been no need to enforce the penal sections of the Act.

The picture shows some of the delegates who attended the Ninth Conference of Controllers of Weights and Measures held.

He called upon the Controllers to devise steps to implement the programme within the specified time of 10 years, with a minimum of trouble to the people and enlisting their co-operation as in the past.

President's Remarks

Shri V. B. Mainkar, Director, Weights and Measures, in his presidential remarks at the Inaugural Session said that weights and measures not only touched every activity of man from birth onwards but also were an indication of the progress of a country in the field of science and technology. He pointed out that in the last 8 years, considerable progress had been made in the adoption of the metric system and the use of weights and measures had become compulsory in all commercial transactions. There was a time when doubts were expressed whether the change-over could be effected even in a period of 50 years. The Parliament laid down a period of 10 years, but the people have taken to the new system within 8 years. It had also been earlier thought that the change-over would cost hundreds of crores of rupees. An estimate made by the Directorate of Weights and Measures, Ministry of Commerce, had shown that a little over Rs. 12 crores had been spent on the change-over.

He pointed out that considerable progress had been made in implementing the metric reform. Organisations for the enforcement of weights and measures had been set up in the States. They had been collecting revenues through stamping fees. It was, however, necessary that the progress achieved should be stabilized. Enforcement of weights and measures was a continuous and statutory responsibility for the States. To meet this responsibility, it was necessary that permanent Organisations of Weights and Measures should be set up in the States. They should also be adequately staffed and made self-sufficient by way of finances. For ensuring uniformity of enforcement all over the country, it was necessary that the Centre should continue to co-ordinate the (Enforcement) Acts and Rules of the States.

Concluding, he said that uniformity of weights and measures had been achieved by independent India after over 2000 years. The fruits of this achievement could be ensured in the future only by State enforcement under Central guidance.

The main conclusions and recommendations of the Conference are summarised below.

(1) Progress of Enforcement of Metric Weights and Measures

The campaign to eliminate the use of unauthorised Weights and Measures should be intensified. Whenever necessary, penal action should be taken.

(2) Organisation for Enforcement

The Standards of Weights and Measures Act, 1956, laid down a period of 10 years for the change-over to the metric system. Considerable progress had been made in establishing the new weights and measures in India. It was now necessary to stabilize the progress achieved. Enforcement of weights and measures was a constitutional responsibility of the States. It was, therefore, essential that in the remaining 2 years, Organisations of Weights and Measures in the States and Union Territories should be adequately staffed, put on a permanent basis and made financially self-sufficient.

Early steps should be taken by all States and Union Territories to make the Organisations of Weights and Measures permanent, if they are not already permanent.

By the middle of 1966 they should also be staffed adequately according to the pattern which had been agreed upon in the earlier Conferences. The State Organisations should also become self-sufficient financially by that time.

Enforcement had been suffering in some States due to inadequacy of staff. If the States have to become self-sufficient in respect of revenue by the middle of 1966, it was essential that adequate inspectorial and supervisory staff should be provided. A programme of verification and re-verification of weights, etc. should be undertaken for realising the full revenue.

The present pay scales of Inspectors of Weights and Measures did not attract competent personnel or retain them in service. It was essential that uniform pay scales should be recommended for Inspectors and higher supervisory staff.

It was recommended that the post of Assistant Controller should be gazetted in view of his responsibilities.

(3) Special Types of Balances for Weighing Precious Stones

The Conference agreed with the opinion of Indian Standards Institution that special types of balances for weighing precious stones were not necessary. Balances of Class 'A' and 'B' should be adequate for weighing precious stones.

(4) Publicity

It was felt that publicity for the metric system of weights and measures was by and large quite successful and, therefore, there was now no need to publish conversion tables of weights, length or capacity measures. The emphasis on exhorting people to use such weights and measures only could also be reduced and publicity for this may be limited to newspaper advertisements only. But with the adoption of metric units for temperatures, areas, volume etc., there was need for intensive publicity in these spheres. This had to be conducted through printed literature, cinema slides and newspaper advertisements. To begin with it was decided to produce folders or brochures on the following subjects :

(*a*) The change-over in industries and particularly engineering industry.

(*b*) Commodities were being packed in sealed containers on a rapidly increasing scale. It was necessary to educate the consumer in all aspects of this new trend.

(*c*) The work done by and the functions of the Organisations of Weights and Measures in the States in relation to the common consumer and the benefits he derives from the service rendered by the State.

(*d*) Achievements during the last 4 or 5 years.

(*e*) Balances for trade and non-trade purposes.

(5) Abolition of Commercial Brass Weights Other Than Bullion Weights

After taking into consideration the views expressed, it was agreed that :

(*a*) The ordinary brass weights series should not be abolished.

(*b*) Manufacturers in some States had indicated that it may be difficult for them to produce satisfactory cast iron weights of 20 grams and 50 grams. Taking into account these difficulties, the Controllers would discourage the manufacturers from producing ordinary brass weights of denominations higher than 50 grams.

(6) Marking of Class on Beam Scales

The clause regarding marking of class on beam scales in the Indian Standards Institution specification should be amended to make it clear that the marking should only be in Roman and in no other script.

(7) Precision Laboratories in the States

It was necessary to recommend a standard design for precision laboratories in the States. Madhya Pradesh and Mysore had already prepared plans. The NPL and the Directorate of Weights and Measures should in the first instance examine these plans and suggest additional designs for consideration in the next Conference, if possible.

(8) Spring Balances

(*a*) *Uniform Specifications :* The specification for spring balances would be uniform when all the Weights and Measures (Enforcement) Rules of the States were amended.

(*b*) There was a discrepancy in the marking of capacity as given in the figure and the text of the specification. The Weights and Measures Sectional Committee (EDC : 41) of the ISI should reconcile the discrepancy.

(*c*) *Sale of non-trade and trade balances :* There should be no objection to the sale of non-trade and trade balances from the same premises. The cash memo should, however, indicate that the balance sold was for non-trade purposes. The spring balances should also bear in bold letters the condition that the balance was not for trade use. Non-trade balances should be marked only in metric units.

(*d*) *Pocket spring balance to be non-trade :* All pocket type balances should be treated as 'Not for Trade'. All other balances should be considered as trade types.

(*e*) *Person weighing machines—spring type :* The Indian Standard for Person Weighing Machines may be amended, if necessary, to accommodate the spring type person weighing machines.

(*f*) *Milk Balances for dairy industry :* Salter's planned to produce balances which would be calibrated to indicate directly the volume of milk weighed on them. Before taking up the production of these balances, it was necessary that the ISI should consider the possibility of laying down a standard on the subject.

(9) Inspector's Tools and Equipment

The Directorate of Weights and Measures would circulate lists of all tools and equipment to be supplied to Inspectors.

In future additional lists of tools would be supplied when new items of weights, measures and weighing and measuring instruments were taken up for verification.

(10) Taximeters and Autorikshaw meters

Specifications for taximeters would be included in the Weights and Measures (Enforcement) Rules soon after they are published by the ISI. Specifications for autorikshaw-meters were under consideration by the ISI. Before taking up the verification and inspection of these instruments, it was necessary to consult the transport authorities in the States and to work out the division of duties between the Weights and Measures Organisations and the concerned Transport Authorities in the States.

(11) Tape Measures

At present steel tape measures were not manufactured in India, although their production was likely to be taken up in the near future. There were a number of imported steel tape measures used in trade. It was necessary that they should be continued in use. They might continue in use provided they satisfied the error requirements of the specification.

(12) Weights and Measures Case Reference

It was desirable that summaries of the more important prosecutions launched and the results obtained should be published in *Metric Measures* so that specialised points of law would be brought to the notice of the Inspectors of Weights and Measures and the general public.

(13) Verification of Platform Weighing Machines Having Two Sets of Proportional Weights

A platform machine of the loose weight type should have only one set of proportional weights for use with it.

(14) Quality Control of Weighing and Measuring Instruments

The ISI under their Certification Marks Scheme had instituted a scheme for quality control and inspection of various products during manufacture. The scheme would involve testing of raw materials and sampling inspection of important characteristics at the stage of production. It was likely that the system would assist manufacturers to produce

weights, measures and weighing and measuring instruments which would be acceptable to Inspectors of Weights and Measures all over India. It was, therefore, agreed that the ISI might apply the Certification Marks Scheme to weighing and measuring instruments. As the specifications for weights and measures gave detail of design etc. it was not necessary to apply the Certification Marks Scheme to these products.

(15) Errors for Packages of Infant Food

On the recommendation of the Dairy Industry Sectional Committee (AFDC : 12) of the ISI, it was agreed that the classification of packages for infant food should be as follows :

Packages with net content between 1001 g and 2000 g		± 3 percent
Packages between 501 and 1000 g	..	± 4 percent
Packages up to 500 g	..	± 5 percent

(16) Markings on Woven Metallic Tapes

Woven metallic tapes have to be marked with the letters 'मी' and 'm' at every metre. It was found that after the 9th metre, there was not enough space to accommodate these letters. It was, therefore, agreed that the clause regarding metre marks should be modified as follows :

The metre markings at 1 to 9m shall, in addition, contain the letters 'मी' and 'm'.

(17) Mobile Vans for States

The Delhi Administration had put into service a mobile van which accommodated all the equipment the Inspector had to carry with him for his field work.* (See feature in this issue). It was recommended that similar vans should be put into service by other States. A minimum of one van per Division would be necessary, if it is to prove effective.

*See separate feature in this issue.

Working Standard Balances : Part 5-Other Components

B. R. DHURANDHAR
Saple's Scale Manufacturing Company (P) Ltd.,
Bombay

IN the first four Parts* of this series of articles we have considered the guiding factors in design, principles which had been observed in laying down the general specification, the beam design which would ensure an efficient working standard balance and the factors which influence the proper use and performance of knife-edges. In this Part we shall consider the function of the components of working standard balances other than the beam and the knife-edges.

The other essential components of a good balance, besides the beam and the knife-edges are bearings, pan suspensions, pans, the stand and the case.

Bearings

The knife-edges rest on bearings. The intensity of load per unit length of the bearing or the knife-edge depends upon how much of the total length of the knife-edge is in contact with the bearing. The load is minimum when the full length of the knife-edge is in contact and goes on increasing as the length of the knife-edge in contact with the bearing becomes less and less.

Free oscillations of the beam are very essential to ascertain sensitivity. They are dependent upon the friction between the knife-edges and the bearings. Friction increases with load and also with the intensity of the load. Good contact between the knife-edge and the bearing *i.e.* contact throughout the length, is possible only when the knife-edge and bearings are highly polished resulting in reduction of friction. A finely polished knife-edge on a flat polished plane gives the best combination. However, for the sake of eliminating certain mechanical constructions, a fine edge with grooved bearings is also used.

The fineness of the knife-edge and the high polish of the bearings can continue to remain so, provided both the knife-edges and the bearings are made of materials which are either naturally hard or synthetically hardened or processed hard

Pan Suspensions

The side bearings are housed in pan suspensions from which the pans are hung.

(1) Working Standard Balances : Part 1—Guiding Factors in Design—*Metric Measures*, Vol. 4, No. 3, pp. 3—6, 1961.
(2) Working Standard Balances : Part 2—General Specifications—*Metric Measures*, Vol. 5, No. 5, pp. 3—8, 1962.
(3) Working Standard Balances : Part 3—Beam Design—*Metric Measures*, Vol. 6, No. 4, pp. 10—14, 1963.
(4) Working Standard Balances : Part 4—Knife edges—*Metric Measures*, Vol. 7, No. 2, pp. 13—15, 1964.

The suspensions are designed in such a way that they oscillate freely over the side knife-edges and do not obstruct the free oscillations of the beam. They are also rigid so that they are not strained under the load in the pans. Such straining alters their shape which may affect the friction between the knife-edges and the bearings.

Pans

Pans are designed so that they accommodate weights equivalent to the full load. For instance, in the case of the 50 kg working standard balance the pans of the balance should allow a cast iron weight of 50 kg to be placed with ease. The size of the pans is limited by the distance between the end knife-edge and the stand. The chains and stirrups of the pans are fitted in such a manner that they allow easy placement of the weights on the pans. They should be sufficiently strong so that they do not give way under the load or get lengthened in use.

Stand

The central bearing on which the fulcrum rests has to carry loads equivalent to the sum of the loads in each pan. Its length is, therefore, more than the lengths of the end bearings. In fact it is designed to carry double the maximum load. The central bearing is supported by means of a housing fitted either in a fork in a portable balance or on the stand in case of the pillar stand type (indoor) balance. Both the fork and the pillar stand are so designed that hey do not get strained under this load. In fact, the stability of the whole balance depends upon a good design of the stand. The stand also incorporates the additional mechanism for raising and arresting of the beam and suspensions when they are not in use. The rigidity of the stand is of primary importance in the smooth working of this arresting mechanism, which has to repeat the operation of raising and arresting the beam without causing a shift of the rest point.

Arresting Mechanism

Another mechanism incorporated in a good balance is for pan arresting. This is important as free oscillation of the beam depends upon the arrestment of the independent swinging of the pans. The pan arresting mechanism helps in steadying them before the beam is set into oscillations.

Cases

A balance will not last long if it is not protected from dust and corrosive atmosphere. Well chosen materials for the protective cases preserve the balance in good condition. Various materials like timber, aluminium, glass are being used. The use of large cases for all 50 kg and 5 kg is not possible due to transport difficulties.

Levelling

An important fitting in a good balance is the provision for levelling it. This is achieved by levelling screws. Geometrically, three points determine a plane and, therefore, two levelling screws and a third fixed point are fitted in every balance to level it. The exact position to determine the level of a balance is to check it on the central plane by means of precision levelling bottles. As the surfaces of other fittings in the stand of the balance are also on this central plane, a spirit level or a plumb bob is fitted elsewhere on the stand. The proper oscillations of a beam round its predetermined position of equilibrium *i.e.* central zero mark on the sector plate, are only possible provided the central plane lies in a perfect horizontal plane.

A balance does not carry any superfluous parts. To make it look graceful, the proportions of the sizes of beam, pans standard are the carefully worked out.

In the next two Parts, which will conclude series, we shall consider the assembly and maintenance of working standard balances.

● ● ●

News & Views

Metric System for East Africa

The Governments of Kenya, Uganda and the United Republic of Tanganyika are considering the desirability of introducing into East Africa the metric system of weights and measures. A Commission has been set up under the chairmanship of Shri P. N. Nayer, Director of Weights and Measures, Ministry of Commerce, Government of India, whose services have been made available for the purpose by the Government of India. Shri Nayer is expected to visit capital cities and principal centres for a preliminary survey of the situation.

A questionnaire, designed to elicit information and opinion on the subject from Government Departments, public undertakings, trade, industry, public, information departments, universities, chambers of commerce, oil companies etc. has been recently circulated.

The Commission will consider whether the adoption of the metric system in East Africa is feasible in terms of the advantages to be derived therefrom, having in mind the material resources available and the probable cost of the exercise, and, if it is feasible, how the introduction should be effected in a phased programme, what legislative action will be required and how the public is to be familiarized with the new system. The implications for governments and public services will receive special consideration.

Comparators for Large Weights Calibration

The National Bureau of Standards, U.S.A., has developed techniques to compare 10,000 lb weights with a load cell to a precision of 5 parts per million. Large weights find wide application in the calibration of devices used to measure the thrust of large missile and rocket engines. Periodically these weights have to be calibrated which means that the equipment is out of services while it is sent to the National Bureau of Standards and back. Of the many techniques, the load-cell elastic device proves satisfactory. It offers the advantages of precision equal to the best of platform scales, portability, rapidity of weighing, availability of equipment and elimination of the need to have all weights calibrated by the NBS.

Elastic devices have long been used as direct-reading instruments, and as such have been widely employed for the measurement of large weights and forces. As direct-reading devices, however, they have not provided the accuracy required for the calibration of weights. Almost any direct-reading device will give increased precision when used as a comparator. By taking advantage of this fact, the NBS has been able to use the load cell to compare large weights with precisions attainable previously only with the best of platform scales. These results are probably not unique to the load cell—it is fully expected that when proving rings are used as comparators similar results will be achieved.

I.O.L.M. New Headquarters

The staff of the International Bureau of Legal Metrology have recently moved to new eadquarters near to Montmartre, Paris, nto premises which were acquired and equipped at a cost of something like £50,000 and whose value appreciated by over 33 per cent within three months of acquisition.

The accommodation comprises a conference room, Director's office, two offices for the Deputies, and secretarial, typists, archivists, and reception rooms.

The establishment at the new headquarters from October, 1964 will consist of the Director, (M. Costamagna), 2 Deputies, (M. J. Jaznorzewski and Mr. E.W. Allwright,) the Secretary, two archivists and clerical and office staff.

(From *The Monthly Review*, July 1964, p. 164).

I.O.L.M. Honorary Membership

The International Committee of Legal Metrology recently decided to recognize the outstanding service to the Organisation of some of its former members by granting them Honorary Membership. The following have been so honoured :

Monseur M. Jacob, Belgium, formerly Head of the Belgian Services and President of the Committee.

Herrn R. Vieweg, German Federal Republic, formerly President of the International Committee of Weights and Measures, and a Member of the Presidential Council of I.O.L.M.

(From *The Monthly Review*, July 1964, p. 164).

Dr. Verman Honoured

Dr. Lal C. Verman, Director, Indian Standards Institution and Honorary Adviser on Standardization to the Government of India, has been awarded the LEO B. MOORE AWARD by the Standards Engineers Society of America, for his extraordinary contribution and distinguished service in the field of standardization, its professional advancement through original research and writing, and creative publications and development.

The Award instituted by the Standards Engineers Society last year after Professor Leo B. Moore, a Fellow of the Society, is given for outstanding contribution in the field of standardization and its advancement through creative application.

The first Award was given last year to Mr. Robert S. McNamara, Defence Secretary to the United States of America. Dr. Verman is the Second recipient of the award, which gives recognition, at international level to the services rendered by him in the field of scientific advancement and industrial standardization for the welfare of the society at large; and for initiation, development and furtherence of standards movement in India through standardization at national level.

The Award was formally presented to Dr. Verman on the occasion of the Sixth Triennial General Assembly of the International Organisation for Standardization (ISO) which was inaugurated in New Delhi on 9 November 1964 by the Vice-President of India, Dr. Zakir Husain.

Metric System in UK

In a paper presented to the engineering section of the 29th Annual Meeting of the British Association for the Advancement of Science—Mr. C. A. J. Martin, Crompton Parkinson Ltd., spoke on the metric system issue for manufacturers. The following extract taken from the *BSI News*, October 1964 would be of interest to our readers.

Reflecting the view of manufacturing industries, Mr. C. A. J. Martin recalled that he had the privilege of being chairman of the committee appointed by the Association of British Chambers of Commerce which, jointly with a committee of the British Association, had produced a report on the metric system

in 1960 (this included a definite recommendation that the UK should change to decimal coinage—a recommendation since endorsed by the Government.) He stated that the biggest change that appeared to have come over the country since that joint report was that most of industry now felt the UK should no longer wait for the USA before coming to a decision on the metric issue.

Mr. Martin went on to say that the change in our world position—where we stood in world external trade—presented us as never before with the need to reach a decision on whether to retain our traditional but illogical inch-lb system or change to the logical decimal metric system now in major world usage.

He quoted figures to show that, between 1960 and 1963 UK exports to Commonwealth countries had fallen from 38 per cent to 30 per cent of our total exports, whereas to the (metric) EEC and EFTA countries of western Europe they had risen from 27 per cent to 33 per cent and for the rest of the metric countries from 22 per cent to 24 per cent. Significantly too, the six EEC (metric) countries alone now held 29 per cent of world external trade at £13,68 million against 19 per cent for the UK and sterling (inch/lb) area at £9,000 million.

The problem is probably of greatest magnitude in engineering manufacturing but equally, and indeed consequently, the advantages to be gained may well prove greatest in this sphere, said Mr. Martin. 'Time is not on our side : the longer we delay in reaching a conclusion the greater the complexity and cost. Thus the responsibility rests on influential bodies to reach their own conclusion and make their voice unmistakably heard for or against a change'.

Change in Units of Quotation in Oilseeds and Oils

The recognised associations trading in Oilseeds and Oils at Bombay, Ahmedabad Sangli, Delhi and Akola have changed their units of quotations for groundnut hedge contract for 250 kg to 100 kg and in the case of oils from 'tin' to 10 kg in deference to the advice of the commission to switch over to uniform and rational units from the current year. (From *Forward Markets Bulletin.*)

NINTH CONFERENCE OF CONTROLLERS OF WEIGHTS & MEASURES HELD IN SHILLONG ON 30 & 31 OCTOBER 1964.

Sitting :—Left to right—(1) Mr. P. G. Bryden, (2) Shri U. R. Panicker, (Controller, L.M.A. Islands), (3) Shri M. V. Patankar, (Dy. Director, ISI), (4) Shri K. N. Mathur, (Controller, Rajasthan), (5) Shri A. A. J. Gomez, (Mint Master, Bombay), (6) Shri V. M. Pednekar (Deputy Controller, Maharashtra), (7) Shri Ramavarma, (Kachappan) Thampuran, (Controller, Kerala), (8) Shri Prem Prakash, (Asstt. Director, NPL), (9) Shri V. B. Mainkar (Director, Weights & Measures, Ministry of Commerce), (10) Shri N. Rajagopal, (Controller, Uttar Pradesh), (11) Shri Badrinath, (Deputy Secretary, Madras), (12) Shri G. Sarmah, (Controller, Assam), (13) Shri V. N. Singh, (Controller, Bihar), (14) S. N. Sihno, (Controller, Madhya Pradesh), (15) Shri S. Banerjee, (Controller, West Bengal), (16) Shri R. N. Dwivedi, (Controller, Orissa).

Standing :—Right to left—(1) Shri H. L. Mehandru, (Controller, Delhi), (2) Shri K. Venkateswaran, (Deputy Director, Ministry of Commerce), (3) Shri A. K. Mukhapadhya, (4) Shri J. S. Bakshi, (Directorate of Weights & Measures), (5) Shri R. N. Hazarika, (Special Officer, Publicity, Assam), (6) Shri Ch. Pratap Singh, (Controller, Manipur), (7) Shri Chandra Kant, (Asstt. Controller, Madhya Pradesh), (9) Shri S. P. Bagwari, (Asstt. Controller, U.P.), (10) Shri Joginder Singh, (Controller, Punjab), (12) Shri S. N. Mehta, (Deputy Controller, Gujerat), (13) Shri Om Prakash Shokeen, (Asstt. Director, Ministry of Commerce), (14) Shri G. Venkateswaran, (Asstt. Director, Ministry of Commerce), (15) Shri J. Ray, (Assistant Director, Ministry of Commerce), (16) Shri P. K. Pathak, (Inspector, Assam), (17) Shri D. R. Saikia, (Assistant Controller, Assam).

Mobile Laboratory & Office of Weights & Measures

THE Weights and Measures Organisation in Delhi, which works under the Director of Industries, Delhi, has put into service a Mobile Laboratory and Office of Weights and Measures. The mobile unit consists of three sections. The first section accommodates the driver and two more persons, the second accommodates 4 officers while the laboratory is located in the rear portion of the van.

The van is taken to the market where the verification of weights, measures, etc. is to be carried out. The traders in the area are given intimation to produce their weights and measures for verification to the mobile laboratory on a specified day. The Inspector and his staff in the mobile unit can then set up the laboratory inside the van and verify the weights and measures and return them to the traders with verification certificates.

Cost of Mobile Unit

The laboratory-office is built on a 5-tonne Bedford Chassis. The body is made of steel. The particulars of the van are as given below:

Chassis	Chassis dual rear with Cowl & Windshield Parkins. P6-Diesel Engine and six-B 25×20-12 Plytyres and tubes.
(*i*) Cost of Chassis	Rs. 26,477·00
(*ii*) Transport Charges from Howrah.	Rs. 780·00
(*iii*) Cost of Body	Rs. 11,700·00
Total	Rs. 38,957·00

Thus the total cost of the laboratory-office is less than Rs. 40,000.

Description

The driver's and officers' compartments are fitted with full size doors on either side. The seats are covered with air-foam cushions. The laboratory compartment opens from the rear and has two aluminium framed half-sliding windows on either side. It contains two boxes of teakwood for keeping weights, scales, measures and other equipment besides the office stationery, forms and records. A water tank of stainless steel and wash basin is also fitted in the laboratory compartment. A tubular luggage carrier connected with a steel ladder is also provided on the van. The laboratory is equipped with the following furniture, working standard weights and measures, test weights, equipment etc.

(1) Chairs folding steel	4
(2) Duree	1
(3) Locks	3
(4) Working Standard Balance 50 kg with stand	1
(5) Working Standard Balance 5 kg with stand	1
(6) Working Standard Balance 200 g	1
(7) Working Standard Metre	1
(8) Working Standard Weights 20 kg to 1 mg.	1 set
(9) Working Standard Capacity Measures 10 litres to 20 ml	1 set
(10) Test Weights 50 kg	10
(11) Test Weights 20 kg	12
(12) Test Weights 10 kg	2
(13) Test Weights 5 kg	2
(14) Test Weights 2 kg	2
(15) Test Weights 1 kg	2
(16) Test Weights 500 g	2
(17) Test Weights 200 g	2
(18) Test Weights 100 g	2
(19) Bench	1
(20) Spirit Level	1
(21) Brush	1

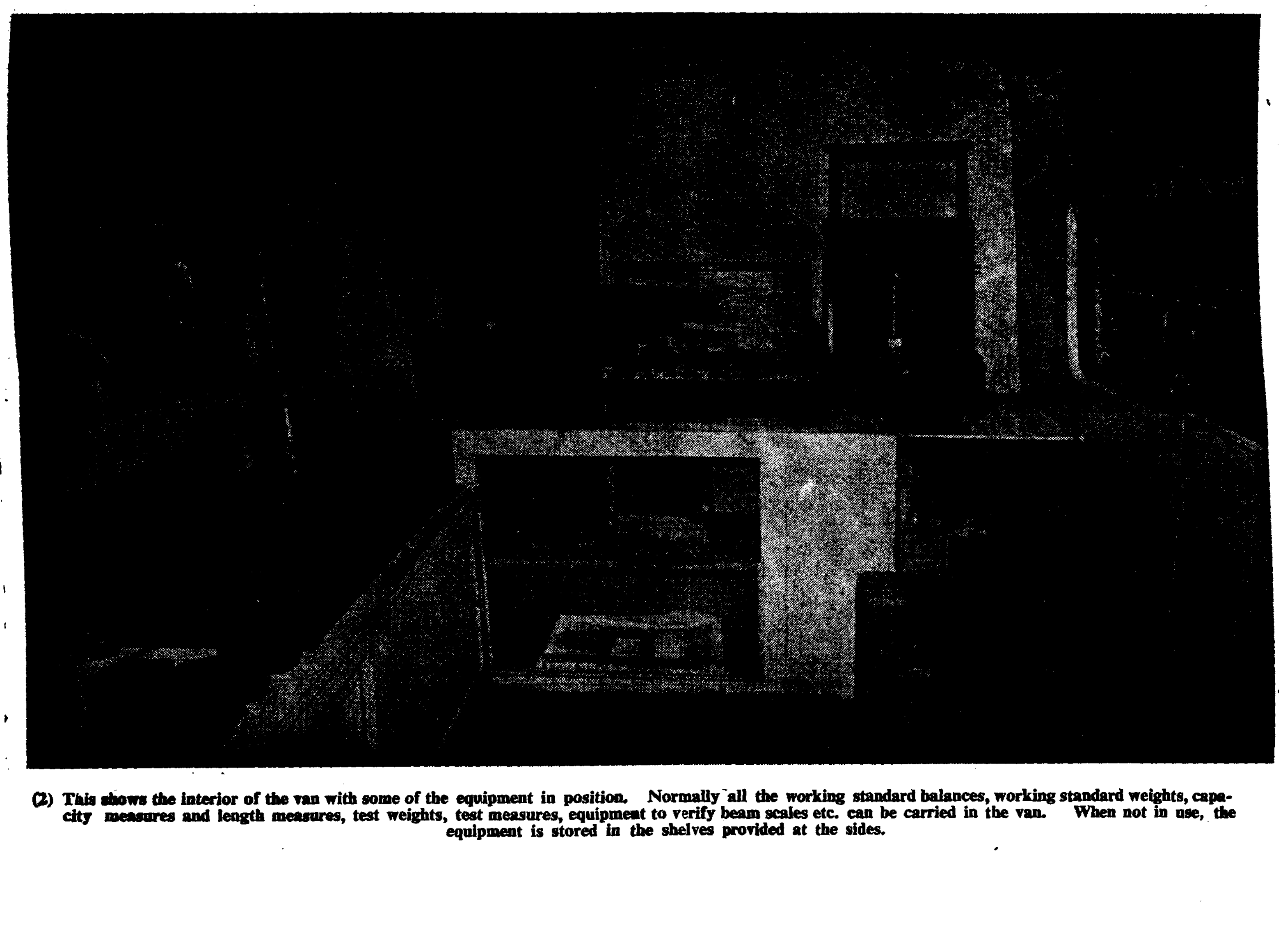
The total expenditure on the van and the equipment is about Rs. 49,000.

Mobile Unit Simplifies Work

Experience has shown that the mobile laboratory-office simplifies the work of the Inspector. He does not have to carry heavy and costly equipment from place to place by bus, train or other transport. This minimises considerably the wear and tear of equipment. What is more, it takes the work of the Weights and Measures Organisation almost to the doorstep of the users of weights and measures. It can also be used for census, inspections and other similar work.

In view of the utility of the van, the Ninth Conference of Controllers recommended that every State should provide at least one such mobile laboratory-office unit per division for the use of the Weights and Measures Organisation.

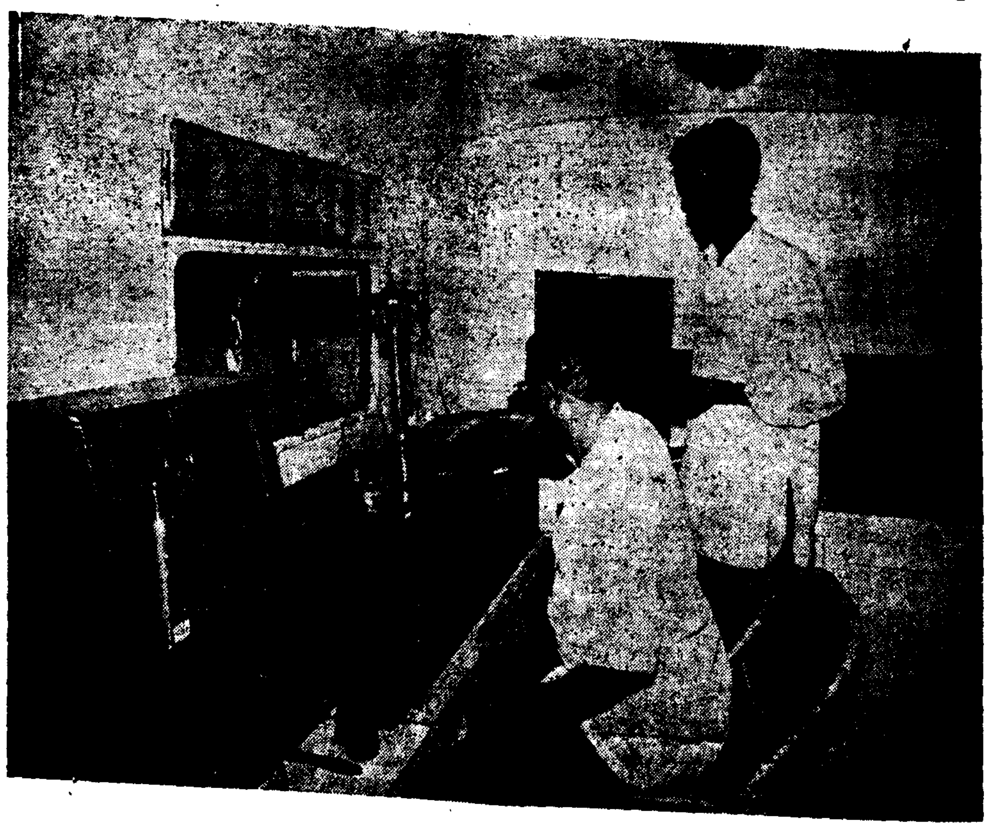
(1) The Delhi Weights and Measures Organisation has put into service a mobile laboratory-office unit for weights and measures. The picture above shows the unit. The driver's compartment can accommodate two persons besides the driver. In the central compartment there is accommodation for four more persons. The third and largest compartment houses the laboratory and has an entrance at the rear of the van.



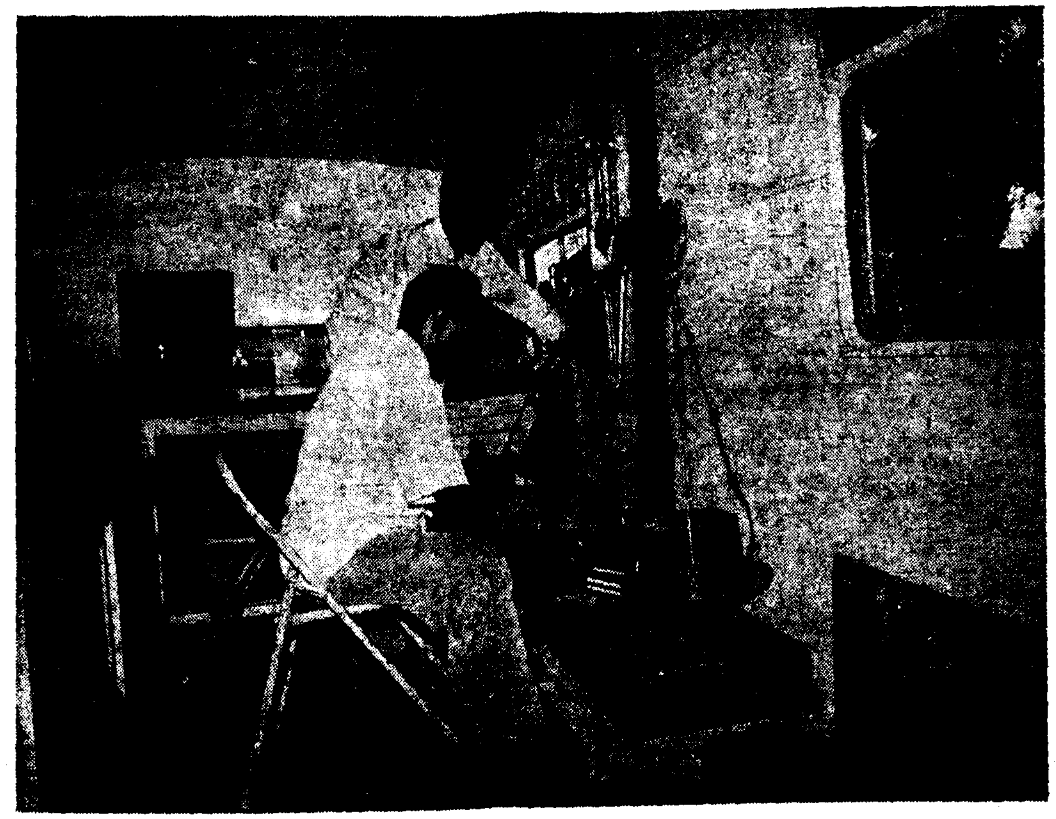
(2) This shows the interior of the van with some of the equipment in position. Normally all the working standard balances, working standard weights, capacity measures and length measures, test weights, test measures, equipment to verify beam scales etc. can be carried in the van. When not in use, the equipment is stored in the shelves provided at the sides.

(3) This shows the left hand side of the laboratory portion of the van. The Inspector of Weights and Measures is seen getting ready to verify cast iron weights. The arrangements for the verification of small beam scales and the working standard length measure can also be seen in the foreground. The sliding shelves can accommodate all the equipment, stationery and publicity literature etc.

(4) The Inspector is shown using the 5 kg working standard balance for verification of weights.

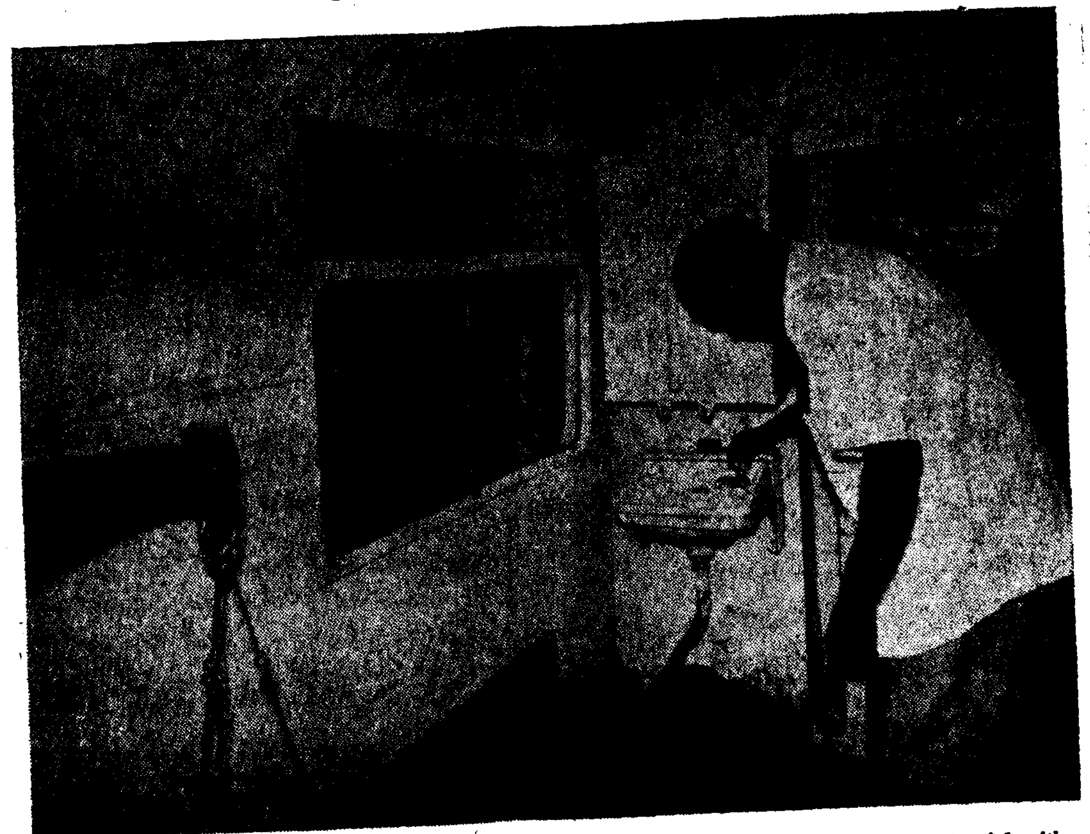


(5) Two Inspectors can work with ease in the laboratory compartment at the same time. Picture shows an Inspector verifying weights on a 5 kg balance and another Inspector and the Manual Assistant preparing to counterpoise a cast iron weight against the working standard weight.



(6) This picture shows the Inspector verifying heavy cast iron weights inside the mobile laboratory.

(9) Here the Inspector is seen comparing a commercial metre length measure with the working standard length measure inside the mobile laboratory.



(10) The laboratory is also fitted with a stainless steel tank which can be filled with water and a sink with a tap. The water can also be used for the verification of commercial capacity measures.

(11) The van carries a timber tripod which can be used for the verification of heavy capacity beam scales. For verification of these beam scales, it is necessary to set up this tripod at a suitable place outside the van. Test weights and working standard weights are used for checking up the accuracy of the beam.

Readers' Forum

Application of Metric Weights & Measures

Dear Sir,

Recently when dealing with figures, it occurred to me that there is an anomaly existing in the field of application of metric system of weights and measures in India.

I feel it is a matter for serious thought.

I came across the 'dozen' and the 'gross' in course of my work and that started me thinking. These quantities and names continue to be in use and practice. It would be clear at once how these quantities (12 and 144) hamper the decimal system. They need to be removed immediately. Many of the commercial houses, big and small, still use this nomenclature which has escaped notice. The 'dozen' and the 'gross' should be immediately removed by law and replaced by '10' and '100'.

I came across the old measure and term of 'cc' for fluids in commercial transactions. This also set me thinking. The 'litre' and the 'ml' are the official legal measures for fluids. The use of 'cc' for fluids under the new law and system does not seem correct.

The 'dozen' and the 'gross' hamper the decimal system. Their use is against the principles of metric system. Their use needs to be stopped.

The use of the term 'cc' causes chaos giving rise to two systems of nomenclature for fluids. The use of 'cc' should be stopped by law and the use of 'litre' and 'ml' should be enforced.

M. V. Bendre

V/12/A, Walchand Nagar,
Distt. Poona.

20 Paise Coin

Sir,

It has been observed that Government of India has taken 1 : 2 : 2 : 5 ratio in denominating the weights, measures, etc. But so far as Indian coins are concerned, the ratio has been taken otherwise. If the denomination of 25 Paise coin would be abolished and a new denomination of 20 Paise coin would be introduced, the above ratio in denominating the coins would be introduced.

It is hoped that it would be a right step in bringing uniformity so far as coinage and weights and measures are concerned.

Without designating the packages of dozen, gross, etc. if the packages would be designated as 1000, 500, 200, 100, 50, 20, 10, 5, 2, 1 i.e., in the ratio of 1 : 2 : 2 : 5, uniformity would be introduced in case of numbers also.

P. K. DATTA PURKAYASTHA

Inspector of Weights and Measures,
Cachar,
Shillong.

Standards News

(Indian Standards which have a particular bearing on the change-over to the metric system are indicated here. Copies would be available from the Indian Standards Institution, Manak Bhawan, 9, Bahadur Shah Zafar Marg, New Delhi or their Branch Offices at Bombay, Calcutta, Kanpur and Madras.)

Tables for Alcoholometry

Indian Standards Institution has published Indian Standard Tables for Alcoholometry (IS : 2302-1962), which covers two tables, namely, Table I and Table II, intended for use in obtaining volumetric content of ethanol at 15°C in an ethanol-water mixture at t°C by the centesimal hydrometers.

Table I contains temperature correction data whereas Table II includes data at 15°C for specific gravity in vacuum, density in vacuum, density in air and volume in litres corresponding to 100 kg (in air) of liquid.

There are many methods for determining the ethanol cotent of alcoholic liquids and their preparations. These methods are based on the density, the refractive index, the oxidation index, the boiling point. etc. The simplest of these methods is the one based on the density of ethanol-water mixture, which decreases with the increase of ethanol content due to the fact that ethanol is lighter than water.

At present, computation of strength of aqueous solutions containing ethanol is made in the country from specific gravity figures at 15·60C (or 60°F) by the pyknometer method and at 51°F by the Sike's metal and glass hydrometers, and the strength is expressed in terms of proof spirit.

It was reported that the glass hydrometers with existing tables do not give correct alcoholic strength for higher concentrations and at higher temperatures. The adoption of metric system in the country also necessitated compilation of suitable alcoholometric tables for their adoption in the country. After careful consideration of these problems, the Committee responsible for the preparation of this standard felt that since volumetric content of ethanol is an essential element in the commercial transaction and revenue assessment in the country, the method of expressing the percentage of alcohol by volume using the centesimal hyrdrometers be adopted in the country.

Coach Bolts (M6 to M24)

Indian Standards Institution has published Indian Standard Specification for Coach Bolts (M6 to M24) (IS : 2609-1964), which specifies requirements for cup head square neck coach bolts and countersunk head square neck coach bolts in the diameter range 6 to 24 mm.

Coach bolts are extensively used in India in railway carriages and in timber work. To meet the immediate demands of the industry, this Institution is engaged in preparing specifications for the more common types of threaded fasteners. This standard is one of a series of Indian Standards on threaded fasteners with ISO metric screw threads.

Price Rs. 2·00

Black Square Head Bolts (M6 to M39) with Square Nuts and Black Square Head Screws (M6 to M24)

Indian Standards Institution has published Indian Standard Specification for Black Square Head Bolts (M6 to M39) with Square Nuts and Black Square Head Screws (M6 to M24) (IS : 2585—1964), which covers the requirements of black square head bolts (diameter 6 to 39 mm) with square nuts and black square head screws (diameter 6 to 24 mm).

The metric screw threads with ISO profile has been recognized in India. All threaded fasteners required for general engineering applications shall have the metric screw threads. This standard is one of a series of Indian Standards on threaded fasteners with ISO metric screw thread.

Price : Rs. 2·00

Cap Nuts and Domed Cap Nuts

Indian Standards Institution has published Indian Standard Specification for Cap Nuts and Domed Cap Nuts (IS : 2687—1964), which prescribes the requirements of cap nuts of sizes M6 up to M36 with coarse pitches, and M8 × 1 up to M36 × 3 with fine pitches; and domed cap nuts of sizes M6 up to M24 with coarse pitches and M8 × 1 up to M24 × 2 with fine pitches.

Cap nuts and domes cap nuts are blind tapped hexagonal nuts used for providing sealing for projected threaded parts or sometimes merely for decorative purposes.

This standard gives only dimensions and materials for cap and domed cap nuts while reference has been made to IS : 1367—1961 Technical Supply Conditions for Threaded Fasteners which gives details of general requirements for the more common type of threaded fasteners.

Price : Rs. 2·00

Dimensions for Wrought Copper and Copper Alloy Rods and Bars

Indian Standards Institution has published Indian Standard Dimensions for Wrought Copper and Copper Alloy Rods and Bars (IS : 2826—1964), which specifies dimensions and tolerances for copper and copper alloy rods and bars.

The decision of the Government of India to adopt the metric system of weights and measures makes it essential that the sizes of metal products should be standardized in metric units. The necessity for evolving standard dimensions of rods in millimetres has been felt by all concerned interests. Accordingly, the Sectional Committee responsible for the preparation of this standard has tried to derive maximum possible advantage from the inherent qualities of the metric system by the adoption of preferred numbers for the selection of sizes of rods.

Price : Rs. 1·50

Base Paper for Carbon Paper

Indian Standards Institution has prepared draft Indian Standard Specification for Base Paper for Carbon Paper [Doc : CDC 15(2259)], which prescribes the requirements and methods of test for base paper for carbon paper.

Medicinal Round Glass Bottles

Indian Standards Institution has prepared draft Indian Standard Specification for Medicinal Round Glass Bottles, [Doc : CDC 10(1612)] which includes all the different types of medicinal glass bottles, namely, screwed neck, plain neck and stoppered neck bottles.

This document is the draft revision of IS : 1108—1957 Specification for Tincture Glass Bottles. This Standard was prepared on the recommendation of the Pharmaceutical Enquiry Committee in order to ensure the quality of glass containers for use in pharmaceutical industry. Later experience showed that glass bottles are used widely by the pharmaceutical industry for storing various types of medicinal preparation including tinctures. It was, hence, decided to enlarge the scope of the standard.

This draft revision prescribes the requirements and the methods of sampling and test for glass bottles used for storing medicinal substances. It prescribes the nominal capacities of bottles in rational metric units and also lays down the overall dimensions in order to ensure uniformity in the shape of the medicinal round glass bottles, manufactured in the country.

Round Printing Ink Containers

Indian Standards Institution has prepared draft Indian Standard Specification for Round Printing Ink Containers [Doc : CDC 28(1444)] which prescribes the requirements for round built-up slip-lid containers manufactured from tinplate for packing printing inks.

At present the printing ink industry is employing a very large number of sizes of containers which is partly due to lack of Indian Standards on the subject and partly due to the variation in specific gravity of the printing inks. On account of the latter factor, it has not been found possible for the present to restrict the heights of the containers to a small number. The Committee responsible for the preparation of this draft standard, therefore, decided to prescribe, for the height of the containers, minimum and maximum values in respect of each diameter, and has further prescribed the increments to be added to the minimum value of the height. It is intended that in due course it would be possible to cut down the heights involved to a small number.

march together work together

"Let people in different parts of the country, however strong their feelings might be on particular issues, never forget that they are Indians first, and that all differences must be resolved within the unalterable framework of one nation and one country. Let us make every endeavour to foster this feeling of oneness and to carry forward the work of national integration."

—Lal Bahadur Shastri
Prime Minister

Our way is straight and clear—to build a strong India with freedom and prosperity for all.

Let us march together, work together as one nation, imbued with courage and determination, goodwill and tolerance.

JAI HIND

PRESERVE UNITY, PROTECT FREEDOM

DA 64/77

TYPICAL METRIC PRICING UNITS FOR WHOLESALE TRANSACTIONS

Serial No.	Commodity	Metric Unit
(1)	**Gold**	10 grams (g)
(2)	**Grocery and Confectionery**	1 kilogram (kg)
	Biscuits, sweetmeats, cardamoms.	
	Textiles and Textile Fibres	
	Cotton yarn, damaged and seconds cloth, raw silk, rayon silk yarn, raw wool, wool manufactures (when sold by weight).	
	Paints & Chemicals	
	Paint (if sold by weight), indigo, liquid chlorine.	
	Hides, Skins & Leather	
	Raw hides, leather (hides and skins).	
	Metals	
	Silver, aluminium sheets, strips and circles, copper and brass wires and utensils.	
	Miscellaneous	
	Tea, meat, camphor tablets, mica.	
(3)	**Grains and Pulses**	1 quintal (q) (100 kilograms)
	Rice, wheat, jowar, arhar, moong, masur, gram.	
	Spices	
	Black pepper, mustard, chillies, dhania, dalchini, turmeric, betelnuts.	
	Plantation Products	
	Rubber, cashewnuts, cashew kernels, tobacco (raw and manufactured).	
	Forest Products	
	Lac and lac products, gums, myrobalans, galnuts, soapnuts.	
	Textiles & Textile Fibres	
	Raw jute, raw hemp, coir yarn.	
	Oils, Oilseeds & Oilcakes	
	Vegetable oil, oilseeds, oilcakes.	
	Non-Ferrous Metals	
	Aluminium : ingots, bars, blocks, slabs, billets.	
	Lead : ingots, sheets and strips.	
	Copper : ingots, blooms, slabs, cakes, tiles, bricks, billets, blisterbars and wirebars, rods, sections and pipes, plates, sheets and strips, circles.	
	Brass : ingots, rods, sections, pipes, sheets, strips circles.	
	Zinc : ingots, sheets, strips.	
	Tin : blocks.	
	Chemicals	
	Caustic soda, bleaching powder, glycerine, soaps, paper salt.	
	Others	
	Sugar, gur, ice, fish, sugarcane, vegetables, tamarind.	
(4)	**Minerals**	one metric tonne (t) (1,000 kilograms)
	Iron ore, manganese ore, bauxite, coal.	
	Iron & Steel	
	Pig iron, iron & steel manufactures, semis (billets for rerolling etc.)	
(5)	Cloth (mill, handloom, silk rayon and woollen cloth)	1 metre (m)
(6)	Jute carpets, coir mats and mattings, sheet glass.	one square metre (m^2)
(7)	Timber.	one cubic metre (m^3)
(8)	Paints (when sold by measure), spirits.	one litre (l)

Weights

(1) In place of the present units of seer, pound, rattal, viss etc., use the kilogram.

(2) In place of the tola, use the gram or 10 grams.

(3) In place of maund or corresponding unit, use the quintal *i. e.*, 100 kg.

Capacity Measures

In place of seer or gallon or any other measure, use the litre.

Length Measures

(1) Use the metre in place of yard or foot and the centimetre in place of inch.

Square Measures

(1) Use the square metre in place of square yard or square foot, and square centimetre in place of square inch.

Cubic Measures

(1) Use the cubic metre in place of cubic yard or cubic foot and cubic centimetre in place of cubic inch.

Packaging

It is advantageous if sizes of packages correspond to series of commercial weights and measures prescribed.

These are: 50 kg, 20 kg, 10 kg, 5 kg, 2 kg, 1 kg, 500 g, 200 g, 100 g, 50 g, 20 g, 10 g, 5 g, 2 g, 1 g, and so on.

TYPICAL PRICING UNITS FOR RETAIL TRADE

Serial No.	Commodity	Metric Unit for Use
(1)	Foodgrains, cereals, pulses, spices, ghee, bread, vegetables, meat, fish, sweetmeats, tea, coffee, sugar, salt	1 kg
(2)	Oil for cooking	1 kg or 1 litre depending upon prevalent practice.
(3)	Fruits	1 kg or number depending upon prevalent practice.
(4)	Milk	1 litre
(5)	Cloth and related materials	1 metre
(6)	Prepackaged materials	Preferably sizes corresponding to series of commercial weights and measures.

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metric measures

ABBREVIATION FOR METRIC UNITS

(1) DECIMAL MULTIPLES AND SUB-MULTIPLES

Prefix	Value in Terms of Unit	Abbreviation
Kilo	1,000	k
centi	$0\cdot01(10^{-2})$	c
milli	$0\cdot001(10^{-3})$	m
micro	$0\cdot000\ 001(10^{-6})$	µ

(2) WEIGHTS

Denomination	Value	Abbreviation
tonne	1,000 kg	t
quintal	100 kg	q
kilogram	1 kg	kg
gram	1 g	g
milligram	1 mg	mg
carat	200 mg	c
(3) CAPACITY		
kilolitre	1 000 l	kl
litre	1 l	l
millilitre	1 ml	ml
(4) VOLUME		
cubic metre	m^3	m^3 or cu m*
cubic centimetre	cm^3	cm^3 or cu cm*
cubic millimetre	mm^3	mm^3 or cu mm*
(5) LENGTH		
kilometre	1 000 m	km
metre	1 m	m
centimetre	1 cm	cm
millimetre	1 mm	mm
micron	1/1 000 mm or 10^{-3} mm	µm
(6) AREA		
square kilometre	1 000 000 m^2	km^2 or sq km*
square metre	1 m^2	m^2 or sq m*
square centimetre	1 cm^2	cm^2 or sq cm*
square millimetre	1 mm^2	mm^2 or sq mm*
(7) LAND MEASURE		
are	100 m^2	a
hectare	100 a	ha
centiare	m^2	ca

*Both these abbreviations are current, but the first set should preferably be used. The former abbreviation is used more commonly internationally than the latter.

Rules for Abbreviations :

(1) Do not make any change, such as addition of 's' to indicate plurality *e.g.*, write 1 kg. 10 kg, 20 *g*. 5 g. 10 t, 20 ml, 27l, 165 km, 2 mm, 100 cm^3, 66 km^2.

(2) Do not capitalize the abbreviations. For example, do not write 1 Kg, 2 Kg, 20 MM, 50 MM; the right way is to write 1 kg, 2 kg, 20 mm, 50 mm, etc.

(3) Do not use any other abbreviations except those given above.

metric measures

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metric

measures

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Definition of Second and Atomic Frequency Standard

JEAN TERRIEN
Director,
Bureau International des Poids et Mesures,
Sevres.
Paris.

Actions of the Conférence Générale des Poids of Measures

In a paper published under the title 'New astronomical definition of unit of time, Prof. A. Danjon, who was at that time Director of Paris Observatory and President of the Comité International des Poids et Mesures, gave the background of the definition of the second adopted in 1956 by this Comité and which is now legally in force :

The second is the fraction 1/31 556 925.974 7 *of the tropical year for* 1900 *January* 0 *at* 12 *hours ephemeris time*

This definition was ratified by the Eleventh Conférence Générale des Poids et Mesures (C.G.P.M.) in 1960. The Twelfth Conférence, which met in October 1964, by its Resolution 5, considered that the time was not yet ripe to change this definition into an atomic one, so that nothing is changed in the definition itself of the second.

Nevertheless, something new was introduced by the Twelfth Conférence Générale des Poids et Mesures : the Comité International des Poids et Mesures (C.I.P.M.) was empowered to designate the atomic or molecular standards of frequency to be used temporarily for the physical measurements of time. Let us explain first what these standards are.

The Atomic Frequency Standards

In practice, most of the measurements of time, of time interval, or of frequency (2), make use of a standard ; this standard has to be calibrated against the definition ; the definition of the second being astronomical, such a calibration is the responsibility of astronomers. The standards for time since about 1935 have been quartz clocks, which produce an electrical periodic signal, the frequency of which is constant within about one part in 10^{10} or a little more. This outstandingly stable value of the frequency of these quartz standards changes after a few weeks owing to ageing of the quartz crystal, and occasional recalibration is necessary. These quartz standards are used, not only as frequency standards, but also as clocks, that is standards of time : the building up of a continuous scale of time is obtained by adding up the number of periods, which

(1) Metric Measures 2, No 5, 1959, pp. 3—5

(2) The frequency of a periodic phenomenon is the number of cycles within one unit of time; the unit of frequency is the hertz, symbol Hz : 1 Hz= 1 cycle per second $= 1 s^{-1}$

is displayed on a dial indicating hours, minutes, seconds, or on some equivalent device.

Since about 1945 atomic (or molecular) standards of frequency have come into use. Their operation relies upon a natural frequency of an atom (or a molecule), which is a natural constant, and which as a consequence cannot change. Up to now, these atomic standards have not been used as clocks, they are set in operation only for checking from time to time the frequency of continuously operating quartz clocks.

The stability of the frequency delivered by the best available atomic standards is believed to be of the order of 1 in 10^{10} or 1 in 10^{11}, and it is hoped that the active work devoted to their improvement will make it possible to obtain even better stability within a few years.

The best confirmed and most used atomic standard makes use of a frequency of the atom of caesium (natural, non-radioactive caesium). This metal consists of a single isotope ; its nucleus contains 133 nucleons and is surrounded by 55 electrons, 54 of which are within closed shells, the 55th being the valence electron which behaves as the valence electron of the other alkali metals such as sodium and potassium.

As in any atomic system, the atom of caesium is allowed by quantum mechanics to be in a number of configurations having each its own energy ; these are the energy states (or levels). The most stable has the lowest energy and is called the fundamental state : it occurs with the highest probability when the atoms are not excited by strong electromagnetic fields, or by ionic bombardment, as in a discharge lamp, or by high temperature. Quantum mechanics allows transitions between two states of different energy. The principle of conservation of energy is preserved, because the energy difference is dealt with by the absorption or the emission of electromagnetic radiation at a frequency which obeys Planck's law.

$E_1 - E_2 = h\nu$;

E_1 and E_2 are the energies of the states between which the transition occurs: ν is the frequency of the electromagnetic radiation absorbed or emitted ; h is Planck's constant, equal to $6 \cdot 625\,6 \times 10^{-34}$ Js.

The atomic states of caesium which are used in the caesium frequency standards are the sub-states of the fundamental one (called hyperfine levels by spectroscopists) which occur when the magnetic dipole moment (or the spin, equal to 1/2) of the valence electron is either parallel, or anti-parallel to the magnetic dipole moment (or the spin, equal to 7/2) of the nucleus. The resulting moment of the whole atom is denoted by the quantum number F, the value of which is $7/2 \pm 1/2 = 3$ or 4. When the caesium atom is placed in a magnetic field (an external field, not produced by the atom itself or by neighbouring ones), each of these sub-states splits up into several components according to the orientation of the atom ; these components are denoted by the value of the quantum number M ; for M=O, there is no alternation of the energies, so that we may omit to consider the splitting in a simplified theory. The energy difference between the two substates F=3 and F=4 corresponds, according to Planck's law, to a frequency which lies within the centimetre range of wave-lengths of electromagnetic radiation.

Means are available to produce such a radiation with a finely adjustable frequency. When the frequency of this man-made radiation is adjusted exactly equal to the frequency of the F=3, F=4 transition of caesium, it stimulated this transition by a kind of resonance effect, and this change can be observed by a change in the bending of the path of caesium atoms travelling within a non-uniform magnetic field.

So, the atomic caesium frequency standard is used to *tune* an electromagnetic oscillator exactly to the natural frequency of a transition of the atom of caesium. If the caesium frequency is known in terms of the definition of the second, it can be used by physicists to calibrate the quartz clocks ; this calibration, given the necessary equipment, is a matter of a few minutes, as the comparison of two frequencies is a straight-forward and highly precise measurement.

The Value of Caesium Frequency

W. Markowitz, R. G. Hall, L. Essen and J. V. L. Parry described in 1958 the lengthy and difficult measurement which they performed to evaluate the frequency of caesium in terms of the definition of the second (3). Numerous astronomical observations of the position of celestial bodies within the solar system, especially of the Moon, related to quartz clocks calibrated against the (unknown) frequency of caesium, and elaborate calculations founded upon the mechanical theories of the solar system, gave the final result which was published and subsequently used : the frequency of the transition of caesium was found to be 9 192 631 770±20 hertz, that is number of periods per second of ephemeris time conforming to the definition ratified by the Conference General des Poids et Mesures in 1960. The uncertainty of ±20 hertz may be an underestimate, because astronomical measurement of ephemeris time can hardly be more precise than about 3 parts in 10^9, even if the observations cover a duration of a few years. Nevertheless, it was so much more convenient to calibrate quartz clocks through a caesium standard, and this calibration was so precise, that the value just quoted came into use with all its figures, as if its uncertainly were much less than it is really. As we shall explain later, this numerical value is now, since October 1964, accepted by convention as an international reference value for the physical measurement of frequency and time interval.

Why Definition of Second has Not Yet Bean Changed into an Atomic One

The caesium atomic frequency standard is more precise than the second defined by ephemeris time and one thinks immediately that as the definition of the second should be related to the most precise basis, that is to the caesium frequency, it should be changed accordingly. But other atomic frequency standards are known, which might provide a much better basis for a new definition of the second within, let us say, a year or a few years : the thallium atom can be used instead of ceasium, it is 50 times less sensitive to the perturbing influence of magnetic fields, an interesting property ; hydrogen has a similar transition and can be used to operate a maser, that is a continuously operating oscillator in which the energy of the excited state itself maintains the oscillation of the electro-magnetic radiation; N. F. Ramsey claims that a stability of 1 part in 10^{11} or better can be obtained. Major laboratories are engaged on intensive research programmes to develop new atomic or molecular frequency standards or to improve the existing ones. Any decision on the best standard is thus liable to be outdated within a short time.

The decisions of the Conference Generale des Poids et Mesures have always been long lasting ones, based upon complete tests of their adequacy. So, it would not have been wise to change the astronomical definition of the second. However, it was urgent to decide upon the use of the atomic standards which, on account of their precision, are necessary today not only for scientific research, but also for important practical applications. In a rapidly changing situation, only provisional steps must be taken and the Twelfth

(3) Frequency of caesium in terms of ephemeris time Phys. Rev. Lett. 1, Aug 1958, p. 105

Conference General so decided, when it adopted the following Resolution 5 :

The Twelfth General Conference of Weights and Measures

Considering that the Eleventh General Conference of Weights and Measures recognised in its Resolution 10 the urgency of arriving at an atomic or molecular standard of time interval for the needs of metrology of high precision that, inspite of the General Conference to adopt a new definition of the second, a basic unit of the International System of Units, because of the new and important progress which may arise from current researches,

Considering also that it is not possible to wait any longer to base physical measurements of time on atomic or molecular frequency standards,

Empowers the International Committee of Weights and Measures to designate the atomic or molecular standards of frequency to be used temporarily.

Requests the organisations and laboratories expert in this field to pursue researches useful for a new definition of the second.

This Resolution maintains the definition of the second adopted in 1956, and no alteration is needed in national legislation dealing with the definitions of physical units.

Declaration of the Comite International des Poids et Mesures

Just after the adoption of the Resolution 5 of the Conference, the C.I.P.M. made the following declaration :

The International Committee of Weights and Measures

Empowered by Resolution 5 of the Twelfth General Conference of Weights and Measures to designate the atomic or molecular standards of frequency to be used temporarily for physical measurements of time

Declares that the standard to be used is the transition between the hyperfine levels F=4, M=0 and F=3, M=0 of the fundamental state $2S_{\frac{1}{2}}$ of the caesium 133 atom unperturbed by external fields, and that the value 9 192 631 770 hertz is assigned to the frequency of this transition.

As a consequence, it is agreed by convention that the frequency of caesium is to be used with the quoted value exactly ; the purpose is to ensure that everywhere in the world, and at any time, the same value shall be used even if, after new astronomical observation, it should turn out that this value is not quite the best to fit the definition of the second. In fact, such a small discrepancy, if it should occur, would be coped with by the astronomers who could make allowance for it, and it should introduce no trouble anywhere else.

As soon as an atomic standard prove itself to be superior to the caesium one, the C.I.P.M. would be able to replace its first declaration by another in favour of this better standard ; the value assigned to its frequency will have been determined accurately in terms of caesium standard, so that there is no fear of a discontinuity. The users will then enjoy the higher precision which they will probably need at that time.

The Future

Finally, when it is thought that no further significant progress is likely for a number of years, it is expected that the Conference Generale des Poids et Mesures will abandon, for physical purposes, the astronomical definition of the second, and adopt an atomic definition based upon the best atomic standard of frequency.

On their side, astronomers dealing with the mechanics of the solar system, of which ephemeris time is an essential part, will need to keep the ephemeris second and the ephemeris time for their own purposes and must be allowed to do so. At present, atomic time and ephemeris time are indistinguishable ; if the adopted numerical value of the frequency of caesium is not quite accurate in terms of the ephemeris seco nd, astronomers will observe a small linear divergence between the atomic and the ephemeris scale of time during the next centuries. If this divergence turns out to be non-linear with time, it will be a new fact, unexplained by present theories.

Conclusion

To sum up the present situation, the definition of the second is not yet changed ; it is expected to be changed later. Owing to urgent needs, one practical standard of frequency, the caesium atomic standard of frequency, calibrated in terms of the present definition of the second, is the standard to be used ; according to the declaration of the Comite International des Poids et Mesures empowered by the Conference Generale des Poids et Mesures, the value assigned by convention to the frequency of the caesium standard is 9 192 631 770 hertz (exactly). The Comite International des Poids et Mesures is authorised, perhaps within a short time, to designate a better atomic frequency standard to be used instead of the caesium one. It is clear that we are at present in a provisional stage.

Litre & Cubic Decimetre

HENRI MOREAU

Bureau International des Poids et Mesures,
Sevres, France

NOW that the decision of the 12th General Conference of Weights and Measures has just re-established identity between the litre and the cubic decimetre, it is not without interest to retrace the history of the duality of these two units, a duality which has existed in scientific metrology for more than three-quarters of a century.

The Litre of 1795

At the time of the creation of the metric system, its promoters laid down that there would be only one standard of weights and measures, the *metre*, which had been adopted as the fundamental unit of the whole system of measurements (Article 2 of the law of 18 Germinal, Year III, that is 7th April 1795). Article 5 of the same law stated that the *litre* was the measure of capacity and that its volume was the cube of a tenth part of the metre. The litre was thus simply a special name for the cubic decimetre.

On the other hand, the plan adopted to fix the new unit of mass, the *kilogram*, envisaged that this unit should be linked with the unit of volume, and consequently with that of length, the metre, through the intermediary of water. We know that the work of effecting this liaison was entrusted in 1791 to Lavoisier and Hauy, and that it was started afresh in 1793 by Lefèvre-Gineau, assisted by Fabbroni, who determined the mass of a known volume of water by weighing successively in water and in air ahollow brass cylinder the dimensions of which had been carefully determined. From these experiments they deduced, after reduction of the weight in air to the weight in vacuo, the mass of a cubic decimetre of water at its maximum density, a result which served to fix the value of the kilogram materialised in 1799 by the platinum standard known as the "Kilogramme des Archives". This standard, which is still kept in Paris, has only been of historical interest since 1889.

By deriving the unit of mass from that of volume in this way, one of the great advantages of the metric system over other systems of measurement was realised : the numbers representing the density of any body and its specific gravity (i.e. density relative to water) became for all practical purposes identical. Nevertheless, one question remained : how accurately had the relation 1 kilogram=mass of 1 cubic decimetre of water at 4°C been determined at the end of the 18th century ? The accuracy of the relation was questioned, but the results of several similar experiments which might have verified Lefèvre-Gineau's work were so discordant (the maximum difference between two results being as much as 700 mg) that it was not only very difficult to be certain of the size of the difference between the real and theoretical magnitudes

of the kilogram, but it was not even possible to be sure of its sign. It is for that reason that the International Commission of the Metre, meeting in Paris in 1872 for the preparatory work on the definition of the metric units and the realisation of standards to represent them, decided, by its Resolution XXII, that the international Kilogram of platinum alloyed with 10% of iridium, should be derived from the "Kilogramme des Archives" in its then state; that is to say, without taking any account of the difference which might exist between its mass and that of a cubic decimetre of water.

The Mass of a Cubic Decimetre of Water

The accurate investigation of the error which was made in the construction of the first Kilogram continued to attract the attention of metrologists. The International Committee of Weights and Measures (C.I.P.M.), which had become the permanent representative of the International Commission of the Metre decided, when the Bureau International des Poids et Mesures (B.I.P.M.) was founded in 1875, to put on its programme the determination of the mass of a cubic decimetre of water.

This ticklish measurement was carried out several times, either by the B.I.P.M. or with its collaboration, between 1895 and 1905. The method generally used was the same as that of Lefévre-Gineau, that is, to determine the volume (V) of a body, as regular in shape as possible, by means of measurements of length, and then to carry out hydrostatic weighings. The required result is the quotient of the mass (m) of the water displaced by the body immersed in it, by its volume (V); m is obtained from the upward thrust (mg) exerted on the body by the water, this thrust being balanced by means of calibrated masses equal to m. The linear dimensions of the bodies used (brass or bronze cylinders or cubes of crown glass or of quartz) were determined by means of a comparator using ruled contact pieces for the cylinders or by interferometric methods for the cubes. The final result which was accepted as the outcome of this great piece of work, with which the names of Ch.-Ed. Guillaume, P. Chappuis, J. Macé de Lépinay, H. Buisson and J.R. Benoit are associated, led to the adoption in 1910 of the value 0·999 973 kg (1) for the mass of 1 cubic decimetre of air-free water at 4°C and under standard atmospheric pressure. In 1929 this value was slightly changed to 0·999 972 kg(2) which leads to the value 1·000 028 dm³ for the volume of 1 kg of water.

This discrepancy of 28 parts in a million represents the accuracy with which, in 1799, Lefévre-Gineau realised the "Kilogramme des Archives" in terms of its original theoretical definition. The result, which must certainly be partly attributable to chance, is remarkable when one takes into account the means available to the physicist and the state of science at that time. In effect, the kilogram is represented, not by the mass of a cube of water having sides of exactly 1 dm, but by one with sides of 1·000 009 dm; that is, an error of about 1µm in the linear dimensions of the cube!.

The "Metrologists' Litre" of 1880

Since the international Kilogram, copied from the "Kilogramme des Archives", does not, as we have just seen, correspond exactly with its theoretical definition, the reference body of mass 1 and volume 1 (that is to say, of density 1) forming the liaison between the two fundamental units of length and mass, is no longer, to be exact, water under the conditions specified above.

In 1880, the C.I.P.M. decided, on the proposition of O.J. Broch, a Norwegian who was then Director of the B.I.P.M., to adopt in its publications, and for official use, the word *litre* to express the volume of 1 kg of pure water at its maximum density(3). After further study of the question by the C.I.P.M. in 1900 and 1901(4), the distinction between the litre (unit of volume or capacity related to the unit of mass) and the cubic decimetre (unit of volume related to the unit of length) was confirmed by the following declaration of the 3rd General Conference of Weights and Measures (C.G.P.M.) in 1901(5) :

1. The unit of volume, for measurements of high precision, is the volume occupied by the mass of 1 kilogram of pure water at its maximum density and under standard atmospheric pressure. This volume is named *litre*.
2. In volume measurements which do not involve a high degree of precision, the cubic decimetre may be regarded as equivalent to the litre and, in such determinations, the expression of volumes based on the cube of the linear unit may be substituted for those which are related to the litre in the form in which it has just been defined.

The reason for this decision arose simply from practical metrological considerations, in that it made available a scientific unit for the determination of volumes with high precision by weighing water, while the direct measurement of a volume from its geometrical dimensions was (and very often still is) difficult and less accurate.

The declaration of the C.G.P.M. of 1901 nevertheless created a regrettable duality between the cubic decimetre and the "metrologists' litre" thus defined, the latter becoming, moreover, a unit outside the metric system. According to the result stated in the preceding paragraph, the relation accepted from 1929 onwards was 1 metrologists' litre (l_m)=1·000 028 cubic decimetre (dm^3).

In order to preserve the simple relationship between the units of mass and length, it was subsequently suggested that pure water should be retained as the reference body, but that another pressure should be chosen or that the reciprocal of the numerical coefficient (1·000 028) which enters into the relation between the metrologists' litre and the cubic decimetre, should be transferred to the density of water. In 1933, shortly after the discovery of deuterium, it was also suggested that the density of water should be adjusted by the addition of heavy water (D^2O, $d \approx 1 \cdot 1$) in such quantity that the litre defined in terms of water so prepared would be exactly equal to the cubic decimetre(6). However, nothing came of these proposals.

As early as 1880, B.A. Gould, an American who was a member of the C.I.P.M., regretted this blemish on the coherence of the metric system, and even expressed the fear that the duality of these units might form "a pretext for opposition to the metric system"(7). Later, some Anglo-Saxons, opponents of the metric system, have, in fact, often used this argument.

Return to the Original Definition of the Litre

In 1954, Ch. Volet, of Swiss nationality and then Director of the B.I.P.M., wrote : "the metrologists' litre is not only a useless creation, but it is also a dangerous idea on account of the very small difference between it and the cubic decimetre. Many authors have published results of accurate measurements of volume or of density without making it possible for us to know whether they are really in terms of the [metrologists'] litre or of the cubic decimetre".

In 1960, A.V. Astin, director of the National Bureau of Standards in Washington, and a member of the C.I.P.M., proposed that the C.I.P.M. should ask the C.G.P.M. to change the definition of the litre adopted in 1901(8). Apprised of this proposal, the

11th C.G.P.M.(8) charged the C.I.P.M. with the task of studying the problem, with the view of bringing to an end the confusion resulting from a duality which the founders of the metric system had evidently not foreseen. As a first step the C.I.P.M. recommended in 1961(9) "that the results of accurate measurements of volume should be expressed in units of the International System and not in [metrologists'] litres." As the result of a new proposal put forward by A.V. Astin in 1963(10), the C.I.P.M. submitted to the 12th C.G.P.M. (October 1964) a resolution which was finally adopted as follows(11) :

The Twelfth General Conference on Weights and Measures,

- (*i*) *Abrogates* the definition of the litre given in 1901 by the Third General Conference of Weights and Measures,
- (*ii*) *Declares* that the word "litre" may be used as a special name for the cubic decimetre,
- (*iii*) *Recommends* that the name "litre" should not be used to express the results of volumetric measurements of high accuracy.

By this resolution the relation adopted originally in 1795, 1 *litre*=1 *cubic decimetre*, was re-established.

Conclusion

Thus comes to an end the co-existence of the litre and cubic decimetre as units having slightly different values. The definition of the litre adopted in 1901 had in any case lost all scientific value from 1932 onwards on account of a hitherto unknown problem, that of variations in the isotopic composition of water. Moreover, the difference of 28 parts per million which has been accepted up till now could not be regarded as immutable; with increasing accuracy of measurement this value would probably be modified if a new determination of the volume of a kilogram of water were undertaken now.

At the same time, it is difficult to envisage the complete abolition from the metrologist's vocabulary of the word litre, which has been in world-wide use for such a long time, and that is why the name "litre" has been retained as a synonym for the cubic decimetre. Its use will be confined to practical and commercial metrology, while all accurate measurements should be expressed in units of the International System (SI); i. e., the cubic metre or its decimal multiples or submultiples.

The decision of the 12th C.G.P.M. will have no effect on everyday metrology; for all measurements where an accuracy of the order of 0·05% is sufficient, the density of water at 4°C can still be taken as 1 kilogram per litre. For measurements of high accuracy (determinations of volume by weighing of water, densities, etc.) the maximum density of pure water under atmospheric pressure, and its reciprocal (minimum specific volume) will be taken respectively as 0·999 972 kg/dm^3 and 1·000 028 dm^3/kg, figures formerly taken for the values of 1 kg/l_m and 1 l_m/kg. All densities of bodies, expressed in terms of the former metrologists' litre should be reduced by 28 parts per million in order to be expresed as kg/dm^3 or g/cm^3, multiples by 10^3 of the SI unit, kg/m^3. Specific gravities (densities relative to water), which are dimensionless numbers, will remain unchanged.

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(2) "La Creation du B.I.P.M. et son oeuvre", Gauthier-Villars, Paris, 1927, p. 258. *Proces-Verbaux C.I.P.M.*, **13**, 1929, p. 273; **22**, 1950, p. 77 and 94.

(3) *Proces-Verbaux C.I.P.M.*, 1880, p. 30, 55 and 62.

(4) *Proces-Verbaux C.I.P.M.*, 1900, p. 76 and 84; 1901, p. 97, 173.

(5) *Comptes rendus des seances de la 3e Conference Generale des Poids et Mesures*, 1901, pp. 38-39.

(6) *Proces-Verbaux C.I.P.M.*, **15**, 1933, p. 72.

(7) *Proces-Verbaux C.I.P.M.*, 1880, p. 62.

8) *Proces-Verbaux C.I.P.M.*, 28, 19060, p. 92. *Comptes rendus des seances de la 11e Conference Generale des Poids et Mesures*, 1960, p. 88 (Resolution) 13).

(9) *Proces-Verbaux C.I.P.M.*, **29**, 1961, p. 34.

(10) *Proces-Verbaux C.I.P.M.*, **31**, 1963, p. 17

(11) *Comptes rendus des seances de la 12e Conference Generale des Poids et Mesures*, 1964, Resolution 6.

Twelfth General Conference on Weights & Measures : Resolutions

THE 12th General Conference on Weights and Measures was held from 6 to 13 October 1964 at Sevres near Paris. Normally the General Conferences on Weights and Measures are held every six years ; but in view of the rapid progress of research work which had been undertaken earlier and the necessity to increase the subscriptions and improve the financial situation, the meeting was called after four years. Ten resolutions were adopted by the General Conference. The background for some of them is as follows :

(1) A tentative definition of second based on a physical constant in place of the astronomical definition was recognised. The new definition is not yet finalised and is meant only for research purposes for the time being.

(2) An anomaly created by the progress of science is that the cubic decimetre and the litre differ by 28 parts in a million. This difference is negligible for purposes of ordinary measurements but becomes important for highly accurate and precise measurements. The 12th General Conference has removed this anomaly by abrogating the definition of the litre accepted earlier and equating the cubic decimetre and the litre.

(3) The subscriptions payable by member-countries have been raised. This increase was necessary as the International Bureau of Weights and Measures has undertaken work on new subjects which would require installation of precision instruments. The scope of the work of the Bureau has been extended requiring the expansion of available facilities. It may be mentioned here that the resources of the International Bureau of Weights and Measures are the common possession of all the member-countries. The increase in subscriptions, therefore, would give every country a greater interest in the work of the International Bureau of Weights and Measures.

A translation of the French text of the resolutions passed by the Twelfth General Conference is published below. The translation has been provided by Shri Prem Prakash, Scientist, Standards Division, National Physical Laboratory, New Delhi, who attended the Conference on behalf of India.

Section of Ionizing Radiations of the International Bureau : the third exceptional grant

Resolution 1

The 12th General Conference on Weights and Measures,

Considering Resolution 1 of the 11th General Conference on Weights and Measures inviting the International Committee on Weights and Measures to organize a section for standards of measurements for ionizing radiations at the International Bureau of Weights and Measures,

Approves the decisions taken by the International Committee on Weights and Measures and extends congratulations to it as well as the International Bureau for the results obtained,

Invites the International Committee on Weights and Measures to continue its task according to the instructions of Resolution 1 of the 11th General Conference.

Resolution 2

The 12th General Conference on Weights and Measures,

Considering

the state of progress in the organization of the Section for standards of measurement for ionizing radiations and the work done already,

the need for urgent completion of civil engineering works and basic equipment necessary for functioning of this section.

Decides to allow the International Bureau of Weights and Measures a third exceptional grant amounting to 850 000 gold francs for these expenses of completion, shared among the contracting States according to the same rules as ordinary annual grant and payable as soon as possible.

Grant for the International Bureau

Resolution 3

The 12th General Conference of Weights and Measures,

Considering

the comments of the International Committee on Weights and Measures attached to the Convening of the Conference, for indicating the function of the International Bureau of Weights and Measures and the absolute need for a living scientific organization which would maintain efficient activities,

the advice collected since December 1963 from the competent circles who have studied these comments :

Approves the detailed study made by the International Committee of Weights and Measures.

States that the means evaluated by the Committee are in conformity with what is expected by the whole world from the International Bureau of Weights and Measures.

Appeals to all States adhering to the Convention of Metre to do all that they can for a fruitful work of International Committee of Weights and Measures and International Bureau of Weights and Measures, and

Instructs the International Committee of Weights and Measures to take all steps necessary for further expansion of the Metric System and adhesion to it by new States.

Resolution 4

The 12th General Conference on Weights and Measures,

Considering

extension of functions assumed by the International Bureau *vis-a-vis* the States,

increase in the precision of basic standards in which the International Bureau is engaged and complexity of techniques required by this precision,

scientific personnel and equipment necessary for the International Bureau to carry out its functions,

Having considered

the proposal of the International Committee of Weights and Measures duly notified in advance to the Governments in conformity with article 6, paragraph 5, of the rule

attached to the Convention of Metre of 1875, modified in 1921,

having considered also the proposal for a graded increase made in the session by the Rumanian Delegation,

Decides to increase the fixed part of the annual grant from 1st January 1965, from what it was before 1st October 1964, in such a way that the fixed part and the complementary part together calculated at the latter date rises gradually to 1 750 000 gold francs in the following way :

1965	1 300 000	gold	francs
1966	1 600 000	„	„
1967	1 750 000	„	„
1968	1 750 000	„	„

NOTE : The annual subscription of countries which cannot come to an agreement henceforth on the increase in the grant for the International Bureau as indicated in this Resolution, remains provisionally unchanged.

The 12th General Conference instructs the International Committee to maintain relation by correspondence with the Government of these countries till they are able to settle their position, latest by 31st December 1964.

Note for the delegates : It is quite understood that this grant will be shared according to the rules adopted by the 11th General Conference on Weights and Measures, i.e. as per 1964 coefficients of UNO with a maximum of 10% and a minimum of 0·5% of the total grant.

Standard of Interval of Time

Resolution 5

The 12th General Conference on Weights and Measures,

Considering

that the 11th General Conference on Weights and Measures stated in its Resolution 10 the urgency to agree upon an atomic or molecular standard for interval of time for the purpose of high metrology,

that, inspite of the results obtained in using atomic standards of cesium frequency, the time has not yet come for a new definition of second, a basic unit of the International System of Units, to be adopted by the General Conference, because of new and important progress, which may be forthcoming after studies which are in progress,

Considering also that one cannot wait any more to base physical measures of time on atomic or molecular standard of frequency,

Authorizes the International Committee on Weights and Measures to indicate the atomic or molecular standards of frequency to be used temporarily,

Invites the Organizations and Laboratories experts in this field to pursue studies useful for a new definition of second.

Declaration of the International Committee of Weights and Measures

The International Committee on Weights and Measures,

Authorized by Resolution 5 of the 12th General Conference on Weights and Measures, to indicate atomic or molecular standards for frequency to be used temporarily for physical measurements of time,

Declares that the standard to be used is the transition between the hyperfine levels F=4, M=0 and F=3, M=0 of the basic state $^2S_{\frac{1}{2}}$ of Cesium 133 atom, not perturbed by external fields, and that the value 9 192 631 770 hertz (cycles per second) is assigned to the frequency of this transition.

Units and prefixes (litre, curie, femto and atto)

Resolution 6

The 12th General Conference on Weights and Measures,

Considering the Resolution 13 adopted by the 11th General Conference in 1960 and the recommendation adopted by the International Committee on Weights and Measures in its 1961 session,

1. Annuls the definition of litre given in 1901 by the Third General Conference on Weights and Measures.

2. Declares that the word 'litre' may be used as a special name given to cubic decimetre.

3. Recommends that the name of litre should not be used for expressing results of high precision volume measurements.

Resolution 7

The 12th General Conference on Weights and Measures,

Considering that curie is used for a long time in many countries as the unit for radionuclide activity,

Recognizing that in the International System of Units (SI), the unit for this activity is second to the power minus one (s^{-1}),

Accepts that curie should be retained still as a unit outside SI for activity with the value $3 \cdot 7 \times 10^{10}$ s^{-1}. The symbol for this unit is Ci.

Resolution 8

The 12th General Conference on Weights and Measures,

Decides to add the following two new prefixes to the list of prefixes for formation of names of multiples and sub-multiples of units, adopted by the 11th General Conference, Resolution 12, paragraph 3 :

Factor by which the unit is multiplied	Prefix	Symbol
10^{-15}	femto	f
10^{-18}	atto	a

Gyromagnetic coefficient of proton (continuation of studies)

Resolution 9

The 12th General Conference on Weights and Measures,

Considering the important part played for metrology in the field of electricity by the gyromagnetic coefficient of proton from which it will be possible in future to work out new electrical standards based on atomic constants,

Approves the activities of the International Committee on Weights and Measures and its Consultative Committee on Electricity undertaken for development of national scientific work in this matter,

Invites the expert national and international laboratories in this field to pursue their studies on the gyromagnetic coefficient of proton, in order to establish the precise value of this constant in view of its application in the improvement of reproducibility of ampere, the basic unit of the International system of Units.

International Practical Scale of Temperature (research to be undertaken)

Resolution 10

The 12th General Conference on Weights and Measures,

Appreciating

The experimental results obtained by the competent laboratories to know the differences existing between the thermo-dynamic temperature and the temperature defined by the International Practical Scale of Temperature,

the progress made already for extending the International Practical Scale of Temperature below 90°K down to 12°K and the introduction of scales of temperaure below 5°K,

Considering the urgency to revise the International Practical Scale of temperature of 1948 and to extend it in the field of low temperatures, down to the boiling points of hydrogen and helium,

Recognizing that important research work should still be carried out to enable the International Committee of Weights and Measures to prepare a proposal, during the following years, for a new definition of the International Practical Scale of Temperature which could be adopted by the 13th General Conference on Weights and Measures,

Invites the large national and international laboratores experts in this field to pursue as actively as possible important research works to revise the International Practical Scale of Temperature particularly :

1. gas thermometry in all the fields of temperature, including the study of the coefficient of expansion of the material of the bulbs particularly at high temperature;
2. measurements of radiation of black bodies between 630° C and 1063°C;
3. formation of a platinum resistance thermometric scale between 630°C and 1063°C intended for replacing the thermocouple scale;
4. verification of the table of values of the reduced platinum resistance below 0°C, including a study on standardizing platinum resistance thermometers;
5. fresh determination of the boiling point of oxygen.

Work of O.I.M.L

THE International Organisation of Legal Metrology, which is called O.I.M.L. for short, was established on the basis of a diplomatic agreement signed by 22 signatories on 12 October 1955 and which became effective on 28 May 1958. At present there are 34 member-countries including India and 8 corresponding members.

Within the short space of six years the O.I.M.L. has processed 8 Provisional International Recommendations which are expected to be adopted by the member-countries. Besides the 8 Provisional International Recommendations, draft recommendations for some 60 subjects are in various stages of progress. A list of the provisional international recommendations and the studies in progress is given below :

Provisional International Recommendations

The following eight Recommendations were adopted provisionally by the second International Conference of Legal Metrology in October 1962.

(1) Cylindrical weights from 1 g to 10 kg (average precision class)

(2) Parallelepiped weights from 5 to 50 kg (average precision class).

(3) Maximum errors permitted in initial verification of weighing instruments with continuous indication (average precision class).

(4) Maximum errors permitted in initial verification of weighing instruments with discontinuous indication or impression (average precision class).

(5) Manometers, vacuometers and mano-vacuometers with elastic receivers and with direct indication by pointer and graduated scale (of the category of working apparatus).

(6) Manometers for instruments for measuring blood pressure.

(7) Medical syringes with glass bodies.

(8) Symbol of similarity (indicating that two quantities correspond to each other without being physically equal to one another) in accordance with the Recommendations of the International Organisation for Standardization.

Studies in Progress

Subjects	*Secretariat Reporter*
A. *General Metrology*	
(1) General principles of legal metrology.	BIML
(2) Vocabulary of legal metrology, fundamental terms.	Poland
(3) Teaching of legal metrology.	France
(4) Metrological documentation.	BIML
B. *Systems of measuring units*	
(1) Units of measure	Council of the President.
C. *Metrological laws and rules*	
(1) Ideas about types, models and systems of measuring instruments.	Federal Republic of Germany.
(2) Methods of approval of types, models and systems of measuring instruments.	Federal Republic of Germany.
(3) Different classes of precision of measuring instruments.	USSR
(4) Legal precision of measurements made by a controlled instrument.	Spain
(5) Stamping and marking of measuring instruments.	Belgium
(6) Control by sampling	Spain
D. *Measurement of Length*	
(1) Metres and double metres.	Belgium
(2) Tape or wire measures for long lengths.	Hungary
(3) Taximeters	Fed. Rep. of Germany.
(4) Instruments for measuring the length of fabrics, cables and wires.	France
(5) Linear measures with flat ends (calibration standard).	USSR
E. *Area measurements*	
(1) Instruments for measuring hides and skins.	Poland

F1. *Measures for volumes of liquids*	
(1) Measurement of volumes in laboratories.	United Kingdom
(2) Butyrometers	Belgium
(3) Medical syringes	Austria
(4) Bottles used as container measures.	France
(5) Drinking glasses	Switzerland
(6) Watermeters	Spain
(7) Dispensers and meters for liquids other than water.	Fed. Rep. of Germany and France.
(8) Measurement of hydrocarbons in storage tanks.	France and Rumania.
(9) Measurement of hydrocarbons in tank lorries and tank wagons.	France and Rumania.
(10) Measurement of hydrocarbons in tankers and ships.	France and Rumania.
(11) Measurement of hydrocarbons in reservoirs under liquid and gaseous phases.	Spain
Fg. *Measurement of volumes of gases*	
(1) Domestic gasmeters	Netherlands
(2) Industrial gasmeters	Fed. Rep. of Germany.
(3) Differential pressure meters.	Fed. Rep. of Germany.
G. *Measurement of masses*	
(1) Definition of apparent mass in air.	Belgium
(2) Weights used in industrial and commercial transactions.	Belgium
(3) Weights for laboratories and for precision measurements.	Belgium
(4) Domestic balances, baby weighing machines and person weighing machines.	Belgium
(5) Weighing instruments with automatic equilibrium.	Fed. Rep. of Germany.
(6) Weighing instruments with non-automatic equilibrium.	France
(7) Electromechanical weighing instruments.	Fed. Rep. of Germany
(8) Printing devices on weighing instruments.	France
(9) Weighing of packets and sacks.	United Kingdom.
(10) Weighing instruments with continuous totalling device.	United Kingdom.
Gv. *Measurement of volume masses*	
(1) Hydrometers and alcoholometers.	Sweden
(2) Optical saccharimeters.	Fed. Rep. of Germany.
M. *Measurement of forces*	
(1) Dynamometers for heavy loads.	Austria
N. *Measurement of pressures*	
(1) Manometers, vacuometers and manovacuometers.	USSR
(2) Instruments for the measurement of blood pressure.	Austria

P. Measurement of temperatures

(1) Clinical thermo-meters.	Fed. Rep. of Germany.
(2) Optical pyrometers	USSR

Qe. Measurement of electrical energy

(1) Domestic electricity meters. (2) Industrial electricity meters.	USSR and France.
(3) Wattmeters and standard meters.	Switzerland and Spain.

Qc. Measurement of calorific energy

(1) Calorimeters	Fed. Rep. of Germany.

S. Measurement of magnetic quantities

(1) Instrument trans-formers.	Fed. Rep. of Germany.

T. Acoustical measurements

(1) Measurement of sounds and noises.	Switzerland

W. Measurement of radioactivity

(1) Dosimetry and pro-tection.	Switzerland

X. Measurement of pollutions and contami-nations

(1) Instruments for mea-suring air pollution.	Monaco

Y. Measurement of the characteristics of bodies

(1) Determination of the degree of mois-ture in grains. (2) Determination of the natural specific weight of grains.	Fed. Rep. of German.
(3) Material Testing machines (strength and hardness).	Austria

Z. Regulation of conditioned products

(1) Regulation of con-ditioned products.	Belgium

CORRECTION

In this issue of *Metric Measures*, January, 1965 on page 14 under **I.O.L.M. Honorary Membership**, the following item has been omitted by oversight. This may now be added :

"Professor G. D. Bourdoun, U.S.S.R. Professor at the University of Moscow, a former Vice-President of the Committee."

News & Views

Standards of Weights and Measures Act, 1956, Amended

THE STANDARDS OF WEIGHTS AND MEASURES (AMENDMENT) ACT, 1964

No. 54 OF 1964

(*30th December*, 1964)

An Act further to amend the Standards of Weights and Measures Act, 1956

Be it enacted by Parliament in the Fifteenth Year of the Republic of India as follows :—

Short title

1. This Act may be called the Standards of Weights and Measures (Amendment) Act, 1964.

Amendment of section. 2

2. In section 2 of the Standards of Weights and Measures Act, 1956 (hereinafter referred to as the principal Act), for clause (*d*), the following clause shall be substituted, namely :—

'(*d*) "metre" means the length equal to 1,650,763·73 wave-lengths, in vacuum, of the radiation corresponding to the transition between the $2p_{10}$ and $5d_5$ levels of the kyrpton atom of mass 86;'.

3. In sub-section (2) of section 3 of the principal Act, for the words "in terms of the international proto-type of the metre", the words "by the International Bureau of Weights and Measures" shall be substituted.

Amendment of section 5

4. In sub-section (2) of section 5 of the principal Act, for the figures "1/31,556, 925·975", the figures "1/31,556,925·9747" shall be substituted.

Insertion of new section 15 A

5. After section 15 of the principal Act, the following section shall be inserted, namely :

Unit of length in navigation by sea or air.

"15A. Notwithstanding anything contained in this Act, a nautical mile which is equal to 1852 metres, may be used as the unit of length in relation to navigation by sea or air."

Uniform Units for Oil Trade

Some amendments to the Bye-laws of the Saurashtra Oil and Oilseeds Association Ltd., Rajkot providing for the uniform units of price quotation in respect of groundnut kernels, groundnut whole, groundnut oil and cottonseed, were approved by the Commission on 1st October, 1964. As a result, units of price quotations have been changed from 250 kg to 100 kg for groundnut kernels; from 20 kg to 100 kg for groundnut whole, from tin of 16 kg to 10 kg loose for groundnut oil and from 250 kg to 100 kg for cottonseed.

The Bye-laws of the Ahmedabad Seeds Merchants' Association Ltd., Ahmedabad were amended on 6 October, 1964 with the approval of the Commission. The amendments mainly relate to change in the units of price quotation from 250 kg to 100 kg in respect of castorseed and cottonseed and from tin to 10 kg (loose) in respect of groundnut oil.

(*Forward Markets Bulletin*, December, 1964, pp. 36-37).

Further Meetings of East African Metric Commission

The first meeting of the Metric Commission for East Africa which opened in Dar-es-Salaam on Monday December 28 will be followed by further meetings in Zanzibar, Mombasa, Nairobi and Kampala.

Nearly 200 replies to the Commission's questionnaire have already been received and oral representations will be heard at the meetings, after which the commission will produce its report on the feasibility of adopting the metric system of weights and measures in East Africa.

The Commission, under the Chairmanship of the Director of Weights and Measures, India, Shri P. N. Nayar, has seven members including Mr. E. Hewitt, Ministry of Commerce & Co-operatives, Dar-es-Salaam, the Superintendent of Weights & Measures, Kenya, Mr. P. E. Phillips, and the Superintendent of Weights & Measures, Uganda, Mr. S. Sekyaya. Trade and Industry are represented by Mr. J. Keragori, Kenya, Mr. J.K. Chande, Tanzania, and Mr. R. J. Mehta, Uganda, while Professor D. Thomson of Makerere College, represents the University of East Africa.

Ice Point Cell

Ice point cells are very widely used by many scientific and industrial laboratories for checking up the zero-depression of thermometers after day's work, and for maintaining the reference junction of precision thermocouples. They are sometimes also used for keeping medicines, triple-point of water cell, etc. at 0°C.

The ancient method using funnel and crushed ice has long back been replaced by thermos flasks and insulated jars provided with spouts, although many school and college books still describe the ancient method for "Lower Fixed Point of Thermometer". In hot countries like ours, it has been found that the jars and flasks are also not dependable because either the ice soon begins to float on water or large particles of water remain locked between pieces of ice. The work of National Bureau of Standards (USA) showed that stirring or recirculation of this water raises its own complications. Sometime back NPL (India) showed the advantage of using shaved commercial ice for this purpose.

Recently NPL (India) has invented an ice point equipment which completely obviates the difficulty. By attending to the cell in morning and evening, the temperature can be maintained to within 0·05 deg of 0°C, round the clock, for as many days as necessary by the device which is now being patented. It consists of an insulated tinplated brass vessel provided with a perforated cylindrical vertical partition and a sieve of brass mesh a little above its bottom. Both portions of the equipment are filled with finely shaved ice—the outer portion being rammed to enable its temperature to fall below 0°C by a small fraction of a degree. Very little of the ice in the inner portion melts and thermometer and thermo-couples, etc. can be placed inside it. As the ice melts, the water collects below the brass mesh till it reaches within a few mm of the mesh—it is then automatically siphoned out.

The patent is now available for exploitation.

Clinical Thermometers

Liquid-in-glass type clinical thermometers for oral and rectal use are very widely used in the country and a large number of them are being manufactured. But they have earned a bad name.

In a recent review, NPL found that this was due to many reasons, the important ones being : (*i*) lack of control and available Indian standard; and (*ii*) lack of adaptation of the thermometer specifications to Indian conditions and climates. The review was considered by the Institution of Chartered Engineers as the best write up and help to thermometer industry during 1964 and the writer, Shri T. D. Bansal was awarded a Gold Medal by the I.C.E. through Shri Raj Bahadur, Union Minister of Transport, on 26 December 1964. An abridged version of this article was also published in *Metric Measures* (November 1964).

The salient points of the proposals, which have been finally utilised now by the Indian Standards Institution are :

(*i*) The time indication of "1/2 minute", "1 minute", "slow", "fast", "stubby", etc. shall not be written any more since it is deceptive according to modern biophysical research. However, every thermometer must acquire the temperature of a stagnant water bath maintained at 42·0°C in 8·0 sec. or less. This has been found experimentally to be "equivalent" to "1/2 minute" in the mouth.

(*ii*) Celsius scale of temperature shall be used. The normal temperature of 37·0°C shall be marked with an arrow; steps in the reading shall be of 0·1 degree and not 0·2 as before.

(*iii*) The range of temperatures marked on the thermometers shall be slightly longer than hitherto. It shall cover at least the span 35·0°C to 43·0°C.

(*iv*) The apparent width of mercury column shall be at least 1 mm.

(*v*) There may be a small mark (Locator) near the start of the scale, to enable the mercury to be viewed at once by looking at the locator, instead of twisting the thermometer between the fingers.

The proposals for some of these features have been highly appreciated abroad while the International Organisation for Standardization has praised them.

According to the ISI standard, now being printed, on the above lines about sixty observations shall have to be made on each thermometer before it is passed. It has been proposed to test each and every one of the two million thermometers we consume every year and now NPL is developing equipment for carrying out this mass scale testing programme at an insignificant price because the cost of production of such a thermometer is so small.

Standard Packs in West Germany

A report received states that the West German Government has drafted a Bill, expected to be enacted early next year, which will require all packaged goods to be made up in standard sizes. Manufacturers will have the alternative of marking the package with the price of the goods per kilo to make price comparisons simpler.

(*Monthly Review*, October 1964, p. 256)

Afghan Officials Study Progress of Metric System in India

At the invitation of the Government of India, two senior officials from the Royal Afghan Government paid a visit to this country from 28 January 1965 to 11 February 1965 to study the progress made in the adoption of the metric system. The officials were Mr. Mahamad Isah Sayami, Director General of Internal Trade, and Mr. Ali Ahmed Razai, Director of Marketing, Ministry of Commerce.

During their stay they visited the Union Ministry of Commerce and had discussions with the Deputy Minister for Commerce, the Secretary, Joint Secretaries and the Officials of the Weights and Measures Directorate. They spent some time in the Directorate of Advertising and Visual Publicity and showed keen interest in the various media used in publicising the metric system.

They also visited various institutions in Delhi concerned with weights and measures, like the Indian Standards Institution, the National Physical Laboratory and the Weights and Measures Department of the Delhi Administration. Besides some firms manufacturing weights and measures in Agra, they visited some important manufacturing establishments in Calcutta and Bombay. They also studied the working of the Weights and Measures Department and the Government of India Mint at Bombay, and the Training Institute and the Weights and Measures Department in Patna.

Readers' Forum

Survey Chains in Metric System

(Shri D. B. Dongre, Executive Engineer, Irrigation Project Dn (Central), Poona-1, has sent the following which is published for eliciting readers' views in the context of change-over to metric system in surveys and land areas. Opinions of readers may be sent to the Editor, *Metric Measures*).

BEFORE adopting the metric system, the survey chains of three lengths 100 ft, 66 ft and 33 ft were in use. The latter two were not used for surveys of road, buildings, canals, dams, wiers or the like. But they were used only for land measurements by the Revenue Department as they were convenient for arriving at the areas in acres, gunthas and annas etc. 100 ft long chains were, however, used for surveys of the Civil Engineering Departments.

In place of 100 ft. long chains, the chains of length nearest to old 100 ft chain is the chain 30 metre long of the metric system. The second choice is the chain 20 metre long. Metric chains of ·25 metre lengths have not, it seems, been advocated and/or manufactured. This is also corroborated by Shri Varshneya, Dy. Director (Metric), National Building Organisation, New Delhi in his chapter 8—Metric system in Surveying in his book "Metric Guide for Civil Engineers and Architects".

The advantages which we had in the old 100 ft long chains in measuring canal miles (500 ft. long) cannot be had with 30 metre long chains in measuring kilometre length of the canal or fractions thereof as will be seen from details below :

1	kilometre means	33.333	nos. of	30	metre	chains
0.50	,,	,,	16.666	,,	,,	,,
0.25	,,	,,	8.333	,,	,,	,,
0.10	,,	,,	3.333	,,	,,	,,

Further in case of 30 metre long chains they are sub-divided into ten sub-divisions with tallies to show 3, 6, 9, 12, etc. metre lengths. All these sub divisions become odd viz. 0·03, 0·06, 0·09, 0·12 kilometre in length and do not properly fit in the decimal system.

If 25 metre chains are manufactured inconvenience mentioned in para 2 supra can be overcome as under—

1	kilometre will mean	40 chains	of 25	metre
0.50	,,	20	,,	,,
0.25	,,	10	,,	,,
0.10	,,	4	,,	,,

Similarly the sub-divisions of the chain will also be fitting in the decimal system. 25 metre chain will have each sub-division of 2·5 metre length which tallies with 2·5, 5, 7·5 metre lengths and links of 0·5, 1·0, 1·5, 2·0 and 2·5 metre lengths.

Conveniences obtained by 25 metre chains could also be claimed by 20 metre long chains but trouble of hauling up chains in surveying will increase by 25% (50 chains will have to be hauled up instead of 40 chains) and operation of chain survey will not be quicker.

It is, therefore, suggested that it would be advisable to manufacture 25 metre chains in view of above.

Standards News

(Indian Standards which have a particular bearing on the change-over to the metric system are indicated here. Copies would be available from the Indian Standards Institution, Manak Bhawan, 9, Bahadur Shah Zafar Marg, New Delhi or their Branch Offices at Bombay, Calcutta, Kanpur and Madras).

Method for Temperature Measurement of Petroleum and its Products, Part II

Indian Standards Institution has published Indian Standard Method for Temperature Measurement of Petroleum and Its Products, Part II (IS : 1519(Part II)—1964), which prescribes the method for determining temperatures of petroleum and its product when such products are stored in liquid state in bulk at pressure above atmospheric. Tanks and vessels which communicate with outside atmosphere during sampling or gauging, but which otherwise operate at pressures few centimetres of water above atmospheric are excluded from the purview of this standard.

The correct determination of temperature is essential in all measurements of oil in bulk storage since errors may seriously affect the accuracy of calculated quantities. The need for care in all measurements cannot, therefore, be over-emphasized. In all calculations concerning the measurement of oil in bulk, the mean temperature of the oil in each container is required; and the object of this standard is to lay down methods which will enable accurate determination of this temperature.

This standard forms Part II of Indian Standard Method for Temperature Measurement of Petroleum and Its Products (IS : 1519) and covers methods for measurement of temperature of materials at pressure above atmospheric. The Part I of this standard (IS : 1519 (Part I)—1961) covers methods for determining temperature of petroleum and its liquid products when in bulk and at atmospheric pressure.

Price Rs 3·00

Dimensions for Steel Tubes for Bicycle Purposes

Indian Standards Institution has published Indian Standard Dimensions for Steel Tubes for Bicycle Purposes (IS : 2484—1964), which layds down the dimensions of steel tubes used for manufacture of bicycles.

The bicycle industry has expanded considerably in the last few years in the country. With this expansion there has been some amount of diversity with regard to the specifications for steel tubes for bicycles as well as the sizes used by different manufacturers. In order to reduce variety and to make it possible for the tubes to be available easily, it was decided to formulate an Indian Standard on dimensions for steel tubes for bicycles.

A survey made regarding the sizes of steel tubes used in other parts of the world indicated that in the bicycle industry only inch sizes are used. Even most of the metric countries specify an exact conversion in metric units of the inch sizes. In view of this, the sizes specified in this standard have been based on the inch sizes so as not to cause the bicycle industry any immediate production difficulty. It is, however, hoped that in due course sizes of steel tubes used for bicycles will be revised to conform to rationalized metric units.

Price Re. 1·00

Insulated Stainless Steel Milk Storage Tank

Indian Standards Institution has published Indian Standard Specification for Insulated Stainless Steel Milk Storage Tank (IS : 2688—1964), which prescribes the requirements for insulated vertical cylindrical tanks of 2 000 litres capacity and horizontal tanks of capacities 5 000, 10 000 and 15 000 litres.

The insulated stainless steel milk storage tanks are widely used to store milk and liquid milk products which have already been cooled. These storage tanks will hold the milk for 24 hours with a little or no rise in the product temperature. There are two types of such tanks, namely, the conventional horizontal and the vertical cylindrical tanks. The storage tank consists of a stainless steel inner shell, suitable insulation and an outer shell and necessary accessories for operation, inspection, control and cleaning.

Price Rs 3·00

Dimensions for Cranked Handles

Indian Standards Institution has published Indian Standard Dimensions for Cranked Handles (IS : 2793—1964), which specifies the material and main dimensions of cranked handles used on machine tools.

This standard is one of a series of Indian Standards being prepared by ISI on the control elements used on a machine tool. This has been undertaken to prevent an unnecessarily large variety of shapes and dimensions of these elements being used, as well as to obtain interchangeability of these elements.

Price Re. 1·00

Methods of Temperature Measurement by Electrical Resistance Thermometers

Indian Standards Institution has published Indian Standard Methods of Temperature Measurement by Electrical Resistance Thermometers (IS : 2806—1964), which gives the methods for the measurement of temperature by means of electrical resistance thermometers.

Temperature measurements are conveniently made by the change of resistance of suitable metals of known electrical characteristics. This standard is intended to give guidance regarding the employment of such a method, its sources of errors, the inherent limitations and the precautions which should be observed.

In the measurement of temperatures it should be known what temperature measurements are essential for the purpose in view and what are non-essential but important for the interpretation of the results. It is always desirable that the aimed accuracy should be limited by the errors inherent in the measurements themselves. These errors may well be less than the tolerance for a particular process. Therefore, the magnitude of the error which would be significant, should be assessed in order to avoid the use of an unnecessarily accurate and hence expensive method.

Price Rs. 4·00

Butter Moulding Machine

Indian Standards Institution has published Indian Standard Specification for Butter Moulding Machine (IS : 2822—1964), which prescribes the general shape and design and materials for semi-automatic butter moulding machine capable of giving an output of up to 350 kg per hour of butter.

The butter moulding machine specified in this standard is meant for use in small-sized dairies for moulding table butter.

Price Re. 1·00

Method for Calibration of Pressurized Storage Tanks

Indian Standards Institution has published Indian Standard Method for Calibration of Pressurized Storage Tanks (IS : 2827—1964), which prescribes methods for calibrating the following types of vessels which are normally used for the bulk storage of liquid petroleum and petroleum products under pressure :

(*a*) Vertical tanks,
(*b*) Horizontal tanks,
(*c*) Spherical tanks, and
(*d*) Spheroidal tanks—plain and noded.

The problem of accurate measurement of bulk quantities of liquid petroleum products is not a simple one. Its solution involves accurate engineering and mathematical work, the skill of the experienced oil gauger, and the use of carefully standardized and calibrated equipments. Accuracy in measurement is essential in the sale, purchase and handling of oil. It not only obviates possible disputes between the buyer and the seller, but also provides the only reliable means of maintaining adequate control over storage and distribution losses.

The measurement of bulk quantities of liquid petroleum products involves various processes, such as temperature measurement of oils in tanks, calibration and computation of capacity tables of tanks, gauging of tanks and calculation of bulk quantities of oils in tanks. The need for accurate calibration of tanks cannot, therefore, be overemphasized. The object of this standard is to lay down methods to be adopted uniformly in the country which will enable accurate calibration of pressurized storage tanks.

In the preparation of this standard due consideration had been given to the prevailing trade practices in the country and to the need for international co-ordination among standards prevailing in different countries of the world in this field. These considerations led the Sectional Committee responsible for the preparation of this standard to base this standard on Petroleum Measurement Manual issued by the Institute of Petroleum (IP), London and standards and other publications of the American Society for Testing and Materials (ASTM), Philadelphia, USA.

This standard is one of a series of Indian Standards on methods for calibration of vessels used for bulk storage of liquid petroleum and petroleum products. It covers methods to be adopted for calibration of pressure vessels of the type (*a*) vertical cylinders, (*b*) horizontal cylinders, (*c*) spheres, and (*d*) plain spheroids and noded spheroids.

Steam-Jacketed Ghee Pans

Indian Standards Institution has published Indian Standard Specification for Steam-Jacketed Ghee Pan (IS : 2829—1964), which prescribes the requirements for steam-jacketed ghee pans of capacities 100, 300, 500 and 1,000 litres.

The ghee pan is used to make ghee from milk cream or butter by boiling with the help of steam. The construction of the ghee pan should be such that the ghee made in it shall have the characteristic aroma, it shall not char and the pan shall meet the hygienic requirements of food processing equipment.

This standard is intended to give the general requirements of the pan of the two types—stationary and tilting, with three different shapes of bottom generally in use, namely, hemispherical, conical and dished.

Price Rs. 1·50

Heavy Cee Jute Bags

Indian Standards Institution has published Indian Standard Specification for Heavy Cee Jute Bags (IS : 2874—1964), which prescribes the constructional details and other particulars of heavy cee jute bags of dimensions 101·5×71 cm (or 40×28 in).

For introduction of quality control of jute products for export, the Government of India set up in February 1963, a Study Group on Quality Control and Preshipment Inspection of Jute Goods for Export, to decide the various steps to be taken in that direction. This Study Group recommended, among other things, the formulation of Indian Standard Specifications for important export items of the products which included heavy cee jute bags of construction covered in this specification. The Sectional Committee responsible for the preparation of this specification took cognizance of this recommendation of the Study Group and therefore, this specification is also intended to serve the purpose of quality control and pre-shipment inspection of heavy cee jute bags.

This standard, in its draft form, was widely circulated to all interests, including the overseas consumers and various suggestions were received. While these suggestions were taken into consideration in finalizing this Indian Standard, there were some suggestions on which studies are being made. Development of standards, by its very nature, is a continuous process and, therefore, it is hoped to review this standard periodically on the basis of the experience gained and the studies made.

Price Rs. 2·50

Jute Corn Sacks

Indian Standards Institution has published Indian Standard Specification for Jute Corn Sacks (IS : 2875—1964), which prescribes the constructional details and other particulars of jute corn sacks (or jute corn bags) of dimensions 104×58·5 cm (or 41×23 in).

For introduction of quality control of jute products for export, the Government of India set up in February 1963, a Study Group on Quality Control and Pre-shipment Inspection of Jute Goods for Export, to decide the various steps to be taken in that direction. This Study Group recommended, among other things, the formulation of Indian Standard Specifications for important export items of the products which included jute corn sacks of construction covered in this specification. The Sectional Committee responsible for the preparation of this specification took cognizance of this recommendation of the Study Group and, therefore, this specification is also intended to serve the purpose of quality control and preshipment inspection of jute corn sacks.

This standard, in its draft from, was widely circulated to all interests, including the overseas consumers, and various suggestions were

received. While these suggestions were taken into consideration in finalizing this Indian Standard, there were some suggestions on which studies are being made. Development of standards, by its very nature, is a continuous process and, therefore, it is hoped to review this standard periodically on the basis of the experience gained in the studies made.

Price Rs. 2·50

B-Twill Jute Bags

Indian Standards Institution has prepared a draft first revision [Doc : TDC 41(810)] of Indian Standard Specification for B-Twill Jute Bags (IS : 2566—1963), which prescribes the constructional details and other particulars of B-twill jute bags of dimensions 112×67·5 cm (or 44 × 26½ in).

This standard was first published in 1963. The Sectional Committee responsible for preparation of this standard decided to revise the standard so that all standards for jute bags would fall in line.

This draft standard will be circulated shortly to interested manufacturers, consumers and technologists for eliciting technical comments.

Asbestos Cement Flat Sheets

Indian Standards Institution has prepared a draft Indian Standard Specification for Asbestos Cement Flat Sheets [Doc : BDC 2(884)].

Asbestos cement flat sheets find wide application in building industry either independently or in combination with corrugated asbestos cement sheets. They are mainly used for external wall claddings, partitions, false ceilings, panelling, furniture and dado work. They possess the advantages of ease of erection and durability of construction. This standard has been prepared with a view to providing guidance to the manufacturers and users in obtaining asbestos cement flat sheets of satisfactory quality. It is important to note that asbestos cement flat sheets are different from asbestos cement building boards which are more porus and flexible and are covered separately in (IS : 2098—1964) Specification for Asbestos Cement Building Boards.

The draft standard will be circulated shortly to all interests concerned for eliciting technical comments.

Licensed Manufacturers and Repairers

(*Metric Measures* had been publishing in the past a series of lists of licensed manufacturers, dealers and repairers of weights and measures, weighing and measuring instruments licensed by the Governments in the various States and Union Territories under their Weights and Measures (Enforcement) Acts. To economise on paper, it is possible only to publish lists of licensed manufacturers and repairers.

A new features of statistics of verification and licences issued is also being published in *Metric Measures*.

—*Editor*)

STATISTICS OF VERIFICATION OF WEIGHTS ETC. AND LICENCES

States/Union Territories	Period	Weights	Capacity Measures	Length Measures	Weighing Instruments	Measuring Instruments	Others	Total number of Mfgs. (As on first day of March 1965)	Dealers	Repairers
1	2	3	4	5	6	7	8	9	10	11
(1) Andhra Pradesh.	1 Feb. 64 to 31 Mar. 64	2,00,101	64,362	6,408	21,747	527	26	14	59	24
(2) Assam ..	1 June 64 to 31 July 64	83,104	—	19,638	490	1,075	45	19	254	238
(3) Bihar ..	1 April 62 to 31 Jan. 63.	1,28,211	—	—	19,309	56	—	30	203	43
(4) Gujarat ..	1 Apr. 64 to 31 May 64	1,77,068	13,444	1,340	21,039	107	—	125	—	158
(5) Kerala ..	—	—	—	—	—	—	—	—	—	—
(6) Jammu & Kashmir	1 Apr. 63 to 31 Mar. 64	2,12,854	2,582	7,511	683	3	4	36	36	2
(7) Madhya Pradesh.	1 Aug. 64 to 30 Sept. 64.	1,76,445	52,105	1,590	69,410	90	—	3	423	245
(8) Madras ..	1 July to 31 Aug. 64	1,59,120	92,733	1,237	23,303	864	—	—	—	—
(9) Maharashtra	1 Apr. 63 to 31 Nov. 63	12,73,216	2,94,420	5,608	—	—	—	—	—	—
(10) Mysore ..	1 Apr. 62 to 30 Nov. 62	4,81,345	1,05,253	1,089	1,96	2	—	8	103	6
(11) Punjab ..	1 Oct. 64 to 30 Nov. 64	1,39,274	9,809	2,856	19,678	87	—	62	468	103

STATISTICS OF VARIFICATION OF WEIGHTS ETC. AND LICENCES

1	2	3	4	5	6	7	8	9	10	11
(12) Orissa ..	Jan. 63 to May 64	1,97,851	30,025	1,055	4,891	77	—	8	103	6
(13) Rajasthan ..	N. A.									
(14) Uttar Pradesh	1 Aug. 64 to 30 Sept. 64	1,47,232	3,741	2,979	13,702	213	—	—	—	—
(15) West Bengal	7 Nov. 64 to 9 Jan. 65.	2,10,467	5,658	275	22,677	19	—	—	—	—
(16) Andaman & Nicobar Islands	N.A.									
(17) Delhi ..	1 June 64 to 31 Aug. 64.	59,032	5,444 +37 Petrol lorries	1,186	8,827	126	—	66	26	71
(18) Goa ..	1 Apr. 64 to 31 May 64	13,523	1,012	23	26	—	—	—	353	—
(19) Himachal Pradesh	1 Feb. 64 to 31 Mar. 64	2,062	127	72	629	5	—	—	1	—
(20) L.M.A. Islands	N.A.									
(21) Manipur ..	1 Oct. 64 to 30 Nov. 64	150	44	—	309	—	—	—	7	3
(22) Pondicherry..	1 Feb. 64 to 30 Nov. 64	4,038	1,341	36	21	4	37	4	10	3
(23) Tripura ..	1 Apr. 62 to 30 July 62	62,050	8,464	720	9	8	—	4	85	3

N.A.—Statistics not available as yet.

TYPICAL METRIC PRICING UNITS FOR WHOLESALE TRANSACTIONS

Serial No.	Commodity	Metric Unit
(1)	**Gold**	10 grams (g)
(2)	**Grocery and Confectionery**	1 kilogram (kg)
	Biscuits, sweetmeats, cardamoms.	
	Textiles and Textile Fibres	
	Cotton yarn, damaged and seconds cloth, raw silk, rayon, silk yarn, raw wool, wool manufactures (when sold by weight).	
	Paints & Chemicals	
	Paint (if sold by weight), indigo, liquid chlorine.	
	Hides, Skins & Leather	
	Raw hides, leather (hides and skins).	
	Metals	
	Silver, aluminium sheets, strips and circles, copper and brass wires and utensils.	
	Miscellaneous	
	Tea, meat, camphor tablets, mica.	
(3)	**Grains and Pulses**	1 quintal (q) (100 kilograms)
	Rice, wheat, jowar, arhar, moong, masur, gram.	
	Spices	
	Black pepper, mustard, chillies, dhania, dalchini, turmeric, betelnuts.	
	Plantation Products	
	Rubber, cashewnuts, cashew kernels, tobacco (raw and manufactured).	
	Forest Products	
	Lac and lac products, gums, myrobalans, galnuts, soapnuts.	
	Textiles & Textile Fibres	
	Raw jute, raw hemp, coir yarn.	
	Oils, Oilseeds & Oilcakes	
	Vegetable oil, oilseeds, oilcakes.	
	Non-Ferrous Metals	
	Aluminium : ingots, bars, blocks, slabs, billets.	
	Lead : ingots, sheets and strips.	
	Copper : ingots, blooms, slabs, cakes, tiles, bricks, billets, blisterbars and wirebars, rods, sections and pipes, plates, sheets and strips, circles.	
	Brass : ingots, rods, sections, pipes, sheets, strips circles.	
	Zinc : ingots, sheets, strips.	
	Tin : blocks.	
	Chemicals	
	Caustic soda, bleaching powder, glycerine, soaps, paper salt.	
	Others	
	Sugar, gur, ice, fish, sugarcane, vegetables, tamarind.	
(4)	**Minerals**	one metric tonne (t) (1,000 kilograms)
	Iron ore, manganese ore, bauxite, coal.	
	Iron & Steel	
	Pig iron, iron & steel manufactures, semis (billets for rerolling etc.)	
(5)	Cloth (mill, handloom, silk rayon and woollen cloth)	1 metre (m)
(6)	Jute carpets, coir mats and mattings, sheet glass.	one square metre (m^2)
(7)	Timber.	one cubic metre (m^3)
(8)	Paints (when sold by measure), spirits.	one litre (l)

Weights

(1) In place of the present units of seer, pound, rattal, viss etc., use the kilogram.

(2) In place of the tola, use the gram or 10 grams.

(3) In place of maund or corresponding unit, use the quintal *i. e.*, 100 kg.

Capacity Measures

In place of seer or gallon or any other measure, use the litre.

Length Measures

(1) Use the metre in place of yard or foot and the centimetre in place of inch.

Square Measures

(1) Use the square metre in place of square yard or square foot, and square centimetre in place of square inch.

Cubic Measures

(1) Use the cubic metre in place of cubic yard or cubic foot and cubic centimetre in place of cubic inch.

Packaging

It is advantageous if sizes of packages correspond to series of commercial weights and measures prescribed.

These are: 50 kg, 20 kg, 10 kg, 5 kg, 2 kg, 1 kg, 500 g, 200 g, 100 g, 50 g, 20 g, 10 g, 5 g, 2 g, 1 g, and so on.

TYPICAL PRICING UNITS FOR RETAIL TRADE

Serial No.	Commodity	Metric Unit for Use
(1)	Foodgrains, cereals, pulses, spices, ghee, bread, vegetables, meat, fish, sweetmeats, tea, coffee, sugar, salt	1 kg
(2)	Oil for cooking	1 kg or 1 litre depending upon prevalent practice.
(3)	Fruits	1 kg or number depending upon prevalent practice.
(4)	Milk	1 litre
(5)	Cloth and related materials	1 metre
(6)	Prepackaged materials	Preferably sizes corresponding to series of commercial weights and measures.

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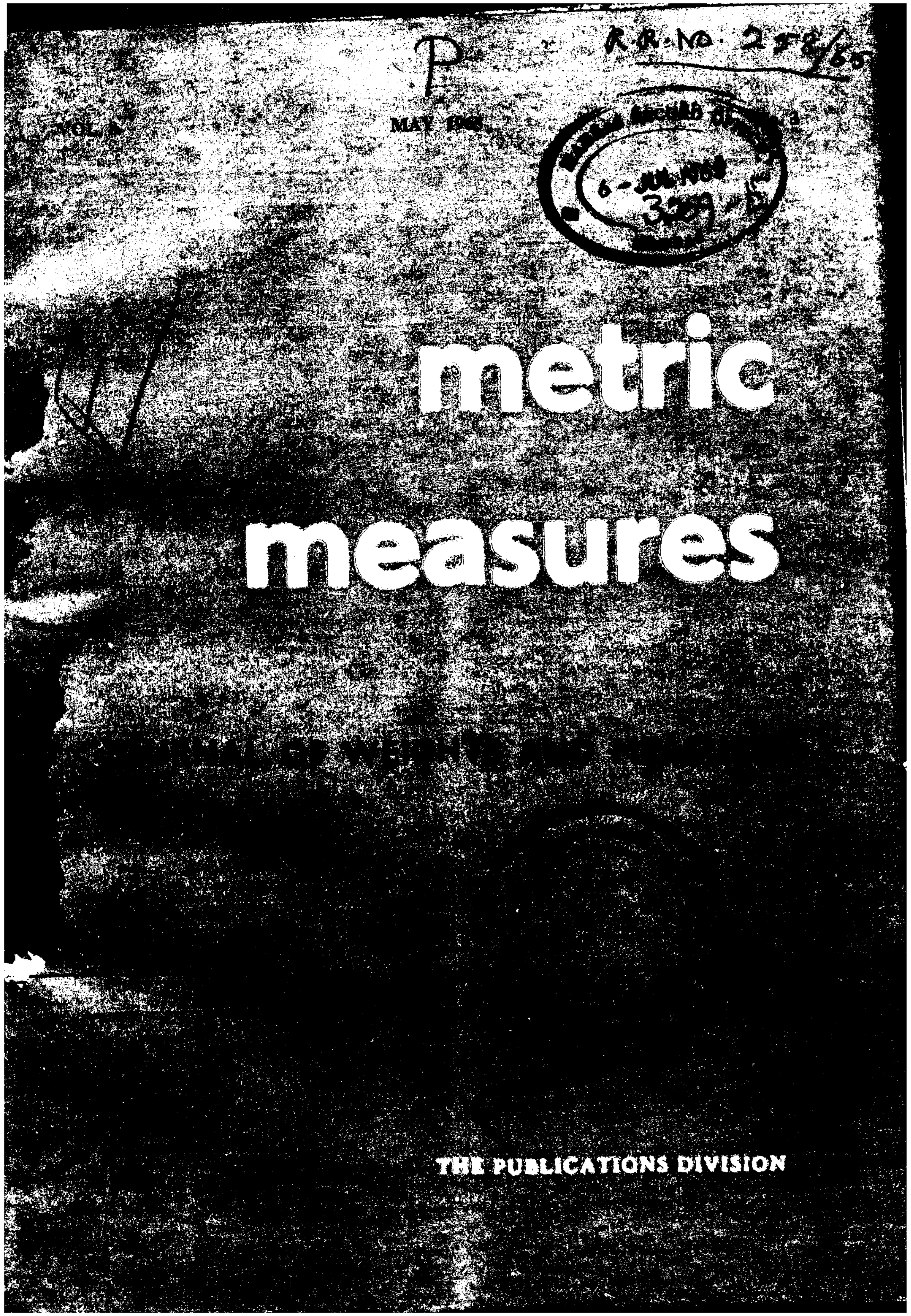

ABBREVIATION FOR METRIC UNITS

(1) DECIMAL MULTIPLES AND SUB-MULTIPLES

Prefix	Value in Terms of Unit	Abbreviation
Kilo	1,000	k
centi	$0 \cdot 01(10^{-2})$	c
milli	$0 \cdot 001(10^{-3})$	m
micro	$0 \cdot 000\,001(10^{-6})$	μ

(2) WEIGHTS

Denomination	Value	Abbreviation
tonne	1,000 kg	t
quintal	100 kg	q
kilogram	1 kg	kg
gram	1 g	g
milligram	1 mg	mg
carat	200 mg	c
(3) CAPACITY		
kilolitre	1 000 l	kl
litre	1 l	l
millilitre	1 ml	ml
(4) VOLUME		
cubic metre	m^3	m^3 or cu m*
cubic centimetre	cm^3	cm^3 or cu cm*
cubic millimetre	mm^3	mm^3 or cu mm*
(5) LENGTH		
kilometre	1 000 m	km
metre	1 m	m
centimetre	1 cm	cm
millimetre	1 mm	mm
micron	1/1 000 mm or 10^{-3} mm	μm
(6) AREA		
square kilometre	1 000 000 m^2	km^2 or sq km*
square metre	1 m^2	m^2 or sq m*
square centimetre	1 cm^2	cm^2 or sq cm*
square millimetre	1 mm^2	mm^2 or sq mm*
(7) LAND MEASURE		
are	100 m^2	a
hectare	100 a	ha
centiare	m^2	ca

*Both these abbreviations are current, but the first set should preferably be used. The former abbreviation is used more commonly internationally than the latter.

Rules for Abbreviations :

(1) Do not make any change, such as addition of 's' to indicate plurality *e.g.*, write 1 kg. 10 kg. 20 *g*. 5 g, 10 t, 20 ml, 271, 165 km, 2 mm, 100 cm^3, 66 km^2.

(2) Do not capitalize the abbreviations. For example, do not write 1 Kg, 2 Kg, 20 MM, 50 MM; the right way is to write 1 kg, 2 kg, 20 mm, 50 mm, etc.

(3) Do not use any other abbreviations except those given above.

metric measures

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Development of Length and Area Measures in Western India: part-1

V. B. MAINKAR, & L. RAJU

Ministry of Commerce,
New Delhi

IN the earlier articles,[1] we examined the length and area measures prevalent in South India through the centuries as mentioned in literature, epigraphs and other sources, in the light of the ancient Indian traditions recorded in the *Arthasastra* and the modifications made in them in the course of time. We shall now examine the extent to which similar measures in Western India were related with the *Arthasastra* and the Indian traditions we discussed in the earlier article. For the purpose of this article, Western India is taken to comprise of the present States of Maharashtra and Gujarat and some of the adjoining districts from the States of Andhra Pradesh, Madhya Pradesh, Mysore etc.

Our examination[1] had shown that there was a basic unity and continuity of metrological traditions in India. This tradition had become unrecognisable through modifications. We applied results of our study initially to South Indian measures because that region presumably preserves the ancient traditions with greater purity than the other regions. Our findings for the South are likely to be useful in examining the Western Indian traditions. A short summary may not, therefore, be out of place.

Traditions Summarized

In the most ancient Indian traditions, there are two main currents. We do not know how far the one influenced the other. The first current is represented by the Indus Valley Civilisation which is presumed to have existed from about 2500 B.C. to 1500 B.C. The second current is represented by the Veda and the traditions flowing from them.

Only three small pieces of length measures have been found in excavations in the vast region covered by the Indus Valley Civilization. These pieces do not give us much insight into their use or application for measuring lengths or areas. We cannot lay down any definite use pattern or relations for these length measures on the slender evidence available. Only after we have examined the Vedic traditions thoroughly, can we ascertain whether the Indus and Vedic traditions in this field were related or not.

The second tradition, *viz* the one arising from the Veda, found its most efficient and systematic expression in the Kautiliya *Arthasastra*. For analysing the *Arthasastra* tables for length measures, we took the 28 *angula hasta* prescribed for use in weights and measures work, as the basic hasta, and assigned to it the value of *exactly* 50 *centimetres*. The higher and lower length units as also area units like nivartana, paridesa and bahu were evaluated on this *single assumption*.

Besides the 28 angula hasta, the *Arthasastra* also prescribes the Prajapatya hasta of 24 angula, the kisku or kamsa of 32 angula, the kisku of 42 angula, and the hasta of 54 angula for area measurements. Units like vyama of 84 angula and paurusha or garhapatya dhanu of 108 angula being only multiples of the 42 angula kisku and 54 angula hasta were not taken into account. Evaluating these units in terms of the equation 28 *angula*=50 *cm*, we derived values for the area units of nivartana and paridesa on the basis of all these length units.

In the post-*Arthasastra* period, it would appear that the divisions of the hasta were changed and two modes of division came into use. One was to divide the hasta measures into 24 parts and define the angula separately for each. For example, if the yava is a constant length, the angula could be 6 yava, 7 yava, 8 yava or the length of the central portion of the middle finger, the diameter of the thumb or the length of the first joint of the thumb etc. The second method was to take the *Arthasastra* hasta of 50 cm (28 angula) and divide it into 24 parts instead of 28 and proportionately reduce the other hasta measures, the angula content thus varying. Both the traditions appear to have been popular.

An examination of the data collected for length measures showed that normally, for commercial purposes the hasta in use in South India had a length of 50 cm. Besides this unit of length measure, other units based on the land area units were also sometimes used.

We examined in detail in Part 3 of the article[1] five inscriptions which had a bearing on South Indian tradition for area measures. Using the paurusha of 108 angula defined in the *Arthasastra*, we were able to correlate and evaluate the 5 inscriptions. In one of the inscriptions, the jena was actually cut in the stone. The measured and the calculated values (45·72 cm (measured) and 45·74 cm or 45·71 cm (calculated)) were almost exactly equal. The second calculation based on the 32-angula kisku of *Arthasastra* gave directly a hasta of 45·71 cm.

Proceding on this fundamental basis, we correlated a number of other inscriptions and evaluated such ancient area units as the veli, ma, mattar, khanduga, nivartana etc.

All these area measures were related rationally in one way or another with the *Arthasastra* traditions.

From this analysis we evaluated the various area measures used in South India and recorded in the *Mannual of Administration*.

For our present article, it may be desirable to record the values we derived for such basic units as the hasta and the angula. These are given in Table 1.

TABLE 1—IMPORTANT BASIC LENGTH MEASURES USED IN SOUTH INDIA

Sl. No.	Angula (cm)	Hasta, kol, gaz etc. (cm)	Ref to Part of Article on South India
1	2	3	4
(1)	1·786	42·86 (24 angula)	
		50·00 (28 angula)	
		57·14 (32 angula) (kisku)	Part 1
		75·00 (42 angula)	
		96·43 (54 angula)	
(2)	2·08	50·00 (24 angula)	
		43·75 (21 angula)	Part 2
		37·50 (18 angula)	

TABLE 1—IMPORTANT BASIC LENGTH MEASURES USED IN SOUTH INDIA—*contd.*

1	2	3	4
(3)	2·08	50·00 (24 angula)	
	1·82	85·42 (41 angula) (Ilahi gaz?)	Part 2
		43·75 (24 angula)	
	1·56	37·50 (24 angula)	
(4)	3·812	45·74 (12 angula) (Jena)	
		83·86 (22 angula) (tutcha kol)	Part 3
		91·48 (24 angula)	
(5)	3·176	76·22 (24 angula)	Part 4
(6)	2·965	71·15	Part 5

Some Definitions

Before taking up the examination of units, it is pertinent to examine the definitions of certain terms which will be used later on.

Gaz

The gaz was commonly used in this region. There are many varieties which we shall discuss later. Normally, it was supposed to be 12/7 or 2 times the hasta. We have discussed it earlier[1] in Part 2.

Tasu

The tasu, also called tassu, tassuj, tassun, is a subdivision of the gaz. Wilson[2] defines it as follows :

> '*Tasu, tassun*—A measure of length, the 20th or 24th part of a gaz. It is known in the North-West Provinces as the subdivision of the gira'

How far this definition holds true will be seen in later discussions. There are many values assigned to the tasu.

Gira

Another unit which is often used as a subdivision of the gaz is called the gira. It is defined by Wilson as follows :

> '*Gira*—A measure of length, a tasu and a half or one-fourteenth or one-sixteenth of a gaz.'

Balfour[3] defines it as follows :

> '*Girah* in Hindi, a knot, a division of a gaz.'

As in the case of the tasu we shall come across a number of values of gira.

Kathi

According to Balfour[3] :

> '*Kathi or Cutty*—Marathi. A land measure varying from 8 to 10 cubits.'

Wilson[2] is, however, more informative :

> '*Kathi*—corruptly cutty, Marathi—A measure of land; as formerly used it was found to vary from five to ten cubits; the average for the survey was taken as the valuation of five cubits and five closed fists or feet $9 \cdot 11 \frac{175}{1{,}000}$ inches, making the bigha equal to 4383 square yards; the term also designates the measure, the rod or pole......'

The value of 9 feet 11 $\frac{175}{1{,}000}$ inches works out to 3·027 metres and the bigha is 3664·75 m^2. There were many other kathi measures besides the one given above. We shall refer to them in greater detail later on.

Jervis[4], however, indicated that 24 angula or 14 tasu form the hasta. He has summarised his findings as follows :

> 'The guz of twenty tussoos is used throughout the whole of Gujerat, Kutch, Draveed, Malabar and Canara. The guz of twenty-four tussoos

throughout Bengal and Behar, the Mharatta empire, also including the Concan, in the Carnatic and Telingana. The guz of 42 fingers is used throughout the Mahomedan Soobha of Hindustan, including the upper provinces of Bengal ceded in 1803, as also in Orissa and Cuttack. The hustu, or cubit, throughout the whole of India, both North and South of the Nurbudda river, is every where the same; that is 24 ungoolus or fingers, or 14 tussoos, in length.'

We have examined the definitions of certain important units. We may now examine the evidence as it accumulated through the centuries.

Incriptional Evidence

One of the remarkable features of Indian archaeology is that except in the Indus Valley Civilization, we rarely come across actual samples of weights, or even measures which have been dug out. The only reliable evidence, that too rather late in history, is supplied by a few inscriptions on temples, forts or other buildings, on which the representations of the basic length measures used for land area measures are inscribed on stones, pillars, walls etc. Fortunately, a few such inscribed measures have been measured and their lengths recorded by certain British and more recently Indian scholars. Most of the other inscriptions refer merely to units of land areas by name without recording their actual values or the interrelations of the units. We noticed this feature in South Indian inscriptions. The western region is no exception.

A number of inscriptions on stone and copper plates found in Western India mention area units like the nivartana, kamba, mattar, bigha, padavarta, bhakti, vrihipitaka etc.[5-11] Dr. M. R. Majumdar has pointed out in a communication to authors that a unit called santi is still current in Saurashtra and is taken to represent land tillable with one santi-plough or hala. It is often taken as 2½ vigha. Most of the above units are merely names to us except the kamba which has already been analysed. No definitions of these units are available in the inscriptions themselves.

Compared to the South, Western India has fewer ancient inscriptions on stone or other materials bearing the sketch of the actual length measures. A group of five length measures were found inscribed in some temples and forts in the Dharwar district. The measurements were first recorded in 1833 by Elliott, Subcollector of Dharwar.

According to Elliott,[12] these measures belong to the Anagoondy or Vijayanagar kings. He says :

> The measure of the Raya Rekha mar is cut on a post in the Gateway of the Gadag Fort and measures exactly 7 ft 9-1/10 in; of these 20 make a Beegah and 36 Beegas a Raya Rekha mar and another in the Buswana temple at Newlgoond gives 7 ft. 66 in. A subsequent Governor under Anagoondy introduced the Vittal Punti mar so called from his own name, into many villages of the black soil. It is marked in the temples of Anegerry and Amenbhavee and on a stone at Hebli—measuring 10 ft. 6·3 in., 10 ft. 11·8 in. and 10 ft. 6 in. respectively. It may generally be estimated as equal to three Raya Rekha mar.

In the above passage obviously 7 ft. 66 in. should be 7 ft. 6·6 in. We have then five length units :

7 ft. 9-1/10 in.	= 2·3647 m
7 ft. 6·6 in.	= 2·3012 m
10 ft. 6·3 in.	= 3·2080 m
10 ft. 6 in.	= 3·2004 m
10 ft. 11·8 in.	= 3·3477 m

The first of these has been recorded as 7 ft 9-1/2 in by the *Gazetteer*[13] for Dharwar and also by Sir Walter Elliott[14] in his article.

The actual length recorded by Elliott in 1833 is 7 ft. 9-1/10 in. This has been verified by one of the authors (V.B.M.) from the original records in the Bombay Archives.

It is said[15] that the original smaller unit consisted of 4½ hasta, but Vithal Pant increased it to 5¾ hasta *i.e.* 'the panch hath, panch muthee, twenty of which go to the side of a Vithal pant Beegah. The average punch hath-punch muthee is about ten and a half ft.'

No other length measure of this antiquity has been recorded in literature. The various accounts of the times of Bijapur kingdom and later do mention certain land measures, but these are just names as in many inscriptions. Elliott[12] (1833) mentions units like beegah and Raya Rekha mar, but whether these units are to be derived from the 7 ft. 9·1 in. measure only or also from others is not clear. He also does not mention whether this relation is inscribed or is traditional. Among area measures he mentions putees, gullas, chiggars, thuls or sthuls, koolurm, noon koolum, khumdee, koodoo, chavar, etc. For none of these, however, a definition occurs, nor has the basic length unit been defined. Other units like nitan (नितन) and partan (परतन) are also mentioned. [16-20]

Three More Measures

Another set of inscribed length units were measured recently. MM. D. V. Potdar and Shri G. H. Khare had mentioned in discussions with one of the authors (V.B.M.) that length measures had been inscribed in buildings and temples in Poona, Saswad and Amrapur. These had neither been mentioned in literature so far nor measured by anybody. At our request, Dr. P. M. Joshi, Director of Archives and Historical Monuments, Government of Maharashtra, kindly arranged to measure them accurately. He has sent the following report on his findings[21]:

(1) *Measurement of the Inscriptions in Shaniwarwada at Poona, Dist. Poona.* The length of the line mark in the side wall of the staircase to Nagarkhana of Shaniwarwada is 2335 millimetres and has a projection of 260 mm in cross wall. There is doubt whether the line mark represents some measurement or is simply a line in view of its projection in the cross wall. There is no other inscription in the staircase leading to Nagarkhana.

(2) *Measurement of Kathi Measure at Saswad, Dist. Poona.*—There is no inscription of kathi as such at Saswad but a portion of the plinth of a small room from one of its extreme corners to the mark of one hole was taken as standard for kathi measurement in old days by village people. The same measures 3183 mm. This room is situated at the entrance of old wada of Nana Saheb Purandare and now Tai Saheb Purandre widow of Malharrao Purandare is the owner of the Wada.

(3) *Measurement of the Inscription at Amrapur, Tal. Shevgaon, Dist. Ahmadnagar.*—The length of the portion between two line marks on a block of stone in Chawdi (now converted in Vithal Rakumai Temple) at Amrapur is 1000 mm and there is one more mark at a distance of 400 mm from one side and 800 mm from another side of the stone.

Jervis' Measures

There is no other record of the actual length measures used in Western India until 1834 when Jervis[4] made an exhaustive survey of the length and area measures of that region. He has recorded the various length measures actually measured by him or by others. These are summarized in Table 2 and Table 3. Some of these were used directly as length measures while others were used as the base for area measures. We have not included the measures, the lengths of which he has calculated on certain assumptions.

The calculated lengths in col. 6 of Table 2 and Table 3 are worked out on the basis of tasu, gira and angula worked out in Table 4.

TABLE 2—VALUES OF GAZ ACTUALLY MEASURED

Sl. No.	Place or Town	Unit	Length recorded in	Length recorded cm	Length Calculated (cm)	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1)	Sawantwadi	gaz	27·5	69·85	(1) 3·485×20=69·70	20 tasu
(2)	Bombay	,,	27·5	69·85		
(3)	Vengurla	,,	27·588	70·0735	(2) 3·494×20=69·88	,,
(4)	Ahmedabad (kinkab manufacturers)	,,	27·75	70·485	49·53×20/14=70·76	,,
(5)	Cambay	,,	28·5	72·39	3·571×20=71·42	,,
(6)	Sangli, Miraj & Tasgaon	,,	30·9	78·49	3·267×24=78·41	24 ,,
(7)	Hubli	,,	31·75	80·65	4·066×24=81·32	24 ,,
(8)	Ratnagiri	,,	32·315	82·08		,,
(9)	Dharwad	,,	32·75	83·19	(1) 3·485×24=83·64 (2) 3·494×24=83·86	,,
(10)	Malvan	,,	32·765	83·22		,,
(11)	Malvan Kusba	,,	32·815	83·35		,,
(12)	Vijaydurg	,,	32·830	83·39		,,
(13)	Bagalkota	,,	32·875	83·50		,,
(14)	Belgaum	,,	32·875	83·50		,,
(15)	Wurad Mubal	,,	32·966	83·73		,,
(16)	Nalgund	,,	33	83·82		,,
(17)	Salsee Muhal (I)	,,	33·566	85·26	3·571×24=85·71	,,
(18)	Salsee Muhal (II)	,,	33·716	85·64		,,
(19)	Chiplun	,,	33·716	85·64		,,
(20)	Sangli, Miraj & Tasgaon	,,	33·8	85·85		,,
(21)	Baji Rao Peshwa	,,	33·86	86·00		(Sl. No. 21 was said to be the standard gaz of the Marathas)
(22)	Sauksi	,,	33·866	86·02		,,
(23)	Suvarndurg	,,	33·866	86·02		,,
(24)	Malund Muhal	,,	33·916	86·15		,,
(25)	Vengurla	,,	33·916	86·15		,,
(26)	Haveri	,,	34·75	88·27	(1) 43·75×2=87·50 (2) 51·88×24/14=88·94	,,

From the data given above under col. (4), Jervis draws the following conclusions regarding the mean length of the gaz.

(1) Gaz of 20 tasu = 27·9271 in (70·93 cm)

(2) Gaz of 24 tasu = 33·5125 in (85·12 cm)

(3) Gaz of 42 angula = 34·2106 in (86·89 cm)

(4) Cubit (hasta) of 14 tasu or 24 angula = 19·54893 in (49·66 cm).

Jervis[4] has also recorded the lengths of a number of kathi or land measuring rods which have been actually measured from physical samples. Table 3 lists these.

TABLE 3—LAND MEASURING RODS

Sl. No.	Place or Town	Unit	Length Recorded in	Length Recorded m	Length Calculated (m)	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)
			GUJARAT			
(1)	Dholka Pargana	Guntha/wasa	94	2·388	(1) 40·81×35/6=2·381 (2) 47·62×5=2·381 (3) 3·176×75=2·382	5 hasta (bamboo) 5 hasta
(2)	Munda	,,	94·85	2·409	48·22×5=2·411	5 hasta
(3)	Mahtur Pargana	,,	96·35	2·447	48·98×5=2·449	5 hasta (A bamboo)
(4)	Napa	,,	97	2·464	2·449	(This was used as the Petlad kutcheri standard).
(5)	Petlad Pargana	,,	97	2·464	2·449	5 hasta (A standard)
(6)	Umred Kasba	,,	97	2·464	2·449	5 hasta
(7)	Kapadwanj	,,	97	2·464	2·449	5 hasta
(8)	Petlad	,,	97·2	2·469	2·449	5 hasta (Marked on a pillar in Petlad)
(9)	Mahmoodabad	,,	98·35	2·498	50×5=2·500	5 hasta (standard marked on Kazi's house).
			MAHARASHTRA			
(10)	Ratnagiri	,,	110·66	2·811	48·22×35/6=2·813	5 hasta, 5 mushti
(12)	Awachitgad	,,	111	2·819		,,
(13)	Suvarndurg	,,	112	2·845	48·79×35/6=2·846	,,
(14)	Raigad	,,	112	2·845		,,
(15)	Anjanwel	,,	112·75	2·864	(1) 57·14×5=2·857	,,
(16)	Rajpuri	,,	112·75	2·864	(2) 48·98×35/6=2·857	,,
(17)	Salsette	,,	112·8	2·865		,,
(18)	Sanskee Prant Kathi	,,	113	2·870		,,
(19)	Malik Ambar's or Shivashahi	,,	93·96	2·387	(1) 40·81×35/6=2·381 (2) 3·176×75=2·382 (3) 47·62×5=2·381	Not mentioned
(20)	Safi Khan's (1664)	,,	93·96	2·387		,,
(21)	Vijaydurg (Naro Trimbak's)	,,	114·254	2·902	50×35/6=2·917	5 hasta, 5 mushti
			OTHERS			
(22)	Jambusar, Amod, Dehej	,,	245·25	6·229	68·88×9=6·199	9 gaz, (gaz=20 tasu) for measuring area of kumbha.
(23)	Broach, Ankleshwar Hansat	,,	89·6	2·276	48·79×4-2/3=2·277	4 hasta, 4 mushti.

NOTE : For explanations of calculated values, see Table 4.

Some Basic Measures Calculated

Before we proceed with the analysis of the data so far presented we may carry out certain fundamental calculations.

The kisku of 32 angula (57·14 cm) mentioned in the *Arthasastra* is an important unit. We found that many South Indian units could also be derived from the kisku.

An important concept in the Western region is the subdivision of the gaz into tasu or gira. Normally, 12 or 14 tasu made the hasta or hat, 20 or 24 tasu or 16 gira made the gaj. The kathi was five hat for Gujarat or 5-5/6 hat in Maharashtra *i.e.*, 120 angula or 140 angula. Tasu usually consisted of two angula and the gira of three angula. But this was not a very strict practice. So the kathi is taken often to be 60 tasu or 70 tasu. To facilitate analysis, we shall divide certain important length units into 12, 14, 16 and 20 parts. Each part we shall call tasu. We shall then multiply each tasu by 10, 12, 14, 16, 20, 24, 60 and 70 to obtain the hat, gaj and kathi measures. Certain deviations are presented later on.

The length measures taken into account are :

(1) Kisku of *Arthasastra* = 57·14 cm.

(2) Hasta of *Arthasastra* = 50·00 cm.

(3) Hasta based on the kamma = 48·79. cm (see Part 3 of article on South India[1]).

(4) Hasta = ½ hasta of 54 angula of *Arthasastra* = $\frac{96\cdot 43}{2}$ = 48·22 cm.

(5) Hasta = 45·74 cm (derived in Part 3 of article on South India[1] and from 57·14 cm kisku).

The results are summarised in Table 4.

TABLE 4—TASU, HASTA, GAJ & KA..

The Principal length unit is divided into 12, 14, 16, 20, parts to obtain the tasu in Column 2. The tasu is then multiplied by 10, 12, 14, 16, 20, 24, 60 and 70 to obtain the hat, gaj and , the kathi

Sl. No.	Tasu cm	× 10 cm	× 12 cm	× 14 cm	× 16 cm	× 20 cm	× 24 cm	× 60 cm	× 70 cm
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
				Kisku=57·14 *cm*					
(1)	4·762	47·62	57·14	66·67	76·19	95·24	114·28	2·857	3·333
(2)	4·081	40·81	48·98	57·14	65·30	81·62	97·96	2·449	2·857
(3)	3·571	35·71	42·86	50·00	57·14	71·42	85·72	2·143	2·500
(4)	2·857	28·57	34·28	40·00	45·71	57·14	68·57	1·714	2·000
				Hasta=50·00 *cm*					
(5)	4·167	41·67	50·00	58·34	66·67	83·34	100·00	2·500	2·917
(6)	3·571			As in Sl. No. (3) above					
(7)	3·125	31·25	37·50	43·75	50·00	62·50	75·00	1·875	2·187
(8)	2·500	25·00	30·00	35·00	40·00	50·00	60·00	1·500	1·750
				Hasta=48·79 *cm*					
(9)	4·066	40·66	48·79	56·92	65·06	81·32	97·58	2·440	2·846
(10)	3·485	34·85	41·82	48·79	55·76	69·70	83·64	2·091	2·440
(11)	3·049	30·49	36·59	42·69	48·79	60·98	73·18	1·829	2·135
(12)	2·440	24·40	29·28	34·16	39·04	48·79	58·56	1·464	1·708
				Hasta=48·22 *cm*					
(13)	4·018	40·18	48·22	56·25	64·29	80·36	96·44	2·411	2·813
(14)	3·444	34·44	41·33	48·22	55·10	68·88	82·66	2·066	2·411
(15)	3·014	30·14	36·17	42·20	48·22	60·28	72·34	1·809	2·110
(16)	2·411	24·11	28·93	33·75	38·58	48·22	57·86	1·447	1·688
				Hasta=45·74 *cm*					
(17)	3·812	38·12	45·74	53·37	60·99	76·24	91·48	2·287	2·668
(18)	3·267	32·67	39·20	45·74	52·27	65·34	78·41	1·960	2·287
(19)	2·859			As in Sl. No. 4					
(20)	2·287	22·87	27·44	32·02	36·19	45·74	54·88	1·372	1·601
(21)	3·176	31·76	38·12	44·47	50·82	63·53	76·23	1·906	2·223

We should remember that each of the above hat units could have been used independently. Let us take an example. The hat of 40 cm is 14 tasu of 2·857 cm each. The kathi based on this should be 70 tasu *i.e.* 2.00 m. But if the hat is treated as a separate unit and taken 5-5/6 times, the kathi would be :

$$\frac{40\times 35}{6} = 2\cdot 333 \text{ metres.}$$

This kathi is used in explaining the Shaniwar Wada measure in a later section.

Another instance is the hat of 47·62 cm in Sl. No. (1) of Table 4. This hat gives a kathi of 47·62×5 = 2·381 metres, which we can use to explain certain kathi measures analysed by Jervis and recorded here in Table 3. Again $\frac{40\cdot 81\times 35}{6} = 2\cdot 381$m.

We may also consider the subdivisions of the tutcha-kol we derived in Part 4 of the article on South India[1]. The tutcha-kol of 83·86 cm was often divided into 24 parts in use. We shall call this division a tasu and obtain various measures based on it as follows:

$$\text{Tasu} = \frac{83\cdot 86}{24}$$

$$= 3\cdot 494 \text{ cm.}$$

10 tasu = 34·94 cm; 20 tasu = 69·88 cm;

12 tasu = 41·93 cm; 24 tasu = 83·86 cm;

14 tasu = 48·92 cm; 60 tasu = 2·097 m;

16 tasu = 55·91 cm; 70 tasu = 2·446 m.

We shall have occasions to refer to many of these values later on.

The Dharwar Measures

We may now examine the length units inscribed in Dharwar temples and forts as reported by Elliott[12]. There are five measures which fall into four groups as follows :

	Given	Calculated		
(1)	2·301 m	60×3·812	= 2·287 m	(5 hasta)
		4×57·14	= 2·286 m	(4 hasta)
		70×3·267	= 2·287 m	(5-5/6 hasta)
(2)	2·365 m	62×3·812	= 2·363 m	(5-1/6 hasta)
		4½ ×52·60	= 2·367 m	(4½ hasta)
		35/6×40·66	= 2·372 m	(5-5/6 hasta)
(3)	3·200 m	5×2× 32·02	= 3·202 m	(5 hasta)
	3·208 m	35/6×54·88	= 3·202 m	(5-5/6 hasta)
(4)	3·348 m	88×3·812	= 3·354 m	(7-1/3 hasta)
		35/6×57·14	= 3·333 m	(5-5/6 hasta)

These measures may be derived from the angula of 3·812 cm. But the result does not always lead to rational explanations. So other plausible explanations are also given. The hasta of 52·60 cm occurs in Krishna district[1]. The hasta of 54·88 cm is explained in Sl. No. 20, Table 4. Another peculiar feature is that except for the 2·287 m and 3·202 metre rods, the use of other measures either in South India or in Western India appears rather restricted. The 3·202 m measure or its multiples were in the use in North Arcot[1], and will be seen to recur in Saswad.

The Archives Measures

We may now examine the information given by the Director of Archives, Maharashtra.[21] Of the three measures, the Saswad measure of 3·183 metres is immediately seen to be related with the 3·202 m measure examined above. The difference of about 19 mm in 3200 *i.e.* 1 in 160 is not large considering the condition of the inscribed measure. It may perhaps be regarded as an adapted measure used to give a bigha equal to an acre.

The measure of 1·000 m at Amrapur is related with the 40 cm hasta derived earlier. It represents $2\frac{1}{2}$ of these hasta and the marks at 400 mm and 800 mm are perhaps divisions of the hat of 40 cm (see Sl. No. 4, Table 4).

The Shaniwar Wada measure is interesting. It has two peculiarities. One wall has a long measure of 2·335 m inscribed on it and at right angles there is a smaller measure of 260 mm *i.e.* 26·0 cm. Now $260\times9=2{\cdot}340$ m *i.e.* the longer measure is 9 times the smaller. When we examined the garden land measures in Krishna district[1], we came across a measure of $4\frac{1}{2}$ cubits or 2·337 m. Now $4\frac{1}{2}$ hasta are equal to 9 vitasti (spans). We may, therefore, conclude that the two measures are identical. The cubit or hasta of Krishna district was worked out on the basis of the adi of 26·68 cm to be 51·88 cm, thus giving a vitasti or span of 259·4 mm $\left(\frac{51{\cdot}88}{2}\right)$ which is equal to 260 mm, well within the accuracy of measurement. But an alternative explanation can also be given for this hasta, though it is not as direct as would be desirable. The angula of 3·1764 cm can be derived from the kisku of 57·14 cm. Proceeding on tasu basis (14 tasu=1 hasta), the hasta is $14\times3{\cdot}1764 = 44{\cdot}47$ cm. To bring it to the tradition of 5 hasta, 5 mushti, we may add 1 mushti (6 mushti=1 hasta) *i.e.* $\frac{44{\cdot}47}{6}=7{\cdot}412$ cm. So one hasta and one mushti is $44{\cdot}47+7{\cdot}41=51{\cdot}88$ cm. Taking this as a new hasta, we get for $4\frac{1}{2}$ hasta= $51{\cdot}88\times9/2=2{\cdot}335$ metres.

There is still another explanation for this rod, but unrelated with the vitasti. Let us take the Amrapur hasta of 40 cm and multiply it by 5 hasta and 5 mushti *i.e.* $40\times35/6 =2{\cdot}333$ metres, which is only 2 mm off from the measured length.

As a matter of interest it may be recorded that $51{\cdot}88\times5\text{-}5/6=3{\cdot}026$ m. This explains the kathi measure of 3·027 m referred to earlier while defining the kathi.

The Jervis Measures

We may now examine the various length measures recorded by Jervis[4]. These are given in Tables 2 and 3, along with the possible derivations on the basis of the calculation made in Table 4.

In Table 2, only three gaj measures do not seem to be easily explained. These are the measures of 80·64 cm, 82·08 cm and 88·27 cm. The explanation for the former two is based on the fact that 24 tasu of 4·066 cm (derived from the hasta of 48·79 cm), give a gaz of 81·32 cm. The Haveri gaz of 88·27 cm is based on the hasta of 7 yava *i.e.* 43·75

cm instead of 42·86 cm; the latter was used for deriving the gaz of 85·71 cm. The former is 87·50 cm. Alternatively, it could be based on the hasta of 51·88 cm. i.e. $\frac{51{\cdot}88\times24}{14}$ $=88{\cdot}94$ cm.

Among the land measuring rods, recorded by Jervis[4] we notice two main groups, one of 2·464 m in Gujarat area and the second of 2·864 m in Maharashtra. We have assumed that both these had perhaps a common base, the one being longer than the other because one was 5 hat long and the other 5-5/6 hat long. In the process of derivation a difference of 15 mm is noticeable in the Gujarat measure and 7 mm in the Maharashtra measure from the recorded values. These differences are somewhat minor as they are of the order of 10 in 2,500 *i.e.* 1 in 250.

Another strange fact should be noted. The measures inscribed in the Shaniwar Wada and other places do not find a place in Jervis' measurements. It is likely that the measures examined by Jervis were fabricated only about 10 to 20 years before their scrutiny *i.e.*, say around 1800-1820. He did not obtain any samples of measures going back 70-80 years nor did he perhaps have the knowledge of the inscribed measures.

Having considered the various commercial and land length measures, we shall take up the examination of the length and area measures used in Maharashtra in Part 2 and Gujarat in Part 3.

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Newton : Unit in Science and Engineering

P. VENKATRAMAIAH
Professor and Head of Physics Department,
Govt. College, of Engineering,
Kakinada.

THE newton has now been prescribed as a unit of force for international use. In this article the importance of newton in relation to older units is brought out.

Newton as a unit has unparalleled importance in the metric system of units. It is like a string passing through all the beads of a chain. It influences almost all the units of the physical quantities in mechanics and electromagnetism.

Newton is the unit of force in the International system of units (SI). The name newton was suggested for the first time by Prof. David Robertson in 1904 to commemorate the great scientist, Sir Issac Newton (1642-1727), and the suggestion was finally accepted in 1950.

Definition

A newton is that force, which when applied to a body having a mass of 1 kilogram, gives it an acceleration of 1 metre per second per second.

The letter symbol for newton is 'N'

Newton and Force

From Newton's second law of motion we get :

$$\text{Force} = \text{mass} \times \text{acceleration.}$$

The unit of force in the International system of units (SI) is derived from this equation :

$$\text{Unit of force} = 1\ \text{kg} \times 1\ \text{m/s}^2 = 1\ \text{kg.m/s}^2$$

This unit of force is called newton.

$$\begin{aligned} 1\ \text{N} &= 1\ \text{kg}\cdot\text{m/s}^2 \\ &= 1000\ \text{g} \times 100\ \text{cm/s}^2 \\ &= 10^5\ \text{g}\cdot\text{cm/s}^2 \\ &= 10^5\ \text{dynes} \\ F &= m \times g \end{aligned}$$

$$\begin{aligned} 1\ \text{kilogram force} &= 1\ \text{kilogram} \times 9 \cdot 81\ \text{m/s}^2 \\ \text{(Kilopond)} &= 9 \cdot 81\ \text{kg. m/s}^2 \\ &= 9 \cdot 81\ \text{newtons} \\ &= (9 \cdot 80665\ \text{N exactly}). \end{aligned}$$

The relation between the various units of force is given in Table 1.

TABLE 1

UNITS OF FORCE—CONVERSION

Force	Dyne	kgf	Newton	Pound	Poundal
1 dyne	1	$1 \cdot 020 \times 10^{-6}$	10^{-5}	$2 \cdot 248 \times 10^{-6}$	$7 \cdot 233 \times 10^{-5}$
1 kilogram force	$9 \cdot 807 \times 10^5$	1	9·807	2·205	70·93
1 Newton	10^5	0·1020	1	0·2248	7·233
1 Pound	$4 \cdot 448 \times 10^5$	0·4536	4·448	1	32·17
1 Poundal	$1 \cdot 383 \times 10^4$	$1 \cdot 410 \times 10^{-2}$	0·1383	$3 \cdot 108 \times 10^{-2}$	1

The dyne is a force of about 10^{-6} kg or about 1 milligram and is so small that it is practically impossible to appreciate its magnitude. The newton, on the other hand, is equal to a force of nearly $\frac{1}{4}$ lb or about 1/10 kg and is, therefore, a quantity whose value can be easily appreciated.

Thus, we find the relation between the mechanical and electrical energy based on the newton.

1 newton-metre = 1 volt. ampere. second
1 N.m = 1 V.A.s

TABLE 2

UNITS OF PRESSURE CONVERSION

Pressure	atm	inch of water	cm. Hg.	N/m^2	lb/n^2
1 atmosphere	1	406·8	76	$1·013\times10^5$	14·70
1 inch of water (a)	$2·458\times10^{-3}$	1	0·1868	249·1	0·03613
1 cm of mercury (a)	$1·316\times10^{-2}$	5·353	1	1333	0·1934
1 newton per $metre^{-2}$	$9·869\times10^{-6}$	0·004105	$7·501\times10^{-4}$	1	$1·450\times10^{-4}$
1 pound per $inch^2$	$6·805\times10^{-2}$	27·68	5·171	$6·895\times10^3$	1

(a) Under standard gravitational acceleration and temperature of 40°C for water, 0°C for mercury.
1 cm of water = 98·07 N/m
1 ft of water = 62·43 Lb/ft

Newton and Pressure

Pressure is defined as force per unit area. Its unit is, therefore, 1 newton/$metre^2$ (N/m^2).

The relation between (newton/$metre^2$) and the other units of pressure is given in Table 2.

Newton and Work or Energy

The unit of work or energy is 1 newton ×metre. One newton×metre is defined as the work done when the point of application of a force of one newton is displaced through a distance of one metre in the direction of the force. This unit is called Joule.

Work = Force × distance
1 joule = 1 newton × 1 metre
= 1 N.m

The electrical unit of energy is obtained as follows :

W = E.Q.
Joule = 1 volt×1 coulomb.
= 1 volt×1 ampere×1 second
= 1 V.A.s.

Joule is used as the unit for thermal energy and watt-second for magnetic energy. We find the following relation to hold good :

1 N.m =1 V.A.s =1 W.s =1 J
(Mechanical) (Electrical) (Magnetic) (Thermal)

The definitions of ampere and volt facilitate the formation of this relation.

Newton and Power

Unit of power is 1 newton-metre (Joule) per 1 second (N.m/s or J/s.) This is called watt. Thus we find that newton enters into the definition of the unit of power.

Newton and Some Other Mechanical Quantities

Stress is expressed in newtons per square metre (N/m^2). Elastic modulus is expressed in newtons per square metre (N/m^2). Surface tension is expressed in newtons per metre (N/m^2)

Gravitational constant $(G)=6·670\times10^{-11}$ $N.m^2/kg^2$

Newton and Electric Charges

Coulomb's law of force between two point charges is given by $F = \frac{Kq_1q_2}{r^2}$

where K is a proportionality constant whose magnitude depends on the units in which the force, charge and distance are expressed. From this equation Coulomb is defined as that point charge, which repels an equal charge of the same sign with a force of 9×10^9 newtons when the charges are one metre apart in vacuum.

$$\therefore\ K=9\times10^9\ \frac{N\,m^2}{C^2}$$

This odd value comes out because of the International system of units.

In the RMKS units, $F=\frac{1}{4\pi\,\varepsilon o}\ \frac{q_1\,q_2}{r^2}$

such that $\frac{1}{4\pi\,\varepsilon o}=K=9\times10^9\ \frac{N.m^2}{C^2}$

$$\varepsilon o=\frac{1}{4\pi\times9\times10^9}\ \frac{C^2}{N.m^2}$$

$$=8·85\times10^{-12}\ \frac{C^2}{N.m^2}$$

It may be noted that, in the e.s.u. system, one stat-coulomb is defined as that charge which repels an equal charge of the same sign with a force of one dyne, when the charges are separated by one centimetre in vacuum. Therefore, Coulomb's law is of the simple form :

$$F=\frac{q^1q^2}{r^2}$$

Newton and the electric Field

Electric field or intensity at any point is measured as the force experienced per unit charge placed at that point :

E=F/q (1)

In the International system of units, since force is expressed in newtons, and charge is Coulombs, the unit of electric intensity will be one newton per coulomb.

Electric field strength or intensity of field in any direction is also defined as the potential gradient in that direction.

$$E=-\frac{dv}{dx} \qquad (2)$$

Therefore, the unit of electric field will be one volt per metre.

From (1) and (2) :

1 newton per coulomb=1 volt per metre. Both these are equivalent units of electric field.

Newton and Capacitance

Newton enters into the units of capacitance. For example, in the RMKS system, the capacitance of a parallel plate capacitor is given by:

$$C=\varepsilon o\ A/d$$

In the RMKS system, permittivity of free space ;

$$\varepsilon o=8·85\ \times10^{-12}\ \ C^2/N.\,m^2$$

Thus in the units of εo we find newton.

$$\therefore C=8·85\times10^{-12}\ \frac{C^2}{N.\,m^2}\times\frac{m^2}{m}$$

$$=8·85\times10^{-12}\ \ C^2/N.m.$$

But $\frac{C^2}{\text{Newton metre}}=\frac{\varepsilon^2}{\text{Joule}}=\frac{C}{\text{Joule/C}}=\frac{C}{\text{Volt}}$ =farad.

Thus, we find that : $\frac{C^2}{N.m.}$ =Farad.

Hence, capacitance is expressed in farads. Even though capacitance is expressed in farads it has newton also in its units.

Newton and Ampere

The definition of ampere changes in the International system because newton is chosen as the unit of force.

Ampere is that constant current, which flowing in two parallel straight conductors of infinite length, of negligible circular cross section and placed at a distance of one metre from each other in vacuum produces a force of 2×10^{-7} newtons per metre length between the conductors.

How the value of this force works out to 2×10^{-7} newtons will be seen from the following calculations.

In RMKS system in which $\mu_0=4\pi\times10^{-7}$ henry/metre, the force between two parallel conductors is given by:

$$F=\frac{\mu I_1 I_2 l}{2\pi R}$$

Now $\mu=\mu_0=4\pi\times10^{-7}$ henry/metre.

But henry/metre$=\frac{\text{weber}}{\text{ampere. metre}}$

$$=\frac{\text{Volt. second}}{\text{ampere. metre}}$$

$$=\frac{\text{volt. second. ampere}}{(\text{ampere})^2\text{. metre}}$$

$$=\frac{\text{volt. coulomb}}{(\text{ampere})^2\text{ metre}}=\frac{\text{Joule/metre}}{\text{ampere}^2}$$

$$=\frac{\text{newton}}{\text{ampere}^2}$$

$\therefore$ $\mu=\mu_0=4\pi\times10^{-7}$ newton/ampere^2

$I_1=I_2=1$ ampere, $l=1$ metre, $R=1$ metre substituting these values:

$$F=4\pi\times10^{-7}\ \frac{\text{n}}{\text{A}^2}\times\frac{1\text{A}\times1\text{A}\times1\text{m}}{2\pi\times1\text{m}}$$

$$=2\times10^{-7}\ \text{newton}$$

It will be interesting to note that the ampere is expressed in terms of metre and newton i. e. in principle the ampere can be established with the help of a metre stick and a spring balance.

Newton and Magnetic Induction

Just as the vector quantity E, the electric intensity characterizes an electric field, B, the magnetic induction, which is also a vector quantity, characterizes the magnetic field. The magnitude of magnetic induction B at any point is defined as:

$$B=\frac{F}{q\ v\sin\phi}$$

where q is the magnitude of the charge, v its velocity, ϕ the angle between v and the direction of the magnetic field and F the force acting on a moving charge at the point.

When F is expressed in newtons, q in coulombs and v in metres per second, B is said to be in 'webers per square metre.' Thus, one 'weber per square metre' is the magnetic induction of a magnetic field in which one coulomb of charge, moving with a component of velocity perpendicular to the field (v sin ϕ) equal to one metre per second, is acted on by a force of one newton. Hence, 1 weber/metre^2=

$$\frac{1\ \text{newton}}{\text{coulomb}\times\text{metre per second}}$$

$$=10^4\ \text{gauss.}$$

In International system of units, magnetic inductance is denoted by the unit Tesla, symbol T.

Newton and Magnetic Pole

Though the method of radial field due to isolated magnetic poles is to be replaced in the RMKS system by the uniform magnetic field of a solenoid for the study of magnetism, still the concept of a magnetic pole is useful for a concrete understanding of the subject.

In the RMKS unit system, Coulomb's law of force between two magnetic poles is given by:

$$F=k\ m_1\ m_2/r^2$$

where K is a constant of proportionality m_1, and m_2 are expressed in webers, r in metres and $K=\frac{1}{4\pi\mu_0}$ where μ_0 is the permeability of free space and $\mu_0=4\pi\times10^{-7}$ newton/ampere^2. It was already shown that

$$\frac{\text{newton}}{\text{ampere}^2}=\frac{\text{henry}}{\text{metre}}$$

$$\therefore F=\frac{m_1 m_2}{16\pi^2\times10^{-7}r^2}\ \text{newtons}$$

From this equation weber can be defined as that pole which repels an equal pole of the same sign with a force of $1/16\pi^2\times10^{-7}$

newtons when the charges are one metre apart in vacuum. This odd value of $1/16\pi^2\times10^{-7}$ getting into this equation is due to the value given to μ_0 in the RMKS units.

It may be noted that in e.m.v. system, one unit charge is defined as that charge which repels an equal charge of the same sign with a force of one dyne when the charges are separated by one centimetre in vacuum. Coulomb's law is of a simple form:

$$F=\frac{m_1\ m_2}{r^2}$$

Newton and the Engineer

The engineer is accumstoed to use the length, force and time (L.F.T.) as the basic quantities. Thus his system has been the metre, kilogram-force and second system (m. kgf. s). In this system force is used to find the mass mass=force/gravity. Thus his unit of mass is obtained by dividing one Kilogram-force by g, the acceleration due to gravity.

$$\therefore\text{unit of mass}=\frac{\text{kgf}}{\text{m/s}^2}=\frac{\text{kgf. s}^2}{\text{m}}$$

The engineer is, therefore, familiar with kilogram as a force and not as a mass. This makes it difficult for him to adjust his mind to the International system which is now universally adopted both for science and technology. To accustom him to the new units a few conversions are given below as examples.

Force : 1N=1/9·80665 kgf.=1/9·81 kgf

1kgf=9·80665 N=9·81 N

It should be clearly understood from this that the number of kilogram-force should be multiplied by the rounded value of 9·81 to give the number of newtons and the number of newtons should be divided by 9·81 to give the number of kilogram-force.

Work : 1J =1 Nm=1/9·81 kgf. m

1kgf. m=9·81 N. m=981 J

Power : $1\,W=\frac{J}{s}=\frac{\text{N. m}}{s}=\frac{\text{kgf.m}}{9\cdot81}$

$$\frac{1\ \text{kgf.m}}{s}=\frac{9\cdot81\ \text{N.m}}{s}=\frac{9\cdot81\text{J}}{s}=9\cdot81\text{W}$$

Pressure : $\frac{N}{m^2}=\frac{1/9\cdot81\ \text{kgf.}}{m^2}$

$\therefore$ 1 kgf/m^2=9·81 N/m^2

Similarly, conversions of other quantities can be obtained.

Newton and the Physicist

It is easy for the physicist to use newton in allquantities and equations, because newton$=10^5$ dynes and because he is already familiar with dyne as the unit of force. Further, he is accustomed to the unit system of which length, mass and time are the basic quantities. The International System of units also uses length, mass and time (metre, kilogram and second) as the basic quantities. Therefore, no change in his knowledge of the system is necessary for him to adapt himself to newton.

Necessity of Newton

Whether easy or not, it has become inevitable for both the scientist and the engineer to use newton as the unit of force hereafter as it has been prescribed in the Internatonal system of units.

Acknowledgements

My thanks are due to Prof. V. V. L. Rao, Principal, College of Engineering, Anantapur for kindly supplying me with a number of books and papers on the subject, and for his valuable suggestions in finalising this paper.

My grateful thanks are also due to the following authors, and publishers from whose publications some tables and material have been reproduced in this paper.

(i) *A Guide to the Metric System.*—Prof. V. V. Rao, (Asia Publishing House).

(ii) *Elements of Physics*—George Shortley and Dudley Williams, Vol. 2; (Prentice Hall Inc. Englewood Cliffs. N. J.)

(iii) *The Unit of Force 'Newton'*.—Dr. Walter Haeder, Berlin.

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(12) ISO/R31/II-1958 Quantities and Units of Periodic and Related Phenomena.

(13) ISO/R31/III-1960 Quantities and Units of Mechanics.

(14) ISO/R31/IV—1960 Quantities and Units of Heat.

Adjustment of Sensitivity of a Knife-edge Balance

P. C. JAIN

Standards Division,
National Physical Laboratory,
New Delhi

THE sensitivity of a knife-edge balance is defined in a number of ways. Some of these definitions are not quite complete. In scientific language, sensitivity may be defined as the ratio between the deflection of the beam and the small change in mass which produces it. Consideration of the moments of forces acting on the beam leads to the following expression for the sensitivity:

$$S=\frac{i}{m}=\frac{l}{Wh+2a\,(P+Q)}$$

m=sensitivity weight
l=length of arms of the beam
W=mass of the beam
h=distance from central knife-edge to centre of gravity of beam
a=perpendicular distance from the central knife-edge to the line joining the end knife-edges
P=mass of pan+suspension
Q=load on pans

These symbols are illustrated in Fig. 1.

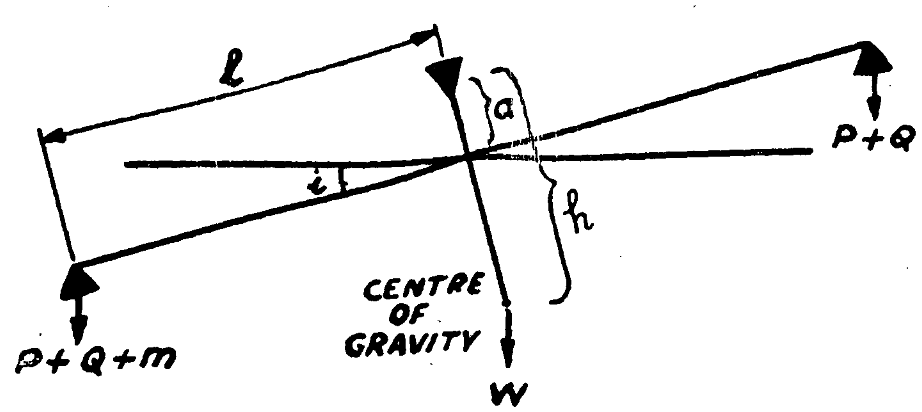

Fig. 1—Sensitivity Illustrated

Where:

S=Sensitivity
i=angle of inclination of beam to the horizontal

Assumptions Made

This expression is based on the following assumptions:

(1) The knife-edges are perfectly sharp, horizontal and parallel to each other.

(2) The effective lengths of the arms of the beam are equal.

(3) The masses of the pans with their suspension stirrups are equal.

From this expression, we can easily infer the conditions for improving the sensitivity. We find that sensitivity can be improved:

(1) by increasing 'l', *i. e.*, by taking a longer beam.

(2) by decreasing 'W', *i. e.*, by taking a lighter beam.

(3) by reducing 'h'. This adjustment can be done by a 'sensitivity nut' or 'gravity bob', usually attached on a separate rod mounted above or behind the beam. This bob is sometimes replaced or supplemented by a small weight sliding on the pointer. This adjustment must not be carried too far, otherwise the balance will become unstable.

(4) by reducing 'a', *i. e.*, by shifting the central knife-edge vertically downward, if it is above the end knife-edges.

Improving Sensitivity

The adjustment of 'a' plays an important role in the performance of a balance, hence we shall discuss it in greater detail.

If the three knife-edges are in one plane, *i.e.*, a=0, then from the above expression for sensitivity we find:

$$S=\frac{1}{Wh}$$

or in other words, 'S' is independent of the load 'Q' on the pans. If such a condition is achieved, then the sensitivity values at all the loads will be the same.

Sensitivity can also be improved by placing the central knife-edge very slightly lower than the end knife-edges so that 'a' is negative. From the expression for sensitivity we can easily see that if 'a' is negative, we obtain increased values of 'S' when 'Q' is increased. On the other hand, 'S' decreases with 'Q', when 'a' is positive.

Examples

We shall now take a few concrete examples and suggest the necessary adjustments to be carried out in each case.

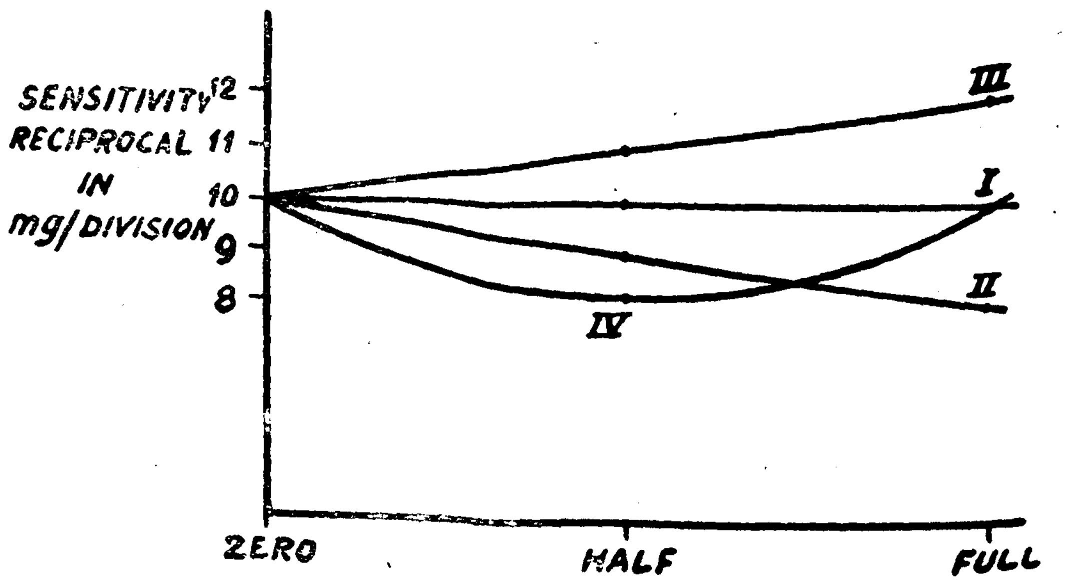

Fig. 2—Variation of Sensitivity-Reciprocal with Load.

*In practice, we usually find out 'sensitivity-reciprocal', which is the inverse-ratio of sensitivity *i. e.* change of mass/deflection. This is more convenient for converting deflections to weights.

Let the values of sensitivity reciprocal. obtained at different loads on four 5 kg Inspector's balances be as follows:

Load	Sensitivity-Reciprocal in mg/division			
	I	II	III	IV
Zero	10	10	10	10
Half	10	9	11	8
Full	10	8	12	10

On plotting the sensitivity—reciprocal values against load, the curves shown in Fig. 2 are obtained.

We see that curves I, II and III are straight lines indicating rigid beams. Curve IV is not a straight line, which indicates an elastic deformation of the beam and knife-edges due to increasing load.

Now we shall discuss each case individually.

Case I

Here sensitivity—reciprocal values remain constant at all loads. The three knife-edges are in one plane and the beam does not flex with load. This is an ideal condition and no adjustment is required. If the sensitivity—reciprocal values are slightly different from the required values but same at all the loads, then by means of the gravity bob it can be adjusted.

Case II

Here sensitivity-reciprocal values are decreasing with increasing load. This indicates that central knife-edge is too low, hence it should be moved up so as to be in the plane of end knife-edges.

Case III

Here sensitivity-reciprocal values are increasing with increasing load. This indicates that central knife-edge is too high, hence it should be moved down so as to be in the plane of end knife-edges.

Case IV

In this case the beam flexes under load and central knife-edge is slightly below the end knife-edges at zero and half-loads, but at full loads all the three knife-edges are in one plane.

Case I is not fully realised in practice owing to the bending of the beam under load. Hence the best compromise is to place the central knife-edge so much below the end knife-edges that at full load all the three knife-edges are coplanar. This can be done according to the formula:

$$a=-x\left(1+\frac{P}{Q}\right)$$

where 'x' is the increase in 'a' at full load. Minus sign(—) indicates that central knife-edges is below the end knife-edges.

Finally, we would like to warn that except for the adjustment by means of gravity bob all the above-mentioned adjustments should be carried out by an expert.

The author is grateful to Shri Prem Prakash, Assistant Director, for suggesting modifications and to the Director for permitting its publication.

REFERENCE

(1) N. P. L. Notes on Applied Science No. 7—Balances, Weights and Precise Laboratory Weighing.

Continued from p 27

The yearly subscription is DM 34 or US $ 8·50. The journal is obtainable from Lange & Springer, Wissenschaftliche Buchhandlung, I Berlin 31 (Wilmersdorf), Heidelberger Platz 3.

The journal is very well produced and printed on A-4 size glazed paper. It is strongly recommended for all scientific laboratories, Weights and Measures Organisations, technical colleges and industry for their information and use.

News & Views

Progress of Madras Weights and Measures Department The Government of Madras has published the Administrative Report of the Weights and Measures Department for the year 1963-64.

The Madras Weights and Measures (Enforcement) Act was passed in September 1958. In 1959, a separate Department was formed under the direct administrative control of the Government in the Industries, Labour and Co-ordination Department and a full time Controller in the senior time-scale of I. A. S. was appointed as its head. Since then, the Organisation had expanded and had under it in March 1964, 8 Assistant Controllers and 54 Inspectors of Weights and Measures.

During the year, the census of trading establishments in the State was completed. The total establishments numbered 1,79,762.

During the year the work of verification and stamping of weights and measures was carried out vigorously. The particulars of this work for the last two years are given below :

	1962-63	1963-64
Weights	1,274,728	771,371
Capacity measures ..	671,342	1,379,509
Length measures ..	19,759	27,496
Beam scales	84,458	185,023
Platform scales and other weighing instruments	8,755	13,468
Petrol pumps and other measuring instruments	1,649	2,076

The fall in verification and stamping of weights is due to the fact that the demand for weights had receded as all the traders have switched over to the new system already.

During the year 206,495 pieces of weights, measures etc. were seized from 70,601 traders. The number of pieces seized during the year 1962-63 was 175,560. A total of 539 manufacturers and 1,104 dealers in weights and measures etc. were licenced.

The Department earned a revenue of Rs. 8,31,048·28 from verification and stamping fees, licensing fees etc. This compares with an overall expenditure of Rs. 7,07,276·74 on the Department.

The "Receipts" and "Charges" for the last three years are given below :

Year	Receipts	Charges	Deficit or Surplus	
(1)	(2)	(3)		(4)
	Rs. P.	Rs. P.		Rs. P.
1961-62	3,11,100·85	6,18,964·32	(—)	3,07,863·47
1962-63	7,77,967·68	8,96,594·77	(—)	1,18,627·09
1963-64	8,31,048·28	7,07,276·74	(+)	1,23,771·54

The Department is becoming self-supporting.

The metric system of weights and measures has been introduced in the State without undue recourse to the panel provisions of the Act. There are, however, always certain persons who continue to contravene the Law. Such traders had to be prosecuted. During the year only three prosecutions were lodged.

From the report, it appears that Madras has made considerable progress in making the Department self-supporting. In fact, they earned about Rs. 1·25 (lakh) more than what they spent on themselves. This is a creditable performance. It is to be hoped that in the future the progress will not only be maintained but taken many steps further.

Use of Non-standard Weighing Instruments

Recently a judgement was passed in the court of the Sub-Divisional Magistrate of Tiruppur, Madras in a case regarding the use of non-standard weighing instruments.

The accused was a dealer in cotton seeds and had taken a ginning factory on lease. The Inspector of Weights and Measures of the area found that the servants of the accused were using unstamped round beamscales with gunny pans and ropes, under the direction of the accused who was sitting nearby. The balances and the gunny pans were used for weighing cotton seeds for sale. The accused was, therefore, prosecuted for using in his business transactions an unstamped and non-standard round beamscale and ropes instead of chains and thereby contravening Section 9(i) and 11 of the Madras Weights and Measures (Enforcement) Act, 1958 and committing an offence punishable under section 28 of the Act.

The accused pleaded that he was not guilty. He claimed that although the non-standard balances and pans were in his possession, he was keeping these only to satisfy his customers who were accustomed to the old weights and measures.

This defence was not accepted on the ground that the (Enforcement) Act had come into force in 1958. The plea of the accused was, therefore, belated. It had been established that the accused had used non-standard balance which was not stamped and was not in accordance with the provisions of the Weights and Measures (Enforcement) Act and the Rules thereunder.

The Magistrate found the accused guilty of the offence of using non-stamped weights and measures in his business transaction. As the accused was a first offender and an old man, he convicted him to a fine of Rs. 75 or in default to undergo simple imprisonment for 15 days.

Quick Conversion of Body Temperature

Shri T. D. Bansal, Scientist, National Physical Laboratory, New Delhi has suggested the following simple method for converting body temperature.

98·6° is equal to 37·0°C. For higher and lower temperatures, convert every 0·2°F= 0·1° while for more accurate calculation, convert 0·9°F to 0·5°C. Thus, if the temperature is 40·0°C, it will be 3 °C above the normal or 5·4°F above 98·6°F, *i.e.*, it would be 104·0°F. If the approximate method is used, viz., 0·2°F is equal to 0·1°C, then the temperature comes out as 104·6°F. For all practical purposes, the half degree difference in the approximation is not of any consequence clinically.

Book Review

METROLOGIA—International Journal of Scientific Metrology, Vol. 1, No. 1, January 1965, Published under the auspices of the International Committee of Weights and Measures, Editor—L.E. Howlett, Canada; Published 4 times a year, by Springer-Verlad, Berlin, Heidelberg, New York.

The appearance of a new journal on weights and measures or metrology is a happy occassion. But when the journal happens to be published under the auspices of the International Committee of Weights and Measures, it becomes an important event of outstanding international importance in the field of science. This is exactly what has happened with the publication of the first issue, January 1965, of the new journal *Metrologia* subtitled *International Journal of Scientific Metrology.* The journal would be published as a quarterly *i.e.*, four times in a year.

The object of the journal is to bring together in one place for convenience and accessibility, articles dealing with fundamental metrology. At present such articles are published in innumerable journals in many countries and in various languages. The intention, as stated in the Editorial, is to publish articles, reporting the results of original researches that contribute to our progress in making fundamental scientific measurements. The Editorial briefly sums the policy of the journal as follows :

'Currently this will comprise any work contributing to the improvement of accuracy and precision in measuring length, mass, time, electric current, temperature, luminance and ionizing radiations, and the accurate determination of physical constants involved in such measurements. Articles pertaining to a large number of different areas of physics will appear together but they will be unified by the fact that they will all be directed towards making the bases of measurement more accurate, reproducible and, if possible, more philosophically attractive. The subject spectrum will include interference, astronomy, photometry, gas thermometry, pyrometry, thermodynamics, radionuclides, neutrons, x-rays, and many other areas of pysics, as well as such physical constants as the gryromagnetic ratio of the proton, the acceleration due to gravity, the velocity of light, etc. Although principal emphasis will be placed on fundamental measurements, reports of experiments or techniques of particular originality and importance in the area of secondary measurement will be accepted, and certain secondary areas of measurement such as high frequency electrical measurement–where there are substantial difficulties in the way of attaining high accuracy, precision and international uniformity–will be of particular interest'.

It is also intended to publish review articles in the same fields so that the specialists as well as the non-specialists may get a rapid survey of progress of fundamental metrology.

The journal will regularly devote space to report the activities and decisions of the General Conference of Weights and Measures, the International Committee of Weights and Measures and its Bureau at Sevres, France.

The contents list of the first issue is impressive as can be seen from the titles quoted below :

L. E. Howlett	..	The Role and Policy of Metrologia
R. Vieweg	..	Zum Geleit
P. Vigoureux	..	A Determination of the Ampere
N. F. Ramsey	..	The Atomic Hydrogen Maser
J. Terrien	..	Scientific Metrology on the International Plane and the Bureau Interntional des Poids et Mesures
H. Moreau	..	The Twelfth General Conference of Weights and Measures.

The articles on the determination of the ampere and the atomic hydrogen maser will be of considerable interest to the specialists. The article by J. Terrien, Director, Bureau International des Poids et Mesures, Sevre, reviews the work done by the International body since its inception. It is a mine of information which brings together in one article the history of the work done since the establishment of the 'Convention du Metre' signed on 20 May 1875. This article will be of general interest to all who are concerned with weights and measures which means a very large number of readers. The article by H. Moreau reviews the recommendations made by the General Conference of Weights and Measures in October 1964. This article is also of general interest besides being of immediate use to the specialist. The first issue which runs to 29 pages is thus full of extremely informative articles which can be read with advantage by the specialists and non-specialists.

Among the articles to be published in future issues, the following have been mentioned in the prospectus :

J. de Boer	..	The International Temperature Scale.
J. A. Hall, N.P.L.		Radiation (Scale of Temperature from 200°C to 1063°C.
H. Moser, P.T.B.		Gas Thermometry.
W. K. Clotheir, N. S.L. Australia	..	A Calculable Standard of Capacitance.
A.H. Cook, N.P.L.		The Absolute Determination of the Acceleration Due to Gravity.
A. P. Baerg, N.R.C. Canada		Standardization of Radion Nuclides.
W. S. Stiles	..	Calorimetry and Photometry.
P. Carre, BIPM	..	Photoelectric Interferometric Comparators.
P. Carre, BIPM	..	Geodetic Measurement.
J. Terrien, BIPM	..	The Index of Refraction of Air.
G. Lansraux	...	Diffraction as a Measurement Tool.

Caesium as a Frequency and Time Standard.

(National Bureau of Standards, Washington, USA).

Standards News

(Indian Standards which have a particular bearing on the change-over to the metric system are indicated here. Copies would be available from the Indian Standards Institution, Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi or their Branch Offices at Bombay, Calcutta, Kanpur, and Madras).

Handbook For Structural Engineers Structural Steel Sections

Indian Standards Institution has published first revision of ISI Handbook for Structural Engineers—Structural Steel Sections. The Handbook, which gives properties of structural steel sections, was first issued in 1959 and has been prepared with the objects of reducing the work involved in design computations, and to facilitate the use of the Indian Standard Code of Practice for use of Structural Steel in General Building Construction (IS:800—1962). The matter contained in the Handbook has been arranged from the point of view of maximum convenience in using it in the design office.

In view of the great importance of steel as a basic raw material for industrialisation, efforts have been made not only to increase the production capacity of steel in the country but also to conserve the available resources and to economise on the use of steel. Therefore, at the request of the Planning Commission, the Indian Standards Institution had taken up in 1953 a Steel Economy Project under which a series of Indian Standards Specifications and codes of practice in the field of steel Production and utilization have been prepared. In addition, a number of design handbooks showing typical designs of different types of structurers are being made available in order to reduce the work involved in design computation.

Price : Rs. 12.50

A-Twill Jute Bags

The Indian Standards Institution has published a revised edition of the Indian Standard Specification for A-Twill Jute Bags (IS:1943—1964). which prescribes the constructional details and other particulars of A-Twill Jute Bags of dimensions 112×67.5 cm (or 44×26½ in).

A-Twill jute bags are primarily used for packing sugar; and this standard, which was first published in 1961, has been revised in order to bring it in line with other standards on jute bags. This specification is also intended to serve the purpose of quality control and pre-shipment inspection of A-Twill jute bags.

Price : Rs. 2.50

General Purpose Glass Thermometers

To meet the requirements for general purpose liquid-in-glass thermometers that are commonly used in educational institutions and in laboratories and many industrial applications where a high order of accuracy is not required, Indian Standards Institution has published Indian Standard Specification for General Purpose Glass Thermometers (IS:2480—1964). This standard prescribes the requirements for general purpose liquid-in-glass Thermometers graduated according to the Celsius (Centrigrade) scale; and the thermometers with least count of 0.5°, 1° and 2°C, which are used in large quantities, in the ranges that are quite popular are covered in this standard. It is hoped that this standard would assist manufacture of such thermometers with reasonable accuracy and at a reasonable price.

Another standard giving a rationalized range of thermometers for use in research and testing laboratories, where a higher degree of precision is required, is under preparation.

Price : Rs. 2.00

Guide for the Selection of Fits

Indian Standards Institution has published Indian Standard Guide for the Selection of Fits (IS:2709—1964), which gives recommendations for the selection of fits in the engineering problems concerned with the mating of a shaft and a hole, and these recommendations are also applicable to non-cylindrical fits. In addition, the Guide gives, in the form of illustrative examples, the representative usage of various classes and grades of fit.

Two Indian Standards on the subject have already been published, namely, IS:919—1963 Indian Standard Recommendations for Limits and Fits for Engineering (Revised) and IS:2101—1962 Recommendations for Limits and Fits for Sizes above 500 mm Up to 3150 mm. These standards make possible innumerable fits ranging from extreme interference to those of from extreme clearance by a proper selection of the fundamental tolerances and fundamental deviations.

The new Indian Standard Guide for Selection of Fits, has, however, been published to provide a convenient and comprehensive guide for the selection of suitable fits for particular types of application in engineering, with a view to facilitating the problems of design engineers dealing with various aspects of designs on widely different types of work. The standard lists the various types of fits, namely, clearance fits, transition fits and interference fits, together with the illustrations form actual practice of assemblies. Also, the correlation between the commonly used terminology of the various types of fits such as 'loose running fit', 'medium keying fit', 'force fit' and the classes indicated in the latest system of symbols specified in the Indian Standards on fits have been listed in the standard which should be of particular utility to those who are not very conversant with the metric and continental practices in this regard.

While preparing this Indian Standard, the relevant standards of industrially advanced countries have been consulted, and in this Guide both the systems of hole basis and the shaft basis have been recommended for use. Continued use of this Guide will result in minimising the number of gauges and tools in engineering production and inspection; and this Standard Guide for the Selection of Fits will, it is hoped, satisfy the need for Indian industry, particularly in its present stage of development.

Price : Rs. 7.00

Dimensions for Taper Handles for Machine Tools

The Indian Standards Institution has published Indian Standards Dimensions for Taper Handles for Machine Tools (IS:2890—1964), which specifies material and dimensions for taper handles used on machine tools.

This is one of a series of Indian Standards being prepared by ISI on the control elements used on machine tools and the work has been undertaken to prevent an unnecessarily large variety of shapes and dimensions of these elements being used as well as to obtain interchangeability of these elements.

Price : Rs. 1.00

Sluice Valves for Water Works Purposes

The Indian Standard Specification for Sluice Valves for Water Works Purposes (IS:2906), published recently, covers requirements for non-rising or rising and inside or outside screw spindle type sluice valves from 350 to 1 200 mm size used for water works purposes with double flanged ends for connections. The standard specifies three classes of sluice valves and the choice of any one class may be made with due regard to the nature of work, anticipated working pressure and other local conditions. It recommends use of spindles of rising type with stationary handwheels as they are convenient to operate and superior in construction compared to those in which handwheel also rises with the spindle.

Price : Rs. 4.00

Tapes for Use in Measurement of Oil Quantities

The Indian Standards Institution has prepared a draft Indian Standard Specification for Tapes for Use in Measurement of Oil Quantities Doc: EDC 41 (524). This draft standard lays down the requirements for tapes with the dip weight attached to its end, for use in gauging petroleum, petroleum products and other liquids.

The draft standard will be circulated for eliciting technical comments.

Milking Pails & Milk Cooling Tanks

The Indian Standards Institution has prepared the following two draft Indian Standards :

(*i*) Draft Revision of IS:1792—1961 Aluminium Milking Pails (Hooded Type) [Doc : AFDC 12 (378) R]

(*ii*) Farm Milk Cooling Tanks [Doc : AFDC 12 (420)].

The draft revision of IS:1792—1961 has been necessitated as after practical trials it was found that the pails according to the standard were defective in some respects. In the draft revision the pail of 5 litre capacity has also been included in addition to pails of 10-, 15- and 20- litre capacity.

The farm milk cooling tank is intended for use at a milk collecting and chilling centre to collect and store raw milk at a temperature which will ensure that milk reaches the pasteurizing plant without any deterioration. The draft standard lays down requirements of material, construction and performance for these types of tanks of capacities varying from 500 litres to 2 000 litres.

These draft specifications would be issued in wide circulation for eliciting technical comments.

OBITUARY

With deep sorrow we record the death of Shri Vishwan Nath Singh, Controller of Weights and Measures, Bihar on 5 April 1965. While on tour to Bhagalpur, he had a sudden heart attack which led to his death at the Bhagalpur Circuit House. His body was flown to Patna cremation.

Shri V. N. Singh was one of the seniormost Controllers of Weights and Measures in India. He was respected and liked by his colleagues both in the State and outside.

Shri V. N. Singh was born on 30 September 1913 in Bhinga State situated in the Bahraich district of Uttar Pradesh. After graduating from the Agricultural College, Kanpur, he entered the Bihar Agricultural Service in 1936, and held several posts in the Agricultural Department.

He was Assistant Director of Agriculture from 1937 to 1952. From 1952 to 1959 he held the post of Chief Inspector of Weights and Measures and from 1959 that of Controller of Weights and Measures.

Since March 1962 he was also the Ex-Officio Principal of the Institute of Weights and Measures, Patna. He was the only Indian to hold the Associate Membership of the Institute of Weights and Measures Administration, U.K.

He served with distinction on many technical and administrative Committees connected with legal metrology and participated actively in the periodic Conferences of Controllers of Weights and Measures. He made outstanding contribution to the successful implementation of the metric reform in the country.

His sudden death has created a void in the growing field of Weights and Measures Administration in India.

We extend our profound sympathies to the bereaved family.

—Editor

TYPICAL METRIC PRICING UNITS FOR WHOLESALE TRANSACTIONS

Serial No.	Commodity	Metric Unit
(1)	Gold	10 grams (g)
(2)	**Grocery and Confectionery**	
	Biscuits, sweetmeats, cardamoms.	
	Textiles and Textile Fibres	
	Cotton yarn, damaged and seconds cloth, raw silk, rayon, silk yarn, raw wool, wool manufactures (when sold by weight).	
	Paints & Chemicals	
	Paint (if sold by weight), indigo, liquid chlorine.	1 kilogram (kg)
	Hides, Skins & Leather	
	Raw hides, leather (hides and skins).	
	Metals	
	Silver, aluminium sheets, strips and circles, copper and brass wires and utensils.	
	Miscellaneous	
	Tea, meat, camphor tablets, mica.	
(3)	**Grains and Pulses**	
	Rice, wheat, jowar, arhar, moong, masur, gram.	
	Spices	
	Black pepper, mustard, chillies, dhania, dalchini, turmeric, betelnuts.	
	Plantation Products	
	Rubber, cashewnuts, cashew kernels, tobacco (raw and manufactured).	
	Forest Products	
	Lac and lac products, gums, myrobalans, galnuts, soapnuts.	
	Textiles & Textile Fibres	
	Raw jute, raw hemp, coir yarn.	
	Oils, Oilseeds & Oilcakes	
	Vegetable oil, oilseeds, oilcakes.	1 quintal (q) (100 kilograms)
	Non-Ferrous Metals	
	Aluminium : ingots, bars, blocks, slabs, billets.	
	Lead : ingots, sheets and strips.	
	Copper : ingots, blooms, slabs, cakes, tiles, bricks, billets, blisterbars and wirebars, rods, sections and pipes, plates, sheets and strips, circles.	
	Brass : ingots, rods, sections, pipes, sheets, strips circles.	
	Zinc : ingots, sheets, strips.	
	Tin : blocks.	
	Chemicals	
	Caustic soda, bleaching powder, glycerine, soaps, paper salt.	
	Others	
	Sugar, gur, ice, fish, sugarcane, vegetables, tamarind.	
(4)	**Minerals**	
	Iron ore, manganese ore, bauxite, coal.	one metric tonne (t) (1,000 kilograms)
	Iron & Steel	
	Pig iron, Iron & steel manufactures, semis (billets for rerolling etc.)	
(5)	Cloth (mill, handloom, silk rayon and woollen cloth)	1 metre (m)
(6)	Jute carpets, coir mats and mattings, sheet glass.	one square metre (m^2)
(7)	Timber.	one cubic metre (m^3)
(8)	Paints (when sold by measure), spirits.	one litre (l)

Weights

(1) In place of the present units of seer, pound, rattal, viss etc., use the kilogram.

(2) In place of the tola, use the gram or 10 grams.

(3) In place of maund or corresponding unit, use the quintal *i. e.*, 100 kg.

Capacity Measures

In place of seer or gallon or any other measure, use the litre.

Length Measures

(1) Use the metre in place of yard or foot and the centimetre in place of inch.

Square Measures

(1) Use the square metre in place of square yard or square foot, and square centimetre in place of square inch.

Cubic Measures

(1) Use the cubic metre in place of cubic yard or cubic foot and cubic centimetre in place of cubic inch.

Packaging

It is advantageous if sizes of packages correspond to series of commercial weights and measures prescribed.

These are: 50 kg, 20 kg, 10 kg, 5 kg, 2 kg, 1 kg, 500 g, 200 g, 100 g, 50 g, 20 g, 10 g, 5 g, 2 g, 1 g, and so on.

TYPICAL PRICING UNITS FOR RETAIL TRADE

Serial No.	Commodity	Metric Unit for Use
(1)	Foodgrains, cereals, pulses, spices, ghee, bread, vegetables, meat, fish, sweetmeats, tea, coffee, sugar, salt	1 kg
(2)	Oil for cooking	1 kg or 1 litre depending upon prevalent practice.
(3)	Fruits	1 kg or number depending upon prevalent practice.
(4)	Milk	1 litre
(5)	Cloth and related materials	1 metre
(6)	Prepackaged materials	Preferably sizes corresponding to series of commercial weights and measures.

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JOURNAL OF WEIGHTS AND MEASURES

40 PAISE

ABBREVIATIONS FOR METRIC UNITS

Prefix	Value in Terms of Unit	Abbreviation
(1) DECIMAL MULTIPLES AND SUB-MULTIPLES		
Kilo	1,000	k
centi	$0{\cdot}01(10^{-2})$	c
milli	$0{\cdot}001(10^{-3})$	m
micro	$0{\cdot}000\ 001(10^{-6})$	µ

(2) WEIGHTS

Denomination	Value	Abbreviation
tonne	1,000 kg	t
quintal	100 kg	q
Kilogram	1 kg	kg
gram	1 g	g
milligram	1 mg	mg
carat	200 mg	c
(3) CAPACITY		
kilolitre	1 000 l	kl
litre	1 l	l
millilitre	1 ml	ml
(4) VOLUME		
cubic metre	m^3	m^3 or cu m*
cubic centimetre	cm^3	cm^3 or cu cm*
cubic millimetre	mm^3	mm^3 or cu mm*
(5) LENGTH		
kilometre	1 000 m	km
metre	1 m	m
centimetre	1 cm	cm
millimetre	1 mm	mm
micron	1/1 000 mm or 10^{-3} mm	µm
(6) AREA		
square kilometre	1 000 000 m^2	km^2 or sq km*
square metre	1 m^2	m^2 or sq m*
square centimetre	1 cm^2	cm^2 or sq cm*
square millimetre	1 mm^2	mm^2 or sq mm*
(7) LAND MEASURE		
are	100 m^2	a
hectare	100 a	ha
centiare	m^2	ca

*Both these abbreviations are current, but the first set should preferably be used. The former abbreviation is used more commonly internationally than the latter.

Rules for Abbreviations:

(1) Do not make any change, such as addition of 's' to indicate plurality *e.g.*, write 1 kg, 10 kg, 20 g, 5 g, 10 t, 20 ml, 27 l, 165 km, 2 mm, 100 cm^3, 66 km^2.

(2) Do not capitalize the abbreviations. For example, do not write 1 Kg, 2 Kg, 20 MM, 60 MM; the right way is to write 1 kg, 2 kg, 20 mm, 50 mm, etc.

(3) Do not use any other abbreviations except those given above.

metric measures

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DIRECTORATE OF WEIGHTS & MEASURES

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metric measures

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Tenth Conference of Controllers

THE tenth Conference of Controllers of Weights and Measures was held in Hyderabad on 16 and 17 June 1965. The Conference was inaugurated by Shri Channa Reddy, Minister, Industries and Finance, Government of Andhra Pradesh. Shri P. N. Nayer, Director of Weights and Measures, Ministry of Commerce presided. Controllers of Weights and Measures of the States and Union Territories and representatives of the National Physical Laboratory (NPL), Indian Standards Institution (ISI) and Ministries of Commerce, Information and Broadcasting, Finance and Law attended the Conference.

Inauguration

Inaugurating the Conference, the Minister said that the subject of weights and measures might appear insipid and insignificant, but weights and measures were all-pervading. They entered into all aspects of life. The decision to adopt the metric system in India was wise. The institution of a single system of weights and measures throughout the country would promote national integration. He was happy to note that the metric system had been enforced with promptness and efficiency in Andhra Pradesh as well as the rest of the country. He advised Weights and Measures Inspectors, however, to be patient and tactful in dealing with the public.

The old Hyderabad State had a long tradition of weights and measures enforcement. The Mint Master of the State had suggested the adoption of the metric system as early as 1930. He wished the Conference success in its work.

He advised the delegates to consider themselves as independent experts. They should be able to render advice on technical matters without inhibitions. It would then be for the State and the Central Governments to consider how far it was feasible to act on it, in the light of all the circumstances.

Shri Pratap Reddy, Director of Industries and Controller of Weights and Measures, Andhra Pradesh thanked the Government of India and State Governments for holding the 10th Conference in Hyderabad. The City of Hyderabad was cosmopolitan and was famed for its hospitality. He hoped the delegates would enjoy their stay in the city and would also be able to take time off to visit the Museum and other places of cultural interest. The State of Hyderabad had long experience of weights and measures enforcement. This heritage enabled Andhra Pradesh to start with a sound enforcement organisation, and to introduce the metric system smoothly and efficiently.

The Chairman said that 1965 was the decennary of the acceptance, in principle, by Parliament of the metric system and decimal coinage. It was also an important landmark in the progress of the metric system in the world as the Government of the United Kingdom had decided to adopt the metric system in that country. This would bring very near to fulfilment, the prophecy of the French statesman

Talleyrand that the metric system would one day belong to the whole world. Independent India had been able to standardise weights and measures over the whole country, by adopting the metric system, in the short period of 8 years. There were difficulties due to limited resources and lack of trained personnel. These were overcome and the metric system adopted, thanks to the joint efforts of trade, industry and the public. In closing, he referred to the premature death of the late Shri V. N. Singh, formerly Controller of Weights and Measures, Bihar, who had made an outstanding contribution to the success of the reform in Bihar as well as the country as a whole.

On 16 June, before commencing its work the Conference placed on record its sorrow on the premature death of Shri V. N. Singh. On 17 June, it passed a Resolution of Condolence on the death of Shri Alapati Venkatramiah, Minister for Municipal Administration, Andhra Pradesh.

Some of the more important recommendations of the Conference are given below :

(1) Organisation for Enforcement of Weights and Measures.

(*a*) The Controller of Weights and Measures should be a whole-time officer with no duties or responsibilities not associated with weights and measures. In Maharashtra and Gujarat, the Director of Industries is *ex-officio* Controller and a Deputy Director *ex-officio* Deputy Controller. These States have had long experience of weights and measures enforcement. In the opinion of the representatives of these States, the present arrangement had worked well and it was not necessary to change it. Inspectors of Weights and Measures and Industries Officers, who corresponded to Assistant Controllers are, however, full-time officers, who are able to devote their time exclusively to weights and measures.

(*b*) There should be one Deputy Controller, in the States, for every 16 Inspectors, and at least one Assistant Controller for every 8 Inspectors. In certain States where the Districts were large and extensive, one Assistant Controller would not be able to supervise the work of 8 Inspectors. It would be necessary in such cases to provide an Assistant Controller for each District.

(*c*) Assistant Controllers had gazetted status in most of the States. They should be given this status, where they did not have it at present.

(*d*) Inspectors of Weights and Measures must have status and salary, not lower than those of Inspectors in other departments having similar responsibilities.

(*e*) The 5th Conference had recommended that there should be one Inspectorial Unit consisting of an Inspector and a manual assistant for every two or three taluqs or a revenue subdivision. In metropolitan areas there should be an Inspector for 2,000 to 3,000 establishments. The Weights and Measures Departments have been staffed on this scale in all States except Punjab and Kerala. The number of Inspectors in Punjab and Kerala should be increased.

(*f*) Inspectors directly recruited must be graduates, preferably in science.

(*g*) The Weights and Measures Departments have statutory functions. They must be made permanent.

(*h*) The Weights and Measures Departments were financially self-supporting (they raised revenue equal to their expenditure) in many of the States. The remaining States must aim to achieve financial selfsufficency by 1966-67.

(2) Training of Inspectors

(a) Basic training for all Inspectors

All Inspectors to be recruited in future should be given three months' training in a suitable institution, according to the syllabus recommended by the Committee on training of personnel at its meeting on 3-4-1964. In the opinion of the representatives of Madhya Pradesh, Andhra Pradesh, Maharashtra, Gujarat and Bengal, the training facilities available in these States were adequate for imparting training in theory, laboratory work and field work according to the syllabus. Personnel for the remaining States and the Union Territories should be sent to the Bihar Institute of Weights and Measures for training. Training should also be given to working Inspectors who have not so far received formal training.

(b) Advanced Training for Senior Inspectors

It was necessary to impart advanced training in the testing of standard balances, verification of complicated measuring instruments, etc. Most of the equipment and other facilities for this training were available at National Physical Laboratory (NPL). It would be advantageous and economical, therefore, to arrange this training at the NPL. A Committee was set up to draw up a syllabus.

(3) Approval of Prototypes of Length Measures and Weighing and Measuring Instruments

All State Governments except the Government of West Bengal, where it was under consideration, have accepted the suggestion that prototypes of length measures and weighing and measuring instruments must be subject to approval by a Central Authority. Legislation should be enacted on the following lines, by amendment of the Weights and Measures (Enforcement) Acts.

(*a*) Every manufacturer should send, by a prescribed date, full manufacturing details with particulars of raw materials used, working drawings and a model, to a person or an institution named by the State Government.

(*b*) The Government may accept the prototype as it is, accept it with modifications or reject it.

(*c*) If a prototype was rejected, the manufacturer should discontinue its production for use in trade in the State. Machines conforming to the prototype would not be stamped by any Inspector of the State.

(*d*) If a prototype was accepted with modifications, a reasonable period would be allowed to the manufacturer for carrying out the modifications. After the expiry of the period only machines conforming to the modified type would be stamped.

(4) Progress of Enforcement

Metric weights and measures have been effectively enforced throughout the country barring certain isolated areas in one or two States. Energetic steps should be taken to seize and remove all non-standard weights and measures from these areas.

Metric length measures were in almost exclusive use in the cloth trade. Yard measures and inch tapes continued to be used in trade in commodities like steel sections, wire and cable, ribbons, etc. These trades should be warned and the measures used seized and removed from the markets.

Manufacturers of pre-packed goods should be advised to pack in convenient metric sizes, where this is not being done at present. Associations of ready-made garments manufacturers as well as important manufacturers should be advised to mark the sizes of garments in centimetres.

(5) Equipment for Weights and Measures Departments

(a) Precision Laboratory

A well designed and equipped precision laboratory for maintenance and testing of standards and standard balances and testing complicated measuring instruments was essential for every State. The Committee to advise on an advanced course of instruction for Inspectors would also recommend the architectural design for the precision laboratory, the types of equipment necessary, their specifications, etc.

(b) Standard balances

Most of the Weights and Measures Departments had acquired sufficient numbers of working standard balances. They had yet to provide themselves with secondary standard balances which were not now manufactured in India. The Andhra Scientific Company and Messrs Saple's Scales Limited had designed secondary standard balances according to specifications prescribed. The manufacture of these balances was expected to start in six months' time. After the models were approved by the National Physical Laboratory, Weights and Measures Departments would be advised to place firm orders with the manufacturers.

(c) Equipment for Marking Glass Measures

It had not so far been possible to get the equipment which was designed by the NPL some years ago manufactured on industrial scale. The small anticipated demand offers small incentives for their commercial production. The only practicable alternative was, for the NPL to produce a few pieces in their workshop for the use of the States which have licensed manufacturers of commercial glass measures. Till they were able to do so, Inspectors may verify glass measures and issue verification certificates. The measures would be identified in the certificate by the manufacturers' name or trade mark, the type of the measure and a serial number. No measure which is not marked with manufacturers' name, type and serial number will be accepted for verification.

(d) Equipment to Test the Thickness of Plating on Metre Measures

A partially destructive test had been suggested by the Central Electro-Chemical Research Laboratory, Karaikudi. Controllers of States which have licensed manufacturers of length measures may purchase the equipment with the assistance of the Central Electro-Chemical Research Laboratory. Samples of the length measures produced by every licensed manufacturer should be tested at least once a year.

(6) Amendment of Weights and Measures (Enforcement) Rules

Among the recommendations are the following:

(a) Permissible Errors in the Net Weights of Bombay Halwa Sold Pre-packed

Size of packages	Permissible errors
1 kg or above ..	2·5 percent.
Above 250 g but below 1 kg	5·0 percent —
250 g or below ..	8·0 percent

(7) Publicity

Metric weights and measures were in general use in trade throughout the country. It was no longer necessary to conduct publicity with the aim of popularising the metric system or making people understand units like kilogram, metre and litre. The metric system had been extended to land area. The public was still not quite familiar with metric units of land area like hectare and are. Publicity should be conducted to make people familiar with these units particularly in the rural areas. A documentary film should be produced on the progress achieved in the reform and the work of Weights and Measures Departments.

(8) Verification of Taximeters

Laboratory tests on taximeters must be conducted by Inspectors of Weights and Measures. The road tests may be left to the Transport Authorities. The specifications for taximeters and the mthod of testing them in the laboratory should be incorporated in the Weights and Measures (Enforcement) Rules. Testing equipment should be installed at Inspectors' Offices in urban areas. Selected Inspectors should be given training at the NPL. This would form part of the advanced training for Inspectors. When the necessary preparations were complete, notices would be sent to taxi owners to present their meters for verification. Lists of taxi owners would be obtained through the Transport Authorities. In big cities like Bombay and Calcutta, Inspectors would have to be assigned exclusively for this work. Taximeters should be verified annually. The fee for verification should be Rs. 5. This recommendation should be forwarded to the Transport Departments of all the States for information.

(9) Metric System in Timber Trade

The timber trade continued to use non-standard units in some States. Associations of traders as well as the traders themselves should be warned against the illegal practice. A Conference of the Chief Conservators of Forests and important Associations of the timber trade should be held to examine any practical difficulties the trade might be experiencing in adopting the new system of measurement.

(10) 18·5 Litre Container for Kerosene Oil

This tin should invariably be filled to 18.5 litres. The Oil Industry Metric Committee should advise their members to refrain from filling this container to any other capacity.

(11) 9·25 Litre Filling Machine

The use of filling machine of this capacity should be discouraged. It should be replaced by a 10 litre filling machine. Recommendation should be brought to the attention of the Oil Industry Metric Committee.

(12) Stamping of Weighing Machines After Repair

It is the responsibility of the repairer to get the machines stamped before delivering them to the owners after repairs. This should be made a condition of the licence granted to every repairer.

(13) Weights, Measures and Instruments Purchased by D.G.S.&D.

The D.G.S.&D. often placed an order on a manufacturer for the purchase of weights, measures and instruments for the use of establishments in a number of States. Weights, measures and instruments intended for the use of establishments within the same State should be verified and stamped before despatch. Where weights, measures and instruments were despatched to an establishment in another State, the Controller of Weights and Measures of that State should be informed, giving full details regarding the consignee, the articles supplied, etc.

(14) Cancellation of Licences

Notice of cancellation of the licence of a manufacturer or a dealer of a State, should be sent to Weights and Measures Departments of all the other States.

(15) Period of Verification of Weights and Weighing Instruments

It is possible that weights and weighing instruments used in certain trades lose their accuracy within a year. It would be desirable to verify them in such cases at intervals of 12 months. Data should be collected on the errors in cast iron weights of various denominations and in different trades after 12 months' use. Samples of weights which had completed one year's use should be taken from different areas and different trades in each State and weighed accurately. The errors should be tabulated and sent to the Directorate of Weights and Measures for analysis.

(16) **Temporary Loan of Weights by Repairers to Users**

Repairers should be required under the terms of the licence to lend sets of weights in place of the weights the traders bring to them for repair. This would discourage repairers delaying repairs unduly.

(17) **Marking of Nett Weight on Packages of Soap Powder, Flakes etc.**

Washing soap was ordinarily sold by weight. It would, therefore, be a violation of the Weights and Measures Act for any one to sell or offer for sale a package of soap flakes or soap powder without marking the nett content on it.

(18) **Verification of Gas Cylinders**

Gas in cylinders was sold by weight. They should be treated in the same way as sealed containers. Samples should be taken and their nett weights verified.

* * * *

Working Standard Balances : Part 6— Assembly, Use and Maintenance

B. R. DHURANDHAR
Saple's Scale Manufacturing Co. (P) Ltd.
Bombay.

IN the five parts* of this article we have studied : (1) the various factors which influence the design of working standard balances, (2) the principles which underlie the general specifications, (3) the role of beam design in ensuring efficient working of the balances and (4 & 5) the factors which determine the design, material and performance of knife-edges, bearings and other components and mechanisms in working standard balances. In this concluding Part we shall examine how various balances are to be handled, set up, used and maintained.

ASSEMBLY AND USE

As we have seen earlier, there are two types of working standard balances—the indoor and the outdoor. The indoor type balances are easier to set up than outdoor balances. Indoor balances, once installed, are not required to be moved from their place but outdoor balances have to be assembled every time before use and dismantled after use and packed in their carrying cases. The instructions in this section relate to assembly, dismantling and use of outdoor balances. Although the instructions are meant for new balances they are largely applicable also to the routine assembly and use of balances.

Normally, the four outdoor working standard balances are packed in five dealwood boxes by the manufacturers at the time of despatch. On receipt from the manufacturer the recipient should note the condition of the boxes. He should bring any damage to the notice of the insurance surveyor and make a report to the supplier as early as possible. To facilitate identification, the manufacturer usually marks serial numbers on the top surface which is painted in red. Only the top sides should be removed These are usually fixed by wire nails which can be taken out with a nail puller.

The components of the 50 kg and 5 kg balances and the stand of the 50 kg balances are fitted in separate teakwood carrying

*(1) Working Standard Balances: Part 1—Guiding Factors in Design—*Metric Measures*, Vol. 4 No. 3, pp. 3-6, 1961.

(2) Working Standard Balances: Part 2—General Specifications—*Metric Measures*, Vol. 5 No. 5, pp. 3-8, 1962.

(3) Working Standard Balances : Part 3—Beam Design—*Metric Measures*, Vol. 6, No. 4 pp. 10-14, 1963.

(4) Working Standard Balances : Part 4—Knife-edges—*Metric Measures*, Vol. 7, No. 2, pp. 13-15, 1964.

(5) Working Standard Balances: Part 5—Other Components—*Metric Measures*, Vol. 8, No. 1, pp. 10-12, 1965.

cases. The components of 200 g and 2 g balances are fitted in the drawers of the glass cases.

Assembly of 50 kg Balance

When received the carrying case of the 50 kg balance is wrapped in cartridge paper, plastic sheets and gum coated papers to protect it from moisture.

The packing paper should be removed, the box opened and then the stuffing used between components for preventing their movement in transit removed. Fig. 1 gives a general idea of how the components of a 50 kg balance are fitted in the carrying case. Dust should be removed by brushing the components as fitted into the box. A brush

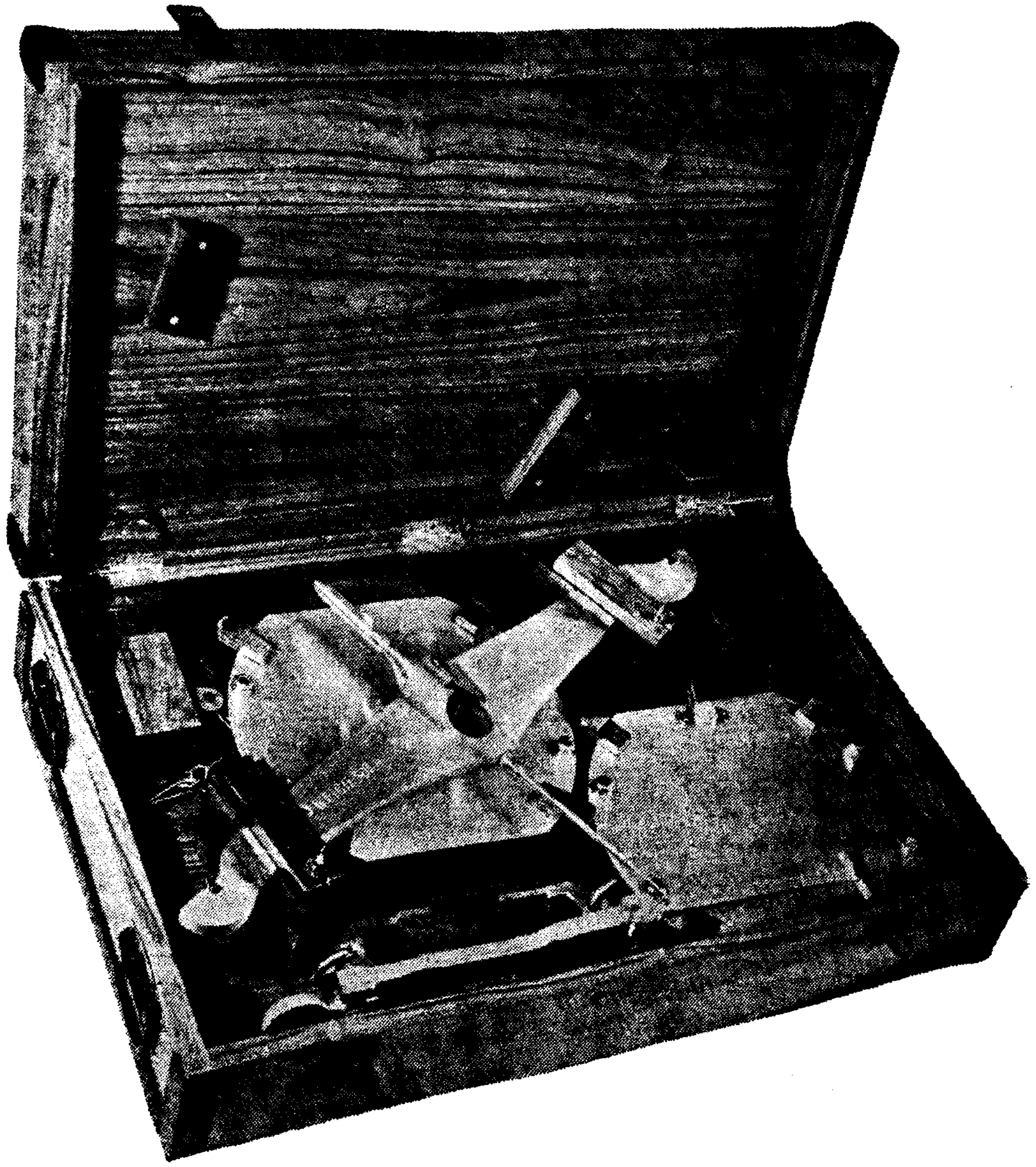

Fig. 1—Components of 50 kg balance fitted in the case.

is usually supplied with the balance for this purpose.

To avoid damage to the components they may be taken out in the following order :

(1) Central bearing fork
(2) Beam
(3) Pan suspensions
(4) Pans

The components should be placed on a clean table. The beam should be placed on felt-padded pieces provided. The butter paper wrapping should be removed from the components and the dust brushed off from them. After unpacking the beam it is necessary to remove the protective greasy coating from the knife-edges by a piece of soft cloth. The chamferred edges of the knife-edges should then be cleaned with another piece of soft cloth dampened with one or two drops of methylated spirit and then rubbed with a piece of chamois leather. *The cloth wetted with methylated spirit should not come in contact with the beam* as it may affect the lacquer coating.

The central bearing fork should now be taken. The agate bearing should be cleaned with the chamois leather piece only, as it is not coated with grease. Care should be taken to clean the end steel pieces and remove any dust from the corner of the agate. Then the pan suspensions should be taken. The agate bearings of the pan suspensions should also be cleaned. Particular care should be taken to clean the corners thoroughly. Next the pans should be cleaned with soft cloth.

The stand should then be removed from its case with care and the leather belt unstrapped. The wing nuts at the knee joints should be loosened. The lower legs of the stand should be opened completely and the wing nuts tightened again. The chain is permanently fixed on one leg. The two open ends of the chain should be hooked on the two legs. The stand should be spread out to form an equilateral triangle on the ground. The beam should then be inserted through the hanging hook into the top of the stand. The stand is now ready. It is desirable to support the legs of the stand with cast iron weights of 50 kg or 20 kg. It is also desirable to spread a thick paper or a piece of thick cloth below the stand to keep the bottom of the pans clean. The top hook of the central bearing fork should be inserted in the beam hanging hook. The head of the locking pin should be held down to permit the front opening of the central fork to be turned to right, approximately to the right angle position. It should be left in that position and the beam lifted and placed gently over the central agate bearing. The knife-edge should be inserted completely, so that the pointed end of the knife-edge does not project beyond the agate bearing. *It must be ensured that the knife-edge is placed gently over the agate bearing so that it does not get damaged.* The front portion of the fork should then be pulled back and locked with the locking nut. Now the beam would oscillate freely. The pan suspensions (marked L and R, for left and right of the operator facing the balance) should be placed over the appropriate knife-edges taking care to avoid scratching of the knife-edge corners. This would not happen if the suspension is slightly tilted while inserting over the knife-edges.

The pans should then be placed on the suspension in a similar manner. One of the pans should be pressed down with a finger so that it touches the ground. The pointer should then go slightly beyond the scale divisions. If it goes too much beyond the scale divisions, the legs of the tripod stand should be adjusted, until the pointer oscillates freely (and equally on both sides of the centre of the scale). If it does not, the balance box fitted under the right pan should be adjusted by adding or removing lead from it. The 50 kg balance is now ready for use.

Assembly of 5 kg Balance

The carrying case for the 5 kg balance is also numbered serially and should be opened in the same manner as the 50 kg balance. It contains the following parts :

(1) Beam
(2) Pan suspensions
(3) Pans
(4) Stand with central agate bearing
(5) Base board with levelling screws.

For purposes of assembly, the base board should be first removed. This is fitted with levelling screws and a square gun-metal piece. The locking lever should be opened. The stand should then be removed from the carrying case and cleaned, taking care to see that the agate bearing at the top is well cleaned. Below the base of the stand a rectangular tapered piece is fitted. This piece should be fitted in the base board and the stand locked with the locking lever on the back side of the stand. The handle should then be worked and placed so that it is towards the right. The beam should then be taken out, the knife-edges cleaned with soft cloth and methylated spirit and chamois leather as in the case of the 50 kg balance. The beam should then be held with the words 'To weigh 5 kg' facing the operator and gently passed over the central agate bearing, so that the knife-edge does not scratch on the end steel pieces. When properly placed, the beam should oscillate freely. The handle should be turned from right to left to stop oscillations. After cleaning the pan suspensions and the pans,

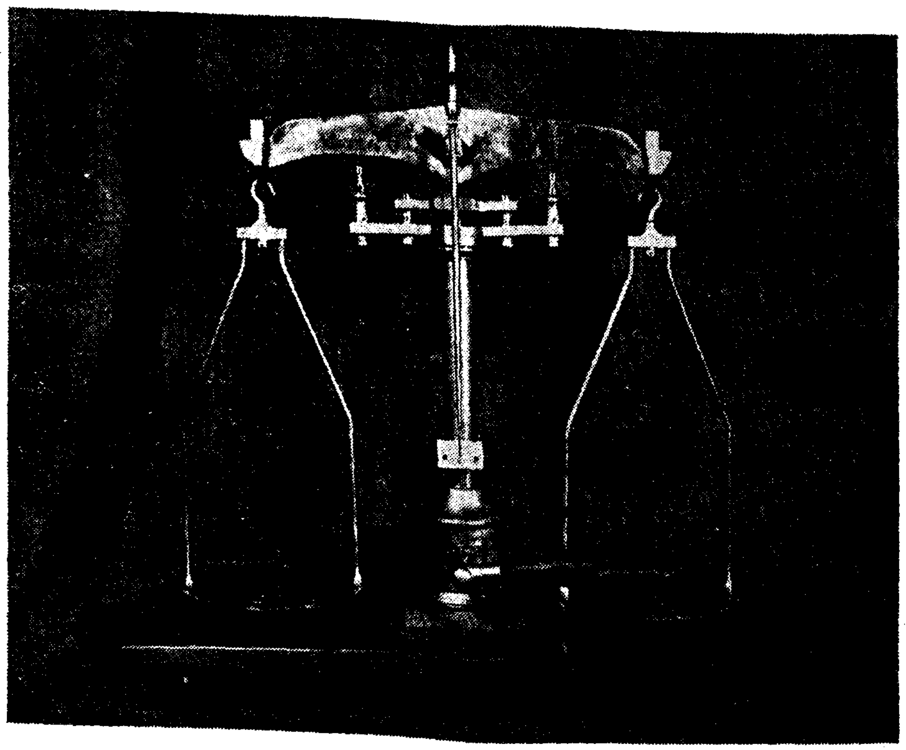

Fig. 2—The 5 kg balance as assembled.

they should be positioned as directed in the case of 50 kg balance. At this stage, it should be ascertained whether the beam with the pans oscillates equally on both sides of the central mark on the sector plate. If not, the balance box below the right hand pan should be adjusted to get equal oscillations on both sides of the central mark.

Assembly of 200 g Balance

The following loose parts are fitted in the drawer of the glass case :

(1) Beam
(2) Pan suspensions
(3) Pans
(4) Beam lifting knob.

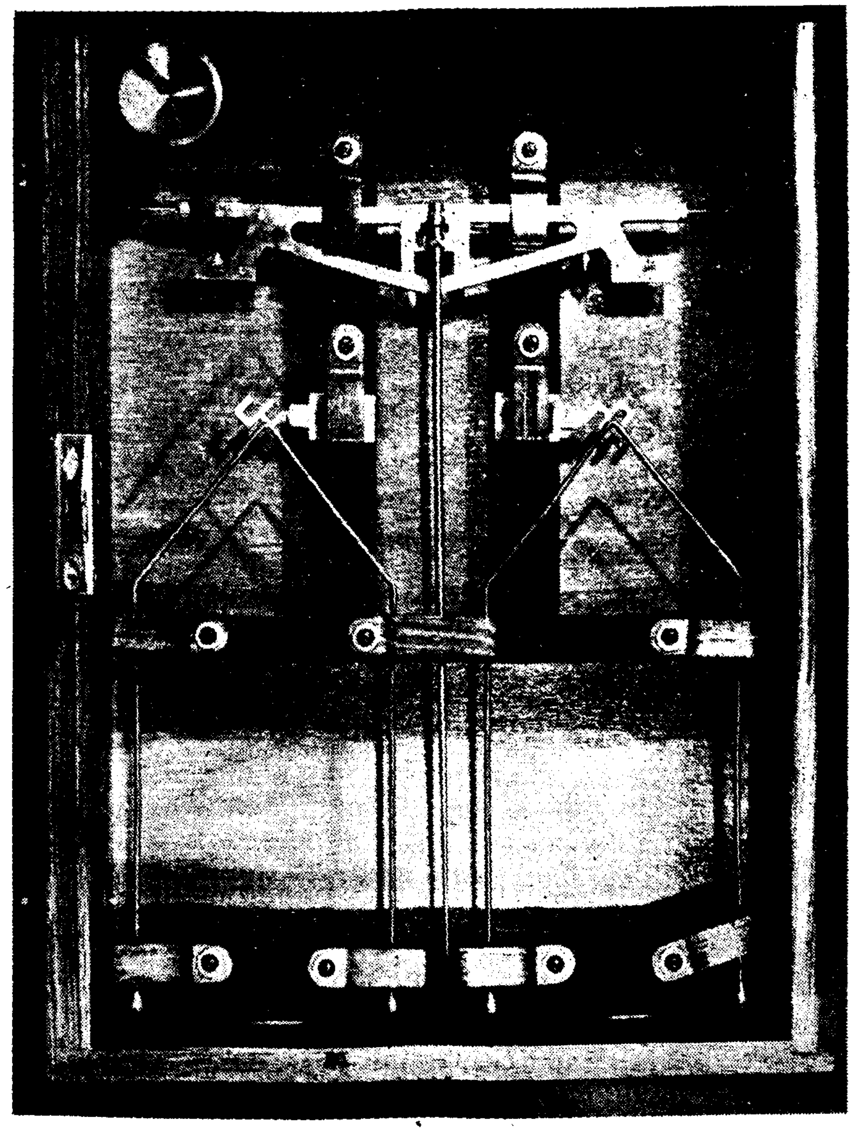

Fig. 3—The 200 g balance in the drawer of the case.

For assembling the balance, the front door of the glass case should be removed completely and the glass case and stand thoroughly cleaned with the brush. The agate bearings should be cleaned thoroughly with a piece of soft cloth. The drawer should be removed from the box and the lifting knob should be fixed on the shaft. The beam should be removed and the knife-edges cleaned as indicated earlier. The lifting knob should be turned completely to the right and the beam with the central knife-edge should be placed on the central agate bearing of the stand. On turning the knob to the left, the oscillations of the beam would be arrested.

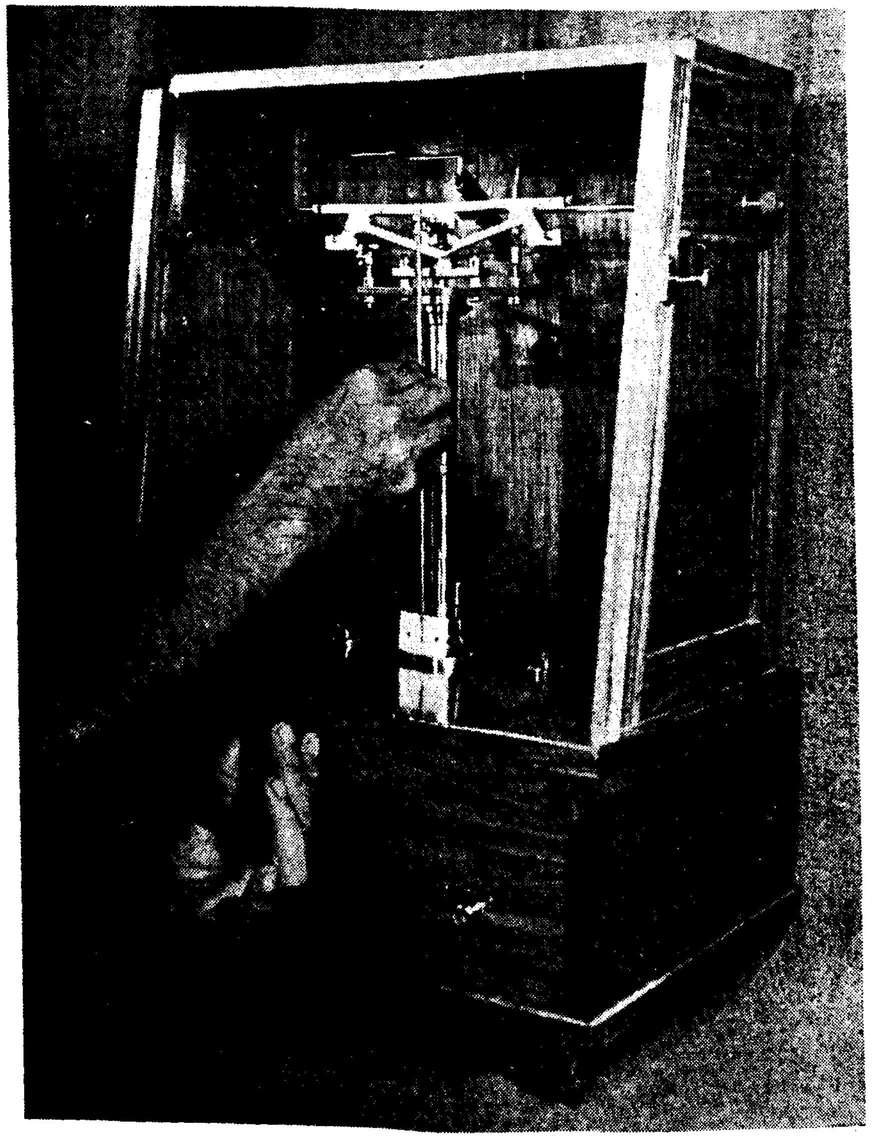

Fig. 4—The method of placing the beam on the stand of 200 g balance. Notice the fingers holding the pointer at the upper end.

The pan suspensions and the pans should then be attached in their proper places. The lifting knob should be worked to ascertain whether the pointer oscillates equally round the central mark. If it does not, the adjusting knobs should be used to achieve the purpose. The balance is then ready for use.

Assembly of 2 g Balance

This is assembled in the same manner as the 200 g balance. In some cases it may not be possible to remove the front door completely. It should then be placed on the top of the case. The beam should be removed first and placed on the central bearings.

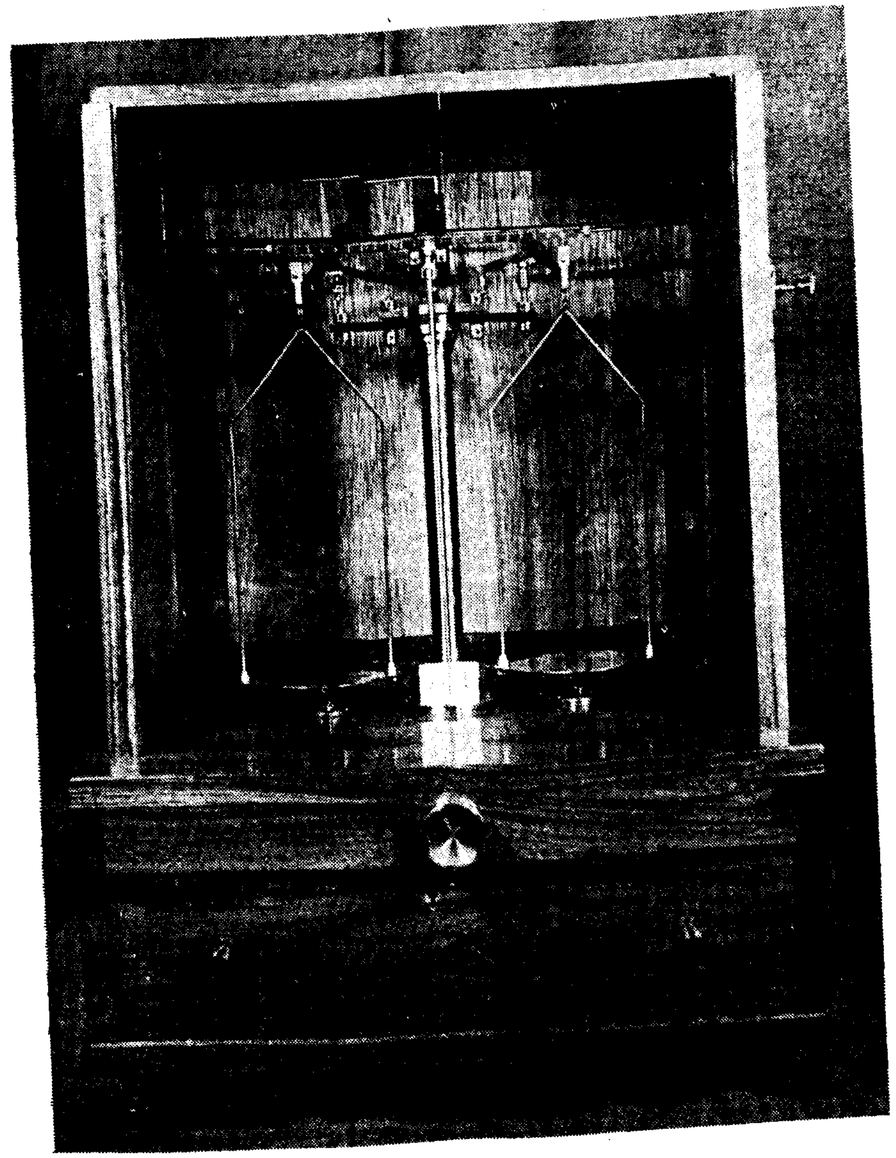

Fig. 5—Assembly of 200 g balance

Care should be taken to see that the knife-edges are not damaged.

The pans are then held by the hand and the beam tilted so that the pointer is on the

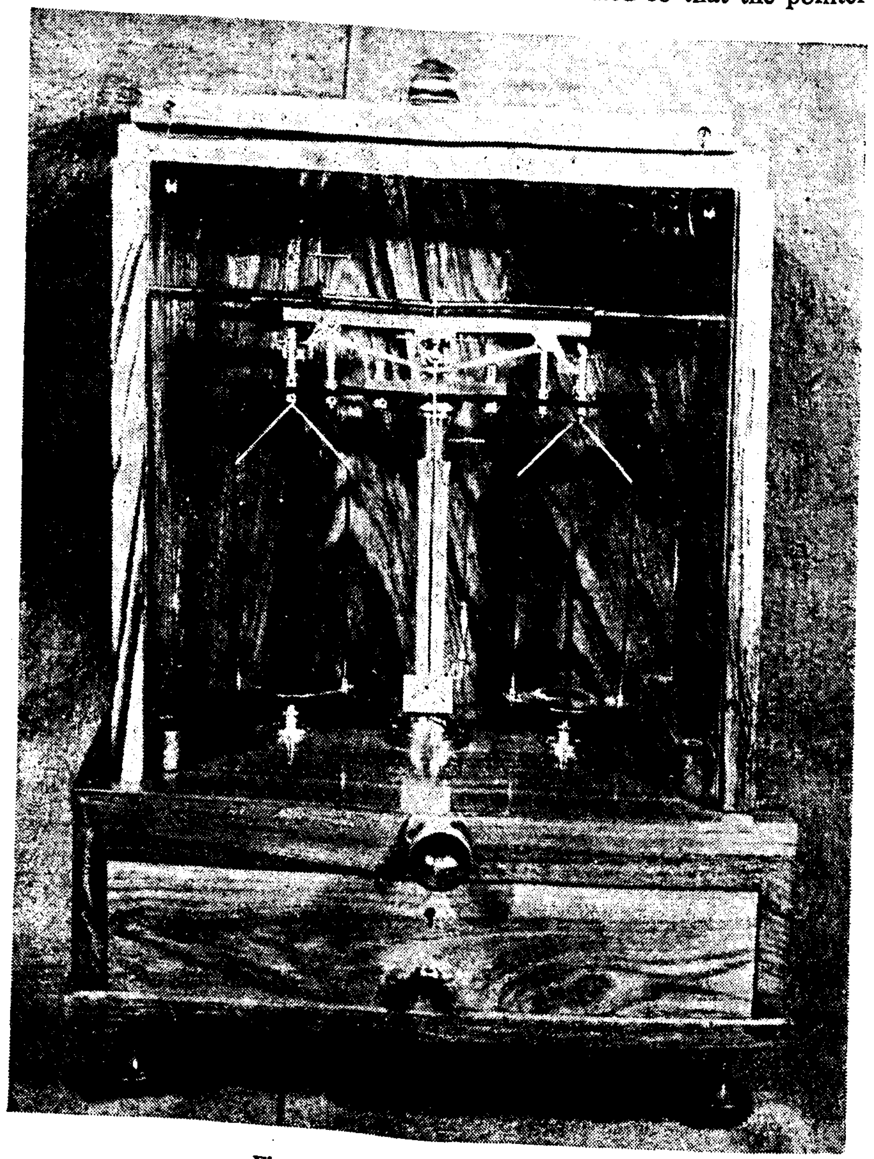

Fig. 6—Assembly of 2 g balance

Use of 50 kg Balance

The balance is usually assembled in a closed space. Before loading, it is advisable to check whether the legs of the tripod stand have been properly fixed and supported from slipping.

zero mark of the scale. (The zero mark on the sector plate in case of the working standard balance is not in the centre but at one extreme. This facilitates taking readings by oscillations. The central mark is numbered 5 instead of zero). When the pans

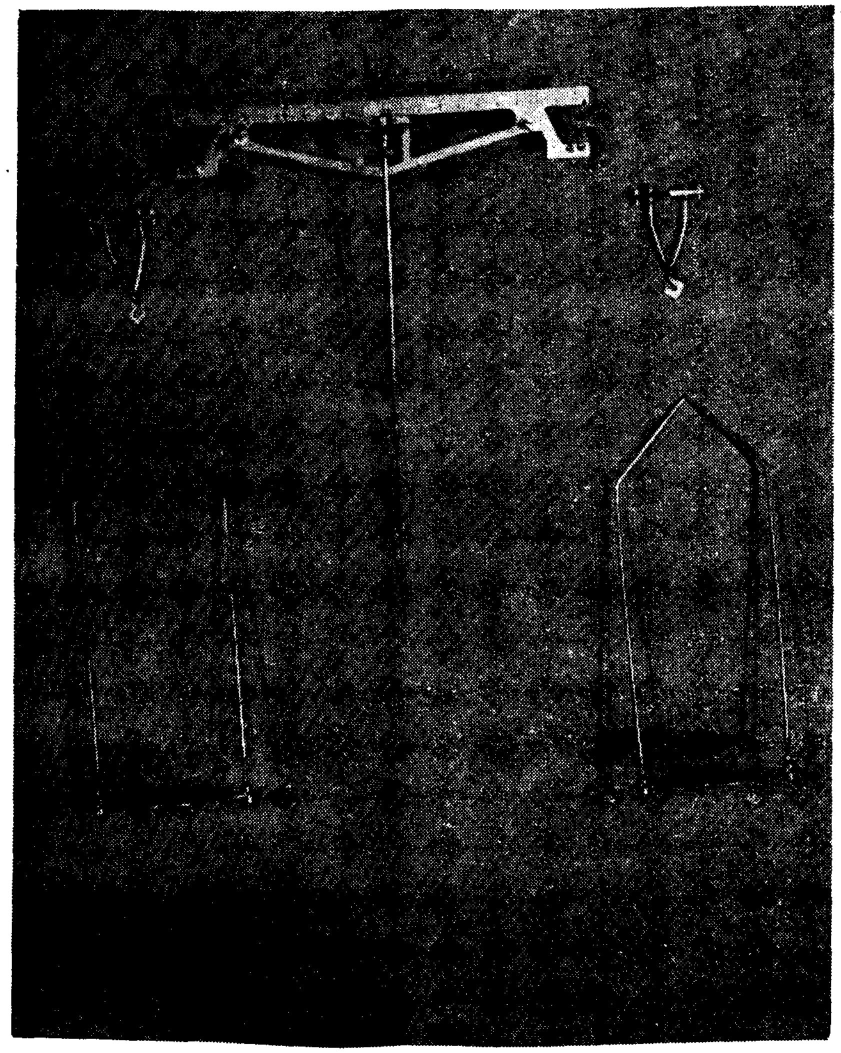

Fig. 7—Parts of the 2 g balance. (Beam suspensions, pans and stand not included).

are released, the pointer should travel slightly below the extreme mark on the other side of the scale. This indicates that the beam is oscillating freely and its rest point is round the central mark of the scale. Let it oscillate two or three times. If the pointer swings unevenly round the mark, the weight of the pan should be adjusted by means of lead in the balance box. If, however, oscillations are dampened, they should be corrected by cleaning the corners of the bearings and wiping the agate bearing and knife-edges clean. *It should be borne in mind that knife-edges and bearings are very hard and brittle.* Care should, therefore, be taken while placing weights in the pan. Any rough handling of the pan is transferred to the knife-edges and the bearings. A weight should, therefore, be placed only after resting the pan on the ground.

Use of 5 kg Balance

The board should be levelled carefully by adjusting the screws and taking cross levels with a spirit level. The pans should be brought to rest by making them touch the base board without jerking. The beam can be made to oscillate by raising it. A trial should be taken to ascertain whether the pointer oscillates round the central mark. If adjustment of weight is necessary this can be done by adjusting the balance box. Checking of weights should always be started by bringing the pans to rest on the base board to prevent damage to knife-edges and agate bearings.

Use of 200 g Balance

The beam should be raised and the oscillations checked. If the pointer swings equally on both the sides of the mark, the verification of the weights should be commenced. This balance is not provided with a balance box, but with two adjusting nuts on the beam. These should be adjusted to obtain equal oscillations on both sides of the pointer scale.

Use of 2 g Balance

In this balance, the oscillations are stopped simultaneously by the arrestment of the beam and the pans. In this case, the central agate bearing is not raised, but is stationary and the beam is lowered on to it. The oscillations should be checked before use.

The adjusting screws of this balance are provided near the pointer. The gravity ball on the back side of the beam is set for a particular sensitivity and should not be displaced from its position. No other screws of the balance should be tampered with.

MAINTENANCE

All the four outdoor working standard balances are designed to withstand shocks in transit and their parts are, therefore, suitably packed in the carrying cases or drawers of the glass cases.

The knife-edges are directly fitted in the beams of the 50 kg, 5 kg and 200 g capacity balances. These would, therefore, never get dislodged from their accurately fitted positions under any circumstances. The knife-edges of the 2 g balance are fitted by means of screws as the thickness of the beam does not permit direct fitting of the knife-edges. The screws are well tightened before supply and need not be touched again. Like any other delicate instrument careful handling is necessary while shifting these balances from place to place.

To obtain the best performance from the balances it is essential that they should be properly maintained. The initial checking of the balances is carried out under clean conditions, both of the sorroundings and the balances themselves. Such clean conditions are, however, difficult to obtain when the Inspector of Weights and Measures moves from place to place, and he may not get a laboratory or a clean room to set up his balances.

Performance Requirements

The following characteristics of the balances should be checked for assessing performance :

(1) Sensitivity
(2) Free oscillations
(3) Error at full load to be within prescribed limits.
(4) Period of oscillations.

Sensitivity

Sensitivity is defined as the ratio between 'change in mass' in one pan of the balance and the corresponding deflection of the beam or of the attached pointer produced by this change. Sensitivity is expressed

as milligrams per division. Sensitivity at different loads of a particular balance is independent of all factors except the position and condition of the knife-edges. This position would not change unless the knife-edges are displaced. Knife-edges could get blunt in use or could be damaged. If the knife-edges are properly fitted, it is very unlikely that they would change their positon. The sensitivity would, therefore, be affected only if the knife-edges get blunt or damaged.

Blunting of Knife-edges

If the knife-edges are not sufficiently hard they get blunted quickly. The use of the correct material and modern techniques of hardening and grinding have minimised the chances of the knife-edges becoming blunt.

The second cause of blunting is the abrasive action of foreign material which may get lodged between the knife-edge and the bearing. Dust and sand are the usual foreign bodies which cause damage to knife-edges.

The only solution to this problem is to prevent any dust or fine particles accumulating between the knife-edges and the bearings. This is best achieved by cleaning the knife-edges as often as possible during use.

Blunting may develop if the knife-edge is exposed to moist weather and remains unused for a long time. It is, therefore, necessary to apply good quality grease or any thick lubricating oil whenever the knife-edge is not in use. Knife-edges may be chipped if they get 'hammered'. Hammering occurs if the beam is suddenly released upon the central bearing during assembly or pan suspensions are not placed over the knife-edges gently and with care. The corners of the knife-edges may also get chipped if care is not taken during assembly of the balance. Hammering may also take place if the pans are loaded with great jerks. The load, however small it may be, should always be placed gently on the pans. This should be done only when the pans are resting on pan rests in the case of 200 g and 2 g balances, on the base board in the case of the 5 kg balance, and on the ground in the case of the 50 kg balance.

Free Oscillations

A good balance should oscillate freely. There is considerable difference between free oscillation and period of oscillation. Free oscillation means that the indicator moves freely and without getting dampened. It is a variable factor and the oscillation may be longer or shorter. The period of oscillation, whatever the extent of the oscillation, is constant for the particular balance and is an important characteristic of the balance. Free oscillations depend upon the friction between the knife-edges and the bearings and may be dampened by bluntness of the knife-edge, a broken knife-edge, broken corners of the knife-edge, dust accumulation or development of rust on the anti-friction plates where the corners of the knife-edge come in contact. If sufficient care has been taken to keep the knife-edges clean, the dampening of the oscillations is due to dust in corners or rusty anti-friction plates. These should be cleaned before use. Dampening of oscillations, however, does not always indicate a fall in sensitivity. The balance could be used with efficiency, even with dampened oscillations.

Error at Full Load

Even the most accurately adjusted balance is not free from inequality in the lengths of the arms. The arm, as we have indicated in earlier Parts, is the distance between the central and the side knife-edges. The error observed in the balance at full load is the result of the slight difference in the length of the two arms of the beam. This error does not vary as long as the distance between the central knife-edge and the side knife edges remains unaltered. Only if the knife-edges are displaced or blunted, can this error change.

Period of Oscillation

The period of oscillation is constant at a given sensitivity. Variation in sensitivity may be caused by a change in the position of the centre of gravity of the beam. It is, therefore, necessary to ensure that the centre of gravity remains unaltered as far as possible. The 2 gram balance is fitted with a gravity ball and this should not be touched. The other balances have arrangements for changing gravity which are not easily manipulated.

It is also necessary that the other components of the balance should also be maintained in a good condition for good performance. For example, the carrying cases are likely to get damaged in transit. It is, therefore, desirable to use and re-use the dealwood packing cases provided with the balances for transit purposes.

Other Components of the Balances

The central bearing fork of the 50 kg balance has a joint in its top and a locking pin at the bottom. These need occasional oiling. The 5 kg balance has a central bearing fitted on a vertical shaft worked by means of a handle. The central bearing bracket works on two stainless steel guides. These should be oiled. The handle has an eccentric inside the bottom of the column. This eccentric should be oiled or greased. The balance stands of 200 g and 2 g balances should also be oiled just like the 5 kg balance. A thin oil called spindle oil or 3-in-one oil should be used and a small drop taken on a thin wire should be put in all the reciprocating parts.

Balances of 5 kg, 200 g and 2 g capacities should be accurately levelled with a spirit level before use. The 50 kg balance has other arrangements for levelling.

In this article, which concludes with this Part, we have considered the various aspects of the specifications, design, construction, assembly, use and maintenance of the working standard balances which are used by the Inspector of Weights and Measures for the verification of commercial weights. These balances are extremely sensitive instruments and should be handled with the greatest care by the Inspector, particularly in transporting them from place to place. A good balance can be damaged by rough and careless handling.

It is hoped that the information given in this comprehensive article would be of use to the Inspectors of Weights and Measures.

Indian Made Weighing Machines

R. RAJAGOPALAN
Central Railway,
Secundarabad

PLATFORM weighing machines made in India are generally of robust construction. The parts are made from stronger sections. The box, levers, stool, plate etc. and knife-edges are longer (accounting for less friction) than those of many foreign makes. But they are not altogether perfect in design and a few desirable improvements are discussed below.

Shape and Position of Loading Chamber in Major Poise

The chamber provided for adding lead for adjusting the weight of the major poise should be so located therein that the additional lead does not have a turning moment about the fulcrum when the poise returns to zero. The section of the chamber should be V-shaped so that the added lead spreads evenly on either side of the V, whose bottom line is vertically below the fulcrum when the poise is in the no-load position. The advantage of this arrangement is that if lead is added at full load it does not affect the empty scale and the process of lead-adjustment is completed in one operation.

In all Indian makes this desirable feature is absent. It is necessary to re-balance the empty scale after evey operation and a trial and error method has to be adopted.

Size of Loading Chamber in Minor Poise

Minute pieces of lead added in the minor poise should not move in the chamber while the poise travels on the minor bar. The loading chamber should be a small hole with a cup-like screw which is the ideal arrangement to eliminate erroneous weighment.

In most Indian makes, this chamber is large and lead moves within the chamber during weighing operations and causes errors.

Steelyard and Protection Bar Notches

At present in Indian machines these notches are not deep enough. When the nibs are a little out of position the operator is unaware of the incorrect positioning. Deeper notches would mean wider section of V and the poise would drop in the desired position into the notch more easily and with greater certainty due to its own weight. Errors would not creep in. The notches in the pro-bar and steelyard should, therefore, be made deeper.

Steelyard Index Plate

Screws used for fastening the graduated plate to the steelyard and the poise rod to brackets can be easily manipulated by mischievous elements. Brass parts are also easily pilfered. Unsocial elements benefit little thereby, but the owner has to pay heavily for replacements.

A solid design with stainless steel etched plate not only would avoid pilferages (stainless steel plates have very little scrap value) but also add to the attractive appearance of the machine.

Vertically-Movable Weight for Sensitivity Adjustments on Steel-yard

In the balance box such a weight helps in quick adjustment of sensitivity on the spot. When a machine is rejected for insensitivity by a few grams this comes to the rescue. In its absence, the machine has to go to the workshop or undergo repairs at site which may take a long time.

The Balance Box

This should be fastened to the steelyard by a screw in a tapped-hole arrangement.

At present this box is secured by a tight-fit screw which is usually disturbed by jerks. Hence a tapped-hole should be provided on the steelyard.

Bearings of Bottom-work

The play of the top-plate tends to move the knife-edges out of their bearings. In Indian designs the shoulder of the bearing is insufficient to prevent a breakdown due to normal movement of the plate while loading or unloading articles for weighment.

A deep shoulder to the bearings of the bottomwork is very desirable.

So far we have considered mainly the no-loose-weight type of machines and to some extent loose-weight machines.

Dial Type Machines

Some improvements in dial-type machines are discussed now.

Oil-seal cups fitted around tension rods connecting the full-bows give added protection in case of jerks and ensure that the tension-rod works vertically. The provision of upper and lower oil-seal cups is highly desirable.

A square-ended spindle gets a grip on the indicator and avoids error which a round-ended spindle causes. The jerks due to oscillation of the indicator make the relative movement on the spindle possible within the round-seating. So all spindles should be square ended.

Weighbridges

As regards weighbridges, the author has come across certain no-loose weight types where the table sinks under loads considerably (upto 4 cm) below the adjoining rails. This is due to the weakness of the levers at the load-bearing points. The section of the levers especially at these points should be deep enough to bear the greatest permissible load without appreciable bending. A high safety factor may be adopted to avoid the sinking of the table.

Indian manufacturers market their products without supplying literture on methods of installation and maintenance in the form of service-instructions. The operation of the machines is facilitated with such literature and manufacturers would benefit by issuing such service instructions.

Spring Balances

As regards spring balances made in India the author's experience is that many do not conform to the standards prescribed by law. Most of them have no ability to recover after being subjected to a load (the maximum) for 24 consecutive hours. In many cases the graduations are unequal. The manufacturers must ensure that the Weights and Measures (Enforcement) Act and Rules are not infringed and spring balances are manufactured to conform to the specifications prescribed in the Rules.

Before concluding this article, a suggestion is made.

National Standard Design

Indian firms design many types of machines. Each maker chooses dimensions and shapes to distinguish his product from others. If the quality and workmanship

reach the levels prescribed, multiplicity of types is not justified as no useful purpose is served. On the other hand, large concerns like Railways who buy all types of makes are obliged to stock spares *of each make* for maintenance purposes which would be unnecessary if one good national standard design is adopted by all manufacturers for every machine.

In such a national standard design or prototype the best features of all existing types could possibly be incorporated advantageously. The national standard design could be improved upon by research in the National Laboratories in India and we would reach perfection in the course of time.

As labour and materials are cheap in India it would be possible for us to enter into foreign markets in our neighbourhood with confidence and earn us valuable foreign exchange which is so vitally required for our expanding economy.

I hope the authorities will examine this suggestion and take necessary steps in the matter.

News & Views

Ninth Indian Standards Convention

The Indian Standards Instituion would be holding the Ninth Indian Standards Convention at Bangalore from 13 to 18 December 1965. The Convention would be inaugurated by Shri S. Nijalingappa, Chief Minister of Mysore, and the inaugural function would be presided over by Shri T. N. Singh, Union Minister for Industry and Heavy Engineering and President of ISI.

There would be nine technical sessions on the following subjects:

S—1 Expediting Preparation of Indian Standards.

S—2 Cost Reduction Through Standardization.

S—3 Extending Usefulness of ISI Certification Marks.

S—4 Implementation of Agricultural and Food Standards.

S—5 Standardization in the Field of Welding.

S—6 Crisis of Shortage of Building Materials.

S—7 Overseas Collaboration and Standardization in India.

S—8 Documentation and Library Housing.

S—9 Standardization as a Tool for Export Promotion.

Out of these sessions, two sessions namely S-7 *Overseas Collaboration and Standardization in India* and S-9 *Standardization as a Tool for Export Promotion* would have a bearing on the adoption of metric system in India. Their scope is as given under:

S—7 *Overseas Collaboration and Standardization in India.*

A large proportion of industrial units in India is operating under some form of collaboration agreement with overseas principals, distributed in many countries. While the need for expeditious development of industry amply justifies the collaboration approach, it does create serious difficulties in propagating the widespread use of Indian Standards in Indian industry. Every collaboration tends to bring in company standards of the overseas principal which are based on the national standards of his country. The Indian entrepreneur who depends for his know-how and sometimes even for his technical personnel on his principal abroad, naturally finds it most difficult to make a change to Indian Standards to develop his own company standards linked with Indian Standards. Moreover, he is required more and more to eliminate imports and depend on indigenous raw materials and equipment, which have obviously to be produced in conformity with Indian Standards.

The session may deal with the various aspects of the problems arising out of this situation.

The following topics illustrate the scope of the session:

(*a*) The general approach which may be adopted to safeguard against such difficulties, when entering into collaboration agreements and in this regard what action may be taken by:

(1) the Indian collaborator,

(2) the overseas principal,

(3) the Government of India, and

(4) the Indian Standards Institution.

(*b*) The problems met with in the existing collaboration set-ups, how these problems are being tackled and with what success.

(*c*) Specific problems arising out of collaboration agreements in meeting the vital demands for defence requirements and food production.

S—9 *Standardization as a Tool for Export Promotion.*

Promotion and expansion of export would be a relatively simple affair, if a comprehensive system of international standards had existed. As it is, either the national standards of the importing country or those of the exporting country are to be depended upon. Generally, of course, the importing countries' standards have to be respected, being as they are on the buying end. Nevertheless if a well-conceived system of national standards of an exporting country is being used for guiding production and distribution, overseas buyers have the advantage of importing, so to say, off the shelf mill-of-the-run products of defined quality at economic level. Standards thus help producers to avoid having to comply with divergent specifications and reduce their production costs. The session will deal with all aspects of standardization at the international, national and company or plant level as they influence the export effort of India and the manner in which they serve to offer guarantees of quality, for example through certification marking and preshipment inspection.

Interesting Prosecutions

(1) A person was fined Rs. 30/- or in default to undergo rigorous imprisonment for one week on each count for committing offences punishable under Sections 29 and 30 of the Madras Weights and Measures (Enforcement) Act, 1958. The accused was found in possession of a one litre measure measuring 40 ml in excess, at the Arachalur shandy on 23 July 1964. The accused knew it to be false and had fraudulently used it for the *purchase* of oil seeds.

(2) A trader in Coimbatore sold salt by measure instead of weighing as required by law. He was sentenced to pay a fine of Rs. 30 or in default to undergo simple imprisonment for two weeks. The accused pleaded guilty under Section 8 of the Madras Weights and Measures (Enforcement) Act, 1958.

(3) A trader was found in possession of a litre cubic dry measure duly stamped for use which had been decreased in its measure by the insertion of a false bottom reducing the cubic contents and its measure. He was prosecuted under Section 33(8) of the Madras Weights and Measures (Enforcement) Act. The accused pleaded guilty and was sentenced to pay a fine of Rs. 75 or in default to suffer simple imprisonment for 2 months.

(4) A trader was prosecuted for manufacturing scales without obtaining licence. The Inspector of Weights and Measures while inspecting the workshop of the accused, had found the accused manufacturing scales without licence. The accused was fined Rs. 25/- or in default to undergo simple imprisonment for 15 days.

* * *

Standards News

(Indian Standards which have a particular bearing on the change-over to the metric system are indicated here. Copies would be available from the Indian Standards Institution, Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi or their Branch Offices at Bombay, Calcutta, Kanpur and Madras.)

Indian Standard Outline Dimensions for Electric Lifts.

Indian Standards Institution has prepared a draft Indian Standard outline dimensions for electric lifts [Doc: ETBDC 9(486)].

This draft standard is a supplement to the work done earlier in connection with the preparation of IS: 1860—1961 Code of Practice for Installation, Operation and Maintenance of Electric Passenger and Goods Lifts, and recommends the outline dimensions of lift wells, lift pits and other layout dimensions necessary for lift installation.

This draft standard is circulated to all interests concerned for eliciting technical comments.

Student Type Microscope

Indian Standards Institution has prepared a draft Indian Standard Specification for Student Type Microscope [Doc: EDC 36(632)], which specifies the general and functional requirements of the student type microscope used in schools and colleges for observation of minute objects under magnification.

The draft standard is circulated to all interests concerned for eliciting technical comments.

Nominal Capacities and Nominal Diameters for Process Equipment

IS: 2843—1964 and IS: 2844—1964 two recently published Indian Standards deal with the nominal capacities of containers and process vessels used in chemical equipment respectively.

Chemical equipments come in various capacities and diameters and are designed to various temperature and pressure conditions. To help the fabricator to offer standard equipment and for the user to order equipment on such basis, it was necessary to lay down a rationalized series of preferred capacities, diameters, temperatures and pressures. These two standards along with two other IS: 2845—1964 and IS: 2846—1964 which deal with nominal pressures and temperatures respectively, will meet this need.

Price: Re. 1·00 each

Bearings

Indian Standards Institution has prepared the following three Draft Indian Standards on Bearings which will be circulated shortly to the interests concerned for their critical comments and suggestions for improvements:

(*a*) Boundary Dimensions for Tapered Roller Bearings, [Doc: EDC 39(891)].

(*b*) Gauging Practices for Ball and Roller Bearings, (Doc:EDC 39(974), and

(*c*) Specification for Sintered Metal Powder Oil-impregnated Bearings, [Doc: EDC 39(905)].

Doc:EDC 39(891) deals with the boundary dimensions for tapered roller bearings

including the tolerances. These are very essential for a satisfactory performance which depends on a minimum running accuracy. A separate specification, IS: 2513—1963 has already been published for boundary dimensions for rolling bearings for general engineering purposes.

Doc:EDC 39(974) establishes the standard gauging practice employing standard measuring loads and measuring pressures for various measurements carried out on ball and roller bearings, in order to get uniform and comparable results. These practices may not, however, necessarily represent the production gauging practices.

Doc:EDC 39(905) lays down requirements for the materials, dimensions, tolerances, inspection and testing procedures for sintered metal powder oil-impregnated bearings. The use of this type of bearings is increasing rapidly in such industries as automobile, machine tool and light engineering, and it is expected that this specification will prove very useful in these fields.

Commercial Timbers

IS: 399—1965, a fundamental Indian standard relating to timber and of course one of the best known on the subject, has recently been revised.

This standard gives the details of the zonal distribution of common commercial timbers of India, classified according to their various uses and important properties.

The present revision was undertaken not only for metricizing the standard but also for effecting other important changes. In addition to the average weight per cubic metre (cubic foot) of various species of timber, the range of weight has also been given. Other important additions made are the incorporation of abbreviated symbols for each species of timber and the comparative strength coefficients. Besides, a few more species have been included in the various zones.

For the purposes of this standard, India has been divided into five zones as shown in the map appended to the standard.

By furnishing information regarding the classification and availability of commercial timbers and their important properties this standard will enable those who are engaged in timber trade to procure the correct species of timber from the nearest available source.

Price : Rs. 10.00

Structural Safety of Buildings: Loading Standards

Indian Standards Institution has published revised edition of Indian Standard code of practice for structural safety of buildings: loading standards (IS: 875—1964). This code covers basic design loads to be assumed in the design of buildings. The imposed loads, including wind loads, which are specified herein, are minimum working loads which should be taken into consideration for purposes of design.

This standard was originally published in 1957 for the guidance of civil engineers, designers, architects and others interested in the field of building design. The code being one of the very important basic codes, has been widely adopted in the country. This revision has been brought out to include the modifications found necessary as a result of wide adoption of the code.

The revised standard incorporates certain important modifications and additions, which are revision of the provisions regarding basic wind pressure and its effects on the building; new clauses on wind load for butterfly type structures; modified wind pressure coefficients for sheeted roofs, both curved and sloping; and deletion of seismic load provisions since a separate and comprehensive code has been prepared on this subject. Opportunity was also taken to adopt metric system of weights and measurements.

Price: Rs. 5.00

Computation of Capacity Tables for Pressurized Storage Tanks.

Indian Standards Institution has published Indian Standard method for computation of capacity tables for pressurized storage tanks (IS: 2808—1964), which prescribes methods of computation of capacity tables for the following types of vessels which are normally used for the bulk storage of liquid petroleum and petroleum products under pressure:

(*a*) Vertical tanks,

(*b*) Horizontal tanks,

(*c*) Spherical tanks, and

(*d*) Spherioidal tanks—plain and noded.

The measurement of bulk quantities of liquid petroleum products involves various processes such as calibration and computation of capacity tables of tanks, gauging of tanks, temperature measurement of oils, and calculation of bulk quantities of oils in tanks. The need for accurate calibration of tanks cannot, therefore, be over-emphasized. The object of this standard, is to lay down methods to be adopted uniformly in the country which will enable computation of capacity tabls for pressurized storage tanks.

Price: Rs. 5.00

Single and Double Column Planing Machines

The Standards Institution has published an Indian Standard IS: 2877—1964, which prescribes the limits of accuracies for single and double column planing machines.

The quality of machine tools in general and of planing machine in particular has considerably been improved during the last few years. It is hoped that within a short time a large number of manufacturers would be able to supply freely planing machines complying with the requirements of this standard with the assistance which it is hoped, the Government of India will organize for the benefit of interested manufacturers.

Price: Rs. 2.50

Corrugated Sheets

A newly published Indian Standard IS: 3007 (Part I)-1964, lays down the method of laying and fixing unreinforced corrugated asbestos cement sheets used as coverings for roofs and walls.

Due to many advantages it offers, such as durability, lightness, ease and quickness of construction, unreinforced corrugated asbestos cement sheets are commonly used for providing structural surface exposed to weather, such as roofs of industrial, institutional, commercial and residential buildings. This code is intended to give guidance in selection of materials and laying of asbestos cement corrugated sheets for obtaining satisfactory performance.

In a different part of this standard requirements regarding laying of semicorrugated sheets have been covered.

Price : Rs. 5.00

Wooden Crates

Indian Standards Institution has recently published Indian Standard Specification for Wooden Crates (IS: 3071—1965), which covers the requirements of wooden crates intended for packing of articles weighing not more than 250 g.

By using wooden crates, a considerable saving both in the volume of timber used and the gross weight of the pack is effected, provided the crate is properly designed and

constructed. The strength and rigidity of a crate are influenced by the three-day corner (locked corner) and the diagonal braces.

An attempt has been made in this standard to lay down the requirements of the framework of wooden crates in relation to the weight of contents packed and the type of load, in view of the fact that large quantities of wooden crates of various sizes and designs are in use for packing a wide variety of articles.

Price : Rs. 4.00

Verification work and Licences Issued

(*Metric Measures* had been publishing in the past a series of lists of licensed manufacturers, dealers and repairers of weights and measures, weighing and measuring instruments licensed by the Governments in the various States and Union Territories under their Weights and Measures (Enforcement) Acts. To economise on paper the practice has been discontinued.

A feature on statistics of verification and licences issued is also being published in *Metric Measures*.

—*Editor*)

STATISTICS OF VERIFICATION OF WEIGHTS ETC. AND LICENCES

States/Union Territories	Period	Weights	Capacity Measures	Length Measures	Weighing Instruments	Measuring Instruments	Others	Total number of Mfgs.	Dealers	Repairers As of July 1965
1	2	3	4	5	6	7	8	9	10	11
(1) Andhra Pradesh	1 Feb. 64 to 31 Mar. 64.	2,00,101	64,362	6,408	21,747	527	26	14	59	24
(2) Assam	1 June 64 to 31 July 64.	83,104	—	19,638	490	1,075	45	19	254	238
(3) Bihar	1 April 62 to 31 Jan. 63.	1,28,211	—	—	19,309	56	—	30	203	43
(4) Gujarat	1 Apr. 64 to 31 May 64.	1,77,068	13,444	1,340	21,039	107	—	125	—	59
(5) Kerala	—	—	—	—	—	—	—	—	—	—
(6) Jammu & Kashmir	1 Apr. 63 to 31 Mar. 64	2,12,854	2,582	7,511	683	3	4	36	36	2
(7) Madhya Pradesh	1 Aug. 64 to 30 Sept. 64.	1,76,445	52,105	1,590	69,410	90	—	3	423	245
(8) Madras	1 July to 31 Aug. 64.	1,59,120	92,733	1,237	23,303	864	—	—	—	—
(9) Maharashtra.	1 Apr. 63 to 31 Nov. 63.	12,73,216	2,94,420	5,608	—	—	—	—	—	—
(10) Mysore	1 Apr. 62 to 30 Nov. 62.	4,81,345	1,05,253	1,089	196	2	—	8	103	6
(11) Punjab	1 Dec. 64 to 31 Jan. 65.	9,12,684	10,684	3,760	20,123	103	—	63	472	104

1	2	3	4	5	6	7	8	9	10	11
(12) Orissa	Jan. 63 to May 64	1,97,851	30,025	1,055	4,891	77	—	8	103	6
(13) Rajasthan	N.A.									
(14) Uttar Pradesh	31 Dec. 64 to 1 Jan. 65	1,75,760	4,867	4,721	48,151	255	—	—	—	—
(15) West Bengal	5 June 65 to 10 July 65	84,945	2,186	—	89	39	—	—	—	—
(16) Andaman & Nicobar Islands	N.A.									
(17) Delhi	1 June 64 to 31 Aug. 64.	59,032	5,444 +37 Petrol lorries	1,186	8,827	126	—	66	26	71
(18) Goa ..	1 Apr. 64 to 31 May 64	13,523	1,012	23	26	—	—	—	353	—
(19) Himachal Pradesh	1 Feb. 64 to 31 Mar. 64	2,062	127	72	629	5	—	—	1	—
(20) L.M.A. Islands	N.A.									
(21) Manipur	31 Jan. 65 to 31 May 65	12,048	21	34	239	—	—	—	7	3
(22) Pondicherry	1 Feb. 64 to 30 Nov. 64	4,038	1,341	36	21	4	37	4	10	3
(23) Tripura	1 Apr. 62 to 30 July 62	62,050	8,464	720	9	8	—	4	85	3

N.A.—Statistics not available as yet.

TYPICAL METRIC PRICING UNITS FOR WHOLESALE TRANSACTIONS

Serial No.	Commodity	Metric Unit
(1)	**Gold**	10 grams (g)
(2)	**Grocery and Confectionery** Biscuits, sweetmeats, cardamoms, **Textiles and Textile Fibres** Cotton yarn, damaged and seconds cloth, raw silk, rayon, silk yarn, raw wool, wool manufactures (when sold by weight). **Paints and Chemicals** Paint (if sold by weight), indigo, liquid chlorine. **Hides, Skins and Leather** Raw hides, leather (hides and skins). **Metals** Silver, aluminium sheets, strips and circles, copper and brass wires and utensils. **Miscellaneous** Tea, meat, camphor tablets, mica.	1 kilogram (kg)
(3)	**Grains and Pulses** Rice, wheat, jowar, arhar, moong, masur, gram. **Spices** Black pepper, mustard, chillies, dhania, dalchini, turmeric, betelnuts. **Plantation Products** Rubber, cashewnuts, kernels, tobacco (raw and manufactured). **Forest Products** Lac and lac products, gums, myrobalans, galnuts, soapnuts. **Textiles and Textile Fibres** Raw jute, raw hemp, coir yarn. **Oils, Oilseeds and Oilcakes** Vegetable oils, oilseeds, oilcakes. **Non-Ferrous Metals** *Aluminium*: ingots, bars, blocks, slabs, billets. *Lead*: ingots, sheets and strips. *Copper*: ingots, blooms, slabs, cakes, tiles, bricks, billets, blisterbars and wirebars, rods, sections and pipes, plates, sheets and strips, circles. *Brass*: ingots, rods, sections, pipes, sheets, strips circles. *Zinc*: ingots, sheets, strips. *Tin*: blocks. **Chemicals** Caustic soda, bleaching powder, glycerine, soaps, paper salt. **Others** Sugar, gur, ice, fish, sugarcane, vegetables, tamarind.	1 quintal (q) (100 kilograms)
(4)	**Minerals** Iron ore, manganese ore, bauxite, coal. **Iron and Steel** Pig iron, iron & steel manufactures, semis (billets for rerolling etc.)	one metric tonne (t) (1,000 kilograms)
(5)	Cloth (mills, handloom, silk rayon and woollen cloth)	1 metre (m)
(6)	Jute carpets, coir mats and mattings, sheet glass.	one square metre (m^2)
(7)	Timber.	one cubic metre (m^3)
(8)	Paints (when sold by measure), spirits.	one litre (l)

Weights

(1) In place of the present units of seer, pound, rattal, viss etc., use the kilogram.

(2) In place of the tola, use the gram or 10 grams.

(3) In place of maund or corresponding unit, use the quintal *i.e.*, 100 kg.

Capacity Measures

In place of seer or gallon or any other measure, use the litre.

Length Measures

(1) Use the metre in place of yard or foot and the centimetre in place of inch.

Square Measures

(1) Use the square metre in place of square yard or square foot, and square centimetre in place of square inch.

Cubic Measures

(1) Use the cubic metre in place of cubic yard or cubic foot and cubic centimetre in place of cubic inch.

Packaging

It is advantageous if sizes of packages correspond to series of commercial weights and measures prescribed.

These are: 50 kg, 20 kg, 10 kg, 5 kg, 2 kg, 1 kg, 500 g, 200 g, 100 g, 50 g, 20 g, 10 g, 5 g, 2 g, 1 g, and so on.

TYPICAL PRICING UNITS FOR RETAIL TRADE

Serial No.	Commodity	Metric Unit for Use
(1)	Foodgrains, cereals, pulses, spices, ghee, bread, vegetables, meat, fish, sweetmeats, tea, coffee, sugar, salt	1 kg
(2)	Oil for cooking	1 kg or 1 litre depending upon prevalent practice.
(3)	Fruits	1 kg or number depending upon prevalent practice.
(4)	Milk	1 litre
(5)	Cloth and related materials	1 metre
(6)	Prepackaged materials	Preferably sizes corresponding to series of commercial weights and measures.

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