ONE HUNDRED AND TWENTY-SIXTH PAPER
(OF TRANSACTIONS).

THE DECIMAL AND METRIC SYSTEMS.

BY

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THE metric system is a decimal system, but a decimal system is not necessarily metric, although so many seem to confuse them. Our systems of weights, measures, and money in this country are neither decimal nor metric—are, in fact, no system at all, but merely arbitrary tables handed down from mediæval, if not primæval times. That they might be improved upon no one doubts. Yet most people are averse to making a change. Some are afraid of a decimal system of coinage, connecting it with the dreaded decimal fraction—with which, by the way, it has nothing to do. Others cry out that any change from our present systems would so disorganise business for the time that they prefer not to have it happen in their time. Others, again, look only at the expense of new weights, measures, and coins, and vote them prohibitive. In the hope of gaining a few more converts to the decimal system of money and the metric system of weights and measures this paper has been undertaken.

Were we to adopt a decimal system of weights and measures and leave our coinage as it is, we should only make "confusion worse confounded." And as the change to decimal coinage would be a simpler and easier step than the change of all our weights and measures, we may consider coinage first. And, at the risk of being considered tiresome and childish, let

us say that a decimal system of coinage means that ten of one coin make one of the next coin. We have it in our own numerical system, thus: ten *ones* make *ten*, ten *tens* make one *hundred*, ten *hundreds* make *one* thousand. We count in this fashion already, making the "carriage" of the arithmetical process always in tens, hundreds, etc., as we only have ten figures in our language. So it is proposed to make our coinage follow the same rule, instead of, as at present, advancing by 4, 12, and 20.

Fifty years ago the scheme was drawn up and favourably reported on by a committee of the House of Commons. Two Royal Commissions had then decided strongly in favour of decimal coinage. Members of Parliament and the Government were in favour of it. The banks, merchants, scientific societies, working-men's associations, all have voted in its favour. A powerful association, supported by the most eminent men of the day, has long been in existence, and yet the years drag on and we still retain our old cumbersome and perplexing system of pounds, shillings, pence, and farthings, all of differing relative values to each other.

In the present system our pound consists of 20 shillings = 240 pence = 960 farthings. The proposal is to leave the pounds and shillings alone, but make the pound up of 1,000 instead of 960 farthings. The farthing being then the one-thousandth part of a pound would be called a mil.

Ten mils make one cent.
Ten cents make one florin.
Ten florins make one pound.

Gentlemen, suppose ten potatoes make a parcel, ten parcels make a peck, ten pecks make a sack, and ten sacks make a load, would you know without figuring that 24,768 potatoes would be *two* loads, *four* sacks, *seven* pecks, *six* parcels, and eight odd potatoes? If you do, then you understand all there is about the decimal system. If you do not see this at a glance you need not be ashamed, for you have comrades among the great people who have managed this nation, including even some of our Chancellors of Exchequer.

In the proposed system of decimal coinage our pound remains the same—our gold standard. Our florin remains the same, ten of them to the pound. A new coin called a cent is used—ten of them to the florin. The farthing (now called a mil) completes the system—ten of them to the cent.

To show the simplicity of the proposed system, let us set down two corresponding sums in addition—one in the old and one in the new—and follow them in detail.

Present system.				Proposed system.			
£	s.	d.		£	f.	c.	m.
1	17	$8\frac{3}{4}$	=	1	8	8	6
2	11	$9\frac{1}{2}$	=	2	5	8	9
4	19	$11\frac{1}{4}$	=	4	9	9	6
£9	9	$5\frac{1}{2}$	=	£9	4	7	1

Add the farthings, 6 = $1\frac{1}{2}$d. Add 6, 9, 6 = 21 = 2 c. 1 m.
Add 1, 11, 9, 8 = 29 = 2s. 5d. Add 2, 9, 8, 8 = 27 = 2 fl. 7 c.
Add 2, 19, 11, 17 = 49 = £2 9s. Add 2, 9, 5, 8 = 24 = £2 4fl.
Add 2, 4, 2, 1 = £9. Add 2, 4, 2, 1 = £9.

It will be seen that the new system is just as much simpler than the old as the addition of columns of plain numerals is simpler than the addition of pounds, shillings, pence, and farthings. As to the simplicity of the system, therefore, no more need be said.

Now as to the transforming of the old coinage to the new. It must be borne in mind that

The pound remains the same and equals 1,000 mils.
The florin remains the same and equals 100 mils.
The shilling remains the same and equals 50 mils.
The sixpence remains the same and equals 25 mils.

This means that all our transactions in the new money will be unaffected as far as gold and silver are concerned. Only our coppers need to be changed, as the old coppers will have lost $\frac{1}{25}$th part of their value. The sixpence, as we have just shown, will consist of 25 mils, whereas the present sixpence contains only 24 farthings; the shilling will contain 50 mils, whereas the present shilling contains 48 farthings—in each case a loss of $\frac{1}{25}$th part.

We shall be told that the disorganisation of business brought about by the confusion of accounts, the loss entailed by orders given at the old values and paid for in the new, are prohibitive. But we shall see, on looking further into the matter, that *no* confusion need arise and *no* loss need be entailed further than is daily being experienced in trade. For it can be shown that the transition from the old money to the new can be made easily and exactly, without pen or pencil, but by a simple mental calculation, as only small sums can ever be involved. Take, for example, £246 17s. $8\frac{3}{4}$d. As already shown, the £246 will remain as before. This leaves 17s. $8\frac{3}{4}$d. to be dealt with. It has also been shown that the florin remains, and it is seen at once that this sum consists of 8 florins, leaving 1s. $8\frac{3}{4}$d. only to be changed into the new money. Now in the new money, as already shown, one shilling is 50 mils. This

leaves 8¾d. to be dealt with. This, by the simplest mental calculation, is seen to be 35 farthings. This is where the real change of money takes place, and it may be worth while to work it out in detail.

The sixpence at present consists of 24 farthings ; in the new money it will consist of 25 mils. If, therefore, we add one mil for every sixpence *odd money*, we shall never be more than $\frac{1}{25}$th—i.e., 4 per cent.—out in our calculation; and not 4 per cent. on the whole amount, but 4 per cent. of something less than 6d. Now 4 per cent. of sixpence is *almost* a farthing, the net result being that in changing the old money into the new and working by the simple rule of adding one mil for each sixpence of odd change you will be approximately, or at the most, one farthing out in your calculation. Do you consider the farthings now? Does the tradesman consider the odd farthing now, except to your disadvantage? Does your banker pay your cheques to the farthing or to the halfpenny? I trow not. Then in the change from the present system to the proposed decimal coinage you cannot lose any more than you are daily losing now. And the change will only affect you on the actual day of change. After that you will be neither gaining nor losing.

To continue our illustration, we found that £246 17s. 8¾d. equals £246 8 florins, with 1s. 8¾d. to be changed into new money. One shilling equals 50 new mils, leaving 8¾d., which equals 35 farthings. Now add 1 mil (for the odd sixpence) to 35 = 36 mils = 86 mils in all. The total then becomes £246 8 fl. 8 c. 6 mils. This can be read as 246 pounds 886 mils, as £246 8 florins and 86 mils, or 246,886 mils, as you will.

Once the change is made it will be made for good. But the transition stage seems to be the cause for alarm. We have taken a considerable sum above ; now let us take a workman's weekly wages. How would he be paid at the end of the week during which the change took place? His wages are, say, 36s. 6d. per week. This is in the new money 18¼ florins—18 florins and our present sixpence, or, in the new money, £1 8 2 5 = 1 pound 8 florins 2 cents and 5 mils, or 1 pound 825 mils.

This shows that in the proposed system what is now even money will remain even money. But suppose the wages work out at 35s. 10¾d. We now see 17 florins, with a balance of 1s. 10¾d. One shilling, as before, is 50 mils, and the 10¾d. is 43 farthings. Add one mil for the odd sixpence = 44 farthings —that is, in all, 94 mils. Result, £1 7 florins 94 mils, or £1 7 florins 9 cents and 4 mils.

On the following week there would be no trouble, as the wages are now fixed in the new money.

On the day of change a man with six pennies in his pocket would require another mil to enable him to get a sixpence in silver. On the day on which the proclamation took effect this would be his loss. On every other day it would be neither loss nor gain, for the additional farthing (or mil) would have to come in before it had to go out. It would come from the same quarter as the six pennies came. Those who collect their incomes by pennies—such as crossing-sweepers—would lose 4 per cent. for a time, but when the new 5-mil pieces came into use they would gain much more than they had previously lost.

It might probably be necessary to make some enactment to settle the last or broken half-shilling of outstanding debts. The fairest way would be to make farthings payable by new farthings (mils) up to 3d. (12 mils), and above that sum to make one additional mil payable up to 6d. Suppose that on the day of change a master owes a workman £1 16s. 3¾d. The pound is paid as now, the 16s. is 8 florins, and the workman knows (better, perhaps, than the master) that 3¾d. is 15 farthings. Now 15 mils, or new farthings, is too little and 16 mils is too much; but as the sum exceeds 12 mils the 16 mils would be paid. One of our Chancellors is reported to have said, when this proposal came out, that if a poor man owed another man a penny—for which 4 mils is too little and 5 mils too much—this would lead to a *mill* between them, and some are said to have cheered him! If men were left to themselves there might be cases in which that which was all but a quarrel before might come to a crisis on the difference between 4 farthings and 5 mils, but there is little need to say that a legislative arrangement would remove all difficulty on a matter which can only happen once.

The opponents of the decimal system may be classified under four heads: First, those who parade the difficulties of decimal fractions; second, those who persist that contracts will continue to be made in the old money and paid for in the new, and ask how the accounts are to be *exactly* rendered in the new money; third, those who exaggerate the difficulties of detail which will arise in the adjustment of duties, stamp duties, etc.; fourth, those who are sarcastic, and introduce something approaching to reflection on motives.

As to the decimal fraction difficulty, we need only say that decimal fractions would not be used at all. There are two ways of treating the relation of part and whole. In one the foot is compounded of twelve inches; in the other the inch is taken as the twelfth part of a foot. It is still common with

some to order $\frac{1}{6}$ of a dozen and $\frac{1}{3}$ of a dozen, and even $\frac{1}{12}$ of a dozen is not unknown, whereas what these people really want is two, four, and one respectively. To the practised arithmetician it really does not matter which is used—he understands the sum. But the assumed or supposed difficulty of decimal fractions has often been used to prejudice people against a decimal system of coinage, etc., when, as a matter of fact, fractions are not used at all, either in our present or proposed system. Half a crown is one-eighth part of a pound, but we do not pay our bills in half-crowns or eighths of a pound. Half a crown is taken at its real value—two shillings and sixpence. With "the man in the street" multiplication is the rule, not division. He knows that twelve pennies make a shilling, and he does not bother about a penny being the twelfth part of a shilling. To him all tables are constructed in ascent. They lead up from the farthing to the pound, not from the pound by fractions down to the farthing. Coppers are the basis. The pound consists of so many pennies or so many shillings, and no one looks on the penny as the 240th part of a pound.

As to the second class of objector, it is, of course, obvious that debts contracted in the old money can or should only be paid once, and it has already been shown how easily the present money can be converted into the new.

The third and fourth classes of objectors are hardly worth notice. The only valid objection really is the confusion which might arise here and there as to the exact payment in new money of debts contracted in the old. But if we look more closely into what this would amount to it will be seen to be an objection more of theory than of practice. We have already seen that the only real change will be with sums less than 6d., and that the 6d. will be worth 25 mils instead of 24 farthings. This means that every farthing will be worth $1\frac{1}{24}$ mil. Take $4\frac{1}{2}$d., for instance = 18 farthings. In new money this will be 18 mils and $\frac{18}{24}$ of a mil—i.e., $18\frac{3}{4}$ mils. This is exact enough, in all conscience. We do not work now to fractions of a farthing—nor, indeed, to farthings in business generally. Farthings are left out of calculation altogether except in very petty transactions, and even then a fraction of a farthing is generally disposed of by the shopkeeper charging the whole farthing. Is it impossible to make people understand that they can secure a very great advantage to themselves and their country at no greater cost than running the risk of sustaining *on some one particular day*, and only on debts below 6d., that loss which they now cheerfully sustain on all days of the year,

and which they would rather bear than trouble themselves with coins less than a farthing?

The value of the decimal system, however, is not that the old money could easily be transposed into the new—that is only incidental. The advantages of a decimal system of money are obvious, and the foregoing arguments have only been used to show that there are no insuperable difficulties to its immediate adoption. The full advantages of the decimal system may be better understood by a study of the decimal system of weight and measures, better known as

The Metric System.

The metric system is a decimal system; but this is not its principal advantage. As a matter of fact it is only a sidelight and adjunct, and has really nothing to do with the basis of the system. The real and great advantage of the metric system is that it has a definite relationship throughout for measures of length, area, capacity, and weight.

The basis of the system is the mètre, divided into tenths, hundredths, and thousandths. The tenth part is designated a decimètre, the hundredth part a centimètre, and the thousandth part a millimètre.

The cube of the decimètre is the standard of capacity, and is called a litre (leeter).

The weight of a litre of fresh water is the standard of weight, and is called a kilo or kilogram.

Here we have a definite and fixed relationship between length, capacity, and weight; and whatever length may be taken as the standard it would be impossible to devise anything more rational as a system. For not only are the units related to each other in this simple way, but all increase and decrease on the decimal system, so that as the base units have fixed and definite relationships to each other, so have the next higher units in each case the same relationship. Now this is just what is wrong with our systems, or, rather, systemless measures and weights, and is just what causes confusion and trouble to old and to young, to ourselves and to our customers abroad. For we have a separate unit for each measure, one for length, one for capacity (which has nothing whatever to do with length), and one for weight (which has nothing whatever to do with either length, breadth, or capacity). Had we only one unit for each of these measures, matters would not be so bad, but we have numbers of each, and each one differs from the other in no regular way. And all these measures have *their own* kinds of multiples, being neither decimal, duodecimal,

binary, nor, in fact, anything but purely arbitrary, and they could hardly have been made more difficult or senseless had that been the aim of them.

Let us take the four principal ones as examples, viz., length, area, capacity, and weight:

BRITISH MEASURES OF

Length		Area	
Units	Proportion	Units	Proportion
Statute mile	8	Acre	4
Furlongs	40	Roods	40
Perches	$2\frac{3}{4}$	Rods	$30\frac{1}{4}$
Fathoms	2	Square yards	9
Yards	3	,, feet	144
Feet	12	,, inches	
Inches	3		
Barleycorns			

Capacity		Weight	
Units	Proportion	Units	Proportion
Barrel	4	Ton	20
Firkins	2	Cwt.	4
Pins	$4\frac{1}{2}$	Quarters	2
Gallons	4	Stones	14
Quarts	2	Lb. avoirdupois ...	16
Pints	4	Ounces	16
Gills		Drachms	$27\frac{11}{32}$
		Grains	

Does anyone pretend that any one of the above tables is rational or reasonable, or that the table is made up on any

plan whatever? Does anyone deny that it would be an advantage to all of us to give up the "arbitrary, perverse, and utterly irrational system under which we have all had the misfortune to be brought up," and to adopt some other system which is uniform in relationship, and in addition, multiplication, and division? In our present systems we have to use different factors for the different tables of length, area, capacity, and weight—and not only that, but different factors for each subdivision of each table. In the metric system there is one fundamental unit from which spring all measures of length, of capacity, and of weight. And having constructed this ideal system of relationship, it seemed natural to associate it with the decimal notation, which is common to all peoples and to all times. The system of counting by tens has been common to all mankind from time immemorial, and probably dates back to the time when men first had ten fingers and ten toes. Ten figures is, and always has been, the limit in all countries and tongues. In our rules of simple arithmetic we use it, and would not need such systems as compound arithmetic if we used the metric system. Neither would the time of our children be wasted by learning such rules as "practice" if we adopted the decimal system and the metric. Let us set out a few of the disadvantages of our present system before dealing with the benefits that would be conferred by the adoption of a more rational one.

Lord Belhaven, in moving the second reading of the Weights and Measures (Metric System) Bill in the House of Lords last year, defined these disadvantages as:

I. The loss both in time and money which is involved in business and trade within our own country.

II. The serious waste of time in the education of children of all classes caused by the teaching of complicated tables of weights and measures and their application to arithmetic.

III. The lamentable loss of our commerce with foreign countries through the use of weights and measures which are perfectly incomprehensible to foreigners, who are accustomed to use the simple metric system.

Take our measures of length—the inch, foot, yard, furlong, and mile. The multipliers or divisors are 12, 3, 220, and 8. In some instances, as in railway work, for instance, the miles and furlongs are the principal factors, and inches or fractions of an inch are not considered. In some businesses the yard is the principal factor—for instance, where cloth is concerned.

In mechanical engineering, with which we are concerned, the inch and foot are the basis on which we work. Usually the inch is divided into $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, $\frac{1}{32}$, $\frac{1}{64}$, but everyone knows that a 64th part of an inch is not a fine measurement, and in these days of duplication of parts to ensure cheapness of production much finer limits than a 64th have to be worked to. No one thinks of continuing vulgar fractions of an inch farther than 64ths, although, to be consistent, we ought to continue in 128ths, 256ths, etc. No, when we come to something finer than barleycorns or 64ths we divide the inch into thousandths, which is as convenient, and for most work as accurate, as need be. So that, with all our various subdivisions of the measures of length by various figures, we have eventually to come down to the decimal when we want to be accurate. A saving of time, therefore, from the cradle to the grave would be effected by using decimal notation throughout.

Take our measures of area. How many people, despite the weary hours spent in school and at home learning and repeating our tables of square measure, are able to say offhand how many square yards there are to a rod, and how many rods to a rood?

Our measures of capacity vary according to the liquid being measured or the part of the country in which the sale is being made. Our measures of weight are perhaps worst of all, for nearly all the terms are employed with different meanings, and the multiples the most inconsistent of all. All these abominations have been very fitly described by our Prime Minister as "arbitrary, perverse, and utterly irrational," and no more serious indictment is necessary.

On the assumption that there is a general concurrence of opinion that our systems of measures are not the best possible, and that advantages would be gained by a change to a more rational system, we are confronted by three proposals. The first and most popular is the metric system, which has been adopted by all civilised countries with the exception of the United States of America, Russia, and ourselves; another proposal is what is called the binary system, which consists of halving everything; and the third is what is known as the duodecimal system.

Taking the last first, all that need be said of the duodecimal system is that it would necessitate the adoption of two more figures in our and every other alphabet, and would mean a complete revolution of all our knowledge of arithmetic, and then would help us to the extent of making *ten* divisible by 2, 3, 4, 5,

and 6. Of the second we have already seen that this is only practicable to a limited extent—say as far as 64ths; for in our inch subdivision we seldom find anyone dividing on the binary system farther than the 64th. So that neither the duodecimal nor the binary system is really under practical consideration, and both have only been advanced with a view to keep back the adoption of the metric system rather than with the purpose of recommending the country to give up the ills it has and fly to others it knows not of. If the metric is only *as good as* some other system, it ought to have the preference with us for the sole reason that it would bring our weights and measures into line with the rest of the world, and so benefit our foreign trade without causing any loss at home. But the metric system is not only *as good as* any other system, it is not only *better than* any system that has ever been in use or proposed for use, but it is founded on principles which are perfect ideals of a system—principles which must be adopted in the most perfect system which may or shall hereafter be proposed. That is, there is one fundamental unit for measures of length, of capacity, and of weight. This is the point—not the fact that *the mètre* is the unit, but that there is *one unit* to which *all others* are definitely related. The mètre happens to be 39 odd inches in length, but any other length would do as well for a standard so long as the dominating principle which makes the metric a system is retained. We do not advocate the metric system because the mètre is the ten-millionth part of a quadrant of the meridian any more than some of you wish the old methods retained because three barleycorns make an inch. We are not pleading for the change to be made to the metric system because 1,000 mm. make one mètre any more than our opponents desire the retention of the present system because $30\frac{1}{4}$ square yards make one pole or perch.

We pin our faith to the metric system because it is rational and consistent, because it uses one fundamental unit for measures of length, of capacity, and of weight, and because its numeration is the same system of notation which we already use in our simple arithmetic.

In the decimètre (the tenth part of a mètre)—any other name would do—we have a convenient standard of length. A cube of this dimension—that is, a cubic decimètre—is the unit of capacity, namely, a litre. And the weight of a litre of water is the unit of weight, namely, the kilogramme—better known as a kilo. Could anything be simpler or more perfect? This is the whole of the metric system. The mètre is divided into

thousandths, hundredths, and tenths, the litre is divided into tenths, and the kilo into thousandths. The mètre can be squared or cubed for measures of area or cubic capacity just as our feet and yards can. For long lengths the kilomètre is used—that is, 1,000 mètres; and, in spite of statements to the contrary, it is quite common to speak of half a kilomètre or a quarter of a kilomètre, just as it is quite usual to ask for half a kilo or half a litre. There is no objection to halving if you wish to. You can halve a litre or a kilo or even a kilomètre just as conveniently as you can halve a pint or halve a pound or even a sixty-fourth of an inch. And if not why not?

Would it take children long to learn that a decimètre is a tenth part of a mètre, that a centimètre is the hundredth part, and that a millimètre meant the thousandth part of a mètre? Not, certainly, any longer than it takes them now to learn that sixteen ounces make a pound, and then re-learn that of another kind of ounce twelve go to make another kind of pound. And the advantage of the metric system is that once they have learnt what a deci*mètre* is they know what a deci*litre* is, and, in fact, what a deci-*anything* is—viz., that it is the tenth part, or that ten of them go to make a complete whole. In our present system a stone weight of a live animal—a pig, for instance—is 14 lb. A stone weight of the same animal dead is 8 lb. Can anything be more disconcerting? This is only one example of many which you all know.

The advantages of the metric system, like the disadvantages of our present system, are threefold:

I. Length, area, capacity, and weight measures have *one* fundamental base unit—i.e., one common to all.

II. The tables of length, area, capacity, and weight are *all* on the same system—i.e., decimal.

III. All calculations of length, area, capacity, and weight are consequently simple arithmetic.

The advantage of having one fundamental base unit for all measures of length, area, capacity, and weight is surely so apparent as hardly to need any argument further than its simple declaration. No one, surely, can be so dense as not to understand its main features in two minutes. Our present systems, compared with it, are complexity and confusion.

The second advantage is that besides the fundamental unit being common to all measures and weights, and besides the fact that the base unit (the mètre) is divided into thousands, hundreds, and tens, all the other co-related units are also divided by tens, hundreds, and thousands. To make this clear,

one has only to think of our tables, where each unit varies from the next by a factor different from the last. *12* in. = 1 ft., *3* ft. = 1 yard, *2* yards = 1 fathom, *144* sq. in. = 1 sq. ft., *9* sq. ft. = 1 sq. yard, *30¼* sq. yards = 1 sq. rod, and so on, each one differing, as one star differs from another in glory.

The third advantage is not by any means the least, for it would be almost incalculable. This, however, has been pretty fully referred to under decimal money, and need not be further argued. Suffice it to say that any child at school would choose a sum of simple addition, subtraction, multiplication, or division in preference to one of compound. And this preference begun at school sticks to us all our lives.

The benefits to be derived by this country from the adoption of the metric system are numerous, but may be summarised under three heads as follows :

I. The simplification of our measures, resulting in general benefit, but principally in the saving of time in teaching children in school. This would, according to the most competent authorities, mean a saving of two years of school life—not to mention the fact that when these metric tables are known they can never be forgotten.

II. The benefit to our internal trade by the use of rational and uniform measures.

III. An increase of our foreign trade with countries already using the metric system.

Several of our Colonies have indicated a desire to adopt the metric system, and it is almost certain that if the Mother Country made the change all our Colonies would immediately follow suit. It is also as near a certainty that the United States of America would soon follow the example. This would then make the system practically universal.

It is useless, at the same time, to deny that the opponents of the metric system are numerous and influential. Some of them are idealists, and will brook no change until we can adopt something which is more perfect even than the metric system—as, for instance, the duodecimal system. On this principle no one would ever change any antiquated method until he could change to perfection, which is absurd. And, after all, we only use standard measures for purposes of business, and if it is a good thing for a country to have a standard for general use within the country it must be a better thing still to have a universal standard. No one, surely, believes that the metric countries will ever consent to discard their system for our

conglomeration of inconsistencies. Germany started out with the intention of forming special standards of its own, and ended by recommending the adoption of the metric system. The Germans, in their practical way, adopted it, and in a few weeks after the change was made everybody understood it. Are our people less intelligent than the Germans that the change would upset all business for years, as some have prophesied? Has any country adopted the metric system and repented it, or given any indication whatever of returning to the old methods? Too much altogether is made of the inconvenience, expense, and trouble that would be entailed by the change. No change for the better is effected without *some* inconvenience. No improvements are ever made without *some* temporary sacrifice. Business cannot *always* be "carried on as usual during alterations." But the people who shirk the change because of present inconvenience or expense are not those who have made for progress in the world. The merchant whose business has grown to such an extent as to necessitate new buildings and who puts off the building of them because of the possible loss during removal must be content to remain in his old premises, and will probably find them in time commodious enough. The manufacturer who admits that a new process of manufacture offered to him is better than his present and refuses to adopt it because it is not perfection is surely pursuing a short-sighted policy. When Whitworth brought out his screw standards they were admitted to be only a compromise, but they were adopted, and the bolt and nut maker who did not conform to the new standard found his business "going." Whitworth standard screws are not perfection, but were not refused on that account. The adoption of Whitworth standards was a boon to this country and others, but Whitworth did not profess or claim that his conclusions were perfect or final. Had the people of his day refused to adopt the standards because of the inconvenience to themselves we should probably still be all using our own pitches and forms of thread. We of the present ought to be willing to put ourselves to some trouble, inconvenience, and expense for the sake of future generations, recollecting what our forefathers have done for us. Were each generation to live for itself only the progress of the world would be very slow.

But in changing from present chaos to possible order even the present generation would immediately feel the benefit. A few weeks, or months at the most, after the change was legally made would find the whole system in working order.

The expense of buying new weights and measures is put forward, and it is stated that this would be hardest of all on the poor shopkeeper or tradesman. The exact contrary is the case. The expense of purchasing new weights and measures would be hardest on the large manufacturer or engineer. But we believe he is willing and able to bear it. There would be no necessity to alter every measurement Jigs would remain. Castings and patterns would be unaltered. The main dimensions of all our work would remain as they are, their designation only being altered. A spade would remain a spade, so to speak, but would be entered on our drawings as a shovel. Gauges would be the most expensive part of the equipment. But seeing that a number of engineers in this country have already adopted the system the advantages would appear to outweigh the cost.

One of the great advantages of the metric system to draughtsmen and those who have to work from drawings is the fact that all dimensions on a drawing are given in one denomination, and are much less likely to be misunderstood or misread. On our drawings now we use feet, inches, and vulgar fractions of an inch. On a metric drawing nothing appears except mètres and millimètres. A size is given as 256 mm. Our vulgar fraction friends say that the objection to this is that the decimal point may be misplaced. The misplacing of the decimal point, however, must always be apparent, and must be almost immediately detected as an error, whereas with our mixture of decimal, duodecimal, and vulgar fraction denominations errors are likely to occur and to escape immediate detection. For instance, 1′ 1½″ is likely enough on a dirty drawing to be read 11½″. For 11½ in. is not so enormously different from 13½ in. as to call for immediate detection. A fitter or turner might well be excused for not recognising at a glance that 11½ in. was wrong. But with the decimal system every misplacing of the decimal point magnifies or reduces the size by *ten times*, thus making errors unlikely, if not impossible. Professor Robert H. Smith, writing on this subject in the *Electrical Review*, says:

"If a smith and a turner had to produce for a machine, the nature of which they knew, a shaft of 13·5 in. diameter, and if the smith wanted to forge it 135 in. diameter, and the turner wanted to turn it to 1·35 in. in diameter, would the works or a lunatic asylum be the better sphere of activity for these arithmetical experts? A mistake from misplacing the decimal point is, in the first place, impossible in the mind of the

calculator if he knows and thinks what he is calculating about—that is, if he is a real engineer; and, in the second place, it *cannot* be carried on into practical work, whether that work be in metal in the workshop or in earth and rock in the field. It is too great an enormity. Before it gets two steps in its insane progress it runs up against a practical man who is not a lunatic, and who is not absolutely without knowledge, and who throws it back to its silly originator. Fancy a railway engineer estimating for 830 miles of railway when the map shows only 83 miles length!

"Note this important fact, that the frequency and the excusability of the mistake of reading $11\frac{3}{4}''$ instead of $1'\ 1\frac{3}{4}''$ on a dirty drawing where many small lines have been rubbed out results altogether from the want of harmony and consistency between our duodecimal subdivision of length units and our decimal numeration. If both were either decimal or duodecimal the mistake would be essentially impossible."

The slide-rule is of comparatively little use to us, with our measurements of yards, feet, and inches, pounds, shillings, and pence, and tons, cwts., qrs., and lb., as the slide-rule can only be used with the decimal system. The time saved by the use of the slide-rule hardly compensates for the loss of time involved in converting these measures into decimals.

Some of our opponents enlist the services of ridicule. One eminent engineer, speaking at one of the learned societies one evening, said he would only claim their indulgence for a further ·08333 of an hour, or better, as an hour is not a decimal portion of a day, for another ·00347 of a day, and he wondered how many of "the metrics," as he was pleased to call them, knew that he meant 5 minutes. Now a day consists of 24 hours—i.e., 1,440 minutes—and we wonder how many of his own vulgar fraction friends would know that he meant 5 minutes if he had described that length of time as $\frac{5}{1440}$ of a day or $\frac{1}{288}$th part of a day. Some of them, we fancy, would have had to resort to their pencil if he had described the same period as the twelfth part of an hour. If ridicule is to be used we fancy "the metrics" have the best side of the fun, and we can imagine what these ridiculing—not to say ridiculous—gentlemen would have to say if the proposal were to change from a uniform system of reckoning by tens to a system, such as we now employ, of having everything of varying quantities and relationships. We can foresee their pretty wit when they ask when an ounce is not an ounce and a pound not a pound, or when they demand how many hundreds there are in a hundredweight. One

gentleman fairly excelled himself by asking whether the year must be divided into ten months, and the months into ten days, etc., and concluded by stating that "the metric system does not fit our time measures, natural or artificial," *because "we have twelve full moons in a year*, and cannot make ten months agree with them." Independent entirely of the fact that the metric system has nothing to do with periods of time, one would think that those who oppose the system on grounds of ridicule would learn something of *fact* before speaking, as it is rather disconcerting to be told in this twentieth century that there are only *twelve* full moons in the year. There are certainly twelve *months* in the year, each one varying in the number of days it possesses, and one of them varying in its length according to the year it happens in—that also having exceptions at the beginning of each century. There is consequently no present uniformity. But "the metrics" do not wish to interfere with time or space. They only wish to rationalise our measures of weight, of length, and of capacity by the adoption of the metric system. But, in the writer's opinion, this will be most difficult to do, and will receive no support from "the man in the street" until our money is decimalised. Once the public realise the benefits conferred by such a system of money as has been outlined, as soon as we are accustomed to think in tens in our money, so soon will we be ready to see the advantages and benefits of thinking in tens, hundreds, etc., with regard to our weights and measures. But until our people obtain the advantages of a decimal system of money they will take little or no interest in a decimal or a metric system of weights and measures. Let the Government stamp their next coining of sixpences as 25 mils, and set the people thinking. Once they begin to think in decimals with regard to money they will want to know why they cannot do the same with weights and measures, and so make them uniform. The people in the United States and in Canada are nearer the adoption of the metric system, because they already have their coinage decimalised. And their system of coinage has been the means of eliminating such contradictory measures as hundredweights and tons of 2,240 lb. Nearly all weights of machinery, etc., in America are given in pounds, and not in tons cwts. qrs. lb., and prices per dozen and per gross are giving way to prices per 100, because their dollar consists of 100 cents. The simple alteration of our farthing to a mil, leaving the pounds, florins, and sixpences as they are, and coining a new copper farthing (calling it a mil) and a new nickel coin worth ten mils—

A Popular Explanation of THE METRIC SYSTEM of Weights and Measures.

This drawing represents a full-sized **Meter.** The lines extending across the Meter divide it into ten parts, or **Decimeters.** The thick lines divide the Meter into one hundred parts, or **Centimeters.** The thin lines divide the Meter into one thousand parts, or **Millimeters.**

(If not absolutely correct to scale, it will be due to the paper shrinking)

UNITS.

The Meter is the basis of the whole "Metric System," it is the unit for measures of length, and is the one ten-millionth part ($\frac{1}{10,000,000}$th) of a quadrant of the meridian, or distance from the pole to the equator.

The Platinum Prototype Meter has been standardized with scientific accuracy, and the Board of Trade, as well as the Governments of other Countries, possess an exact *fac-simile* of the Standard Meter.

THE KILOMETER (or 1,000 Meters) is used for measures of long distance

The Square Meter is the unit for measures of surface, and is a square having sides each one meter in length.

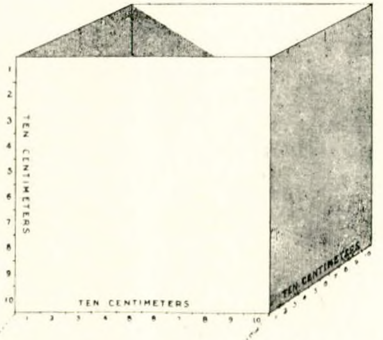
For land measuring 100 Square Meters are called an "Are."
10,000 „ „ „ a "Hectare"

The Cubic Meter is the unit for measures of volume or solids, and is a cube having edges each one meter in length.

The Liter, the unit for measures of capacity, is a "cubic decimeter," that is, the capacity of a cubic vessel measuring one decimeter or ten centimeters on all its inside edges.

The annexed drawing is a full-sized "Liter" of rectangular shape.

The Gram is the unit for measures of weight, and is the weight of a cubic centimeter of pure cold water.



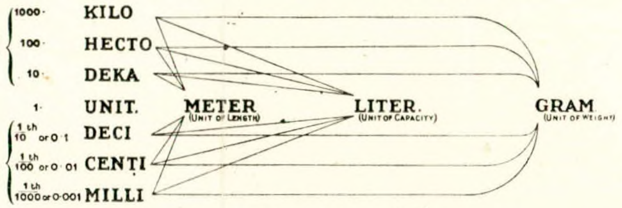
FOLDING DOUBLE DECIMETER.

MULTIPLES AND SUB-MULTIPLES.

The Multiples in the Metric System are indicated by the Greek Prefixes indicating "Deka" ten times, "Hecto" one hundred times, "Kilo" one thousand times.

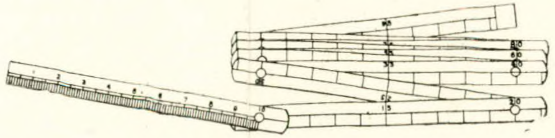
The Sub-Multiples are indicated by the Latin prefixes— "Deci" one tenth, "Centi" one hundredth, "Milli" one thousandth.

It is, therefore, evident that the Multiples and Sub-Multiples always bear to one another the relation of ten or a multiple of ten, and it is merely necessary to move the decimal point to read the figures in any desired Multiple or Sub-Multiple.



Anyone constructing the above diagram intelligently will understand the Metric System

The Multiples of the Meter are	The Dekameter = 10 Meters. „ Hectometer = 100 „ „ Kilometer = 1,000 „	The Sub-Multiples of the Meter are	The Decimeter = $\frac{1}{10}$th of a Meter „ Centimeter = $\frac{1}{100}$th „ „ Millimeter = $\frac{1}{1000}$th „
The Multiples of the Liter are	The Dekaliter = 10 Liters. „ Hectoliter = 100 „ „ Kiloliter = 1,000 „	The Sub-Multiples of the Liter are	The Deciliter = $\frac{1}{10}$th of a Liter. „ Centiliter = $\frac{1}{100}$th „ „ Milliliter = $\frac{1}{1000}$th „
The Multiples of the Gram are	The Dekagram = 10 „ „ Hectogram = 100 „ „ Kilogram = 1,000 „	The Sub-Multiples of the Gram are	The Decigram = $\frac{1}{10}$th of a Gram „ Centigram = $\frac{1}{100}$th „ „ Milligram = $\frac{1}{1000}$th „



FOLDING METER FOR POCKET.

THE RELATION OF WEIGHTS AND MEASURES.

One of the greatest advantages of the "Metric System" is the direct relation between weights and measures, which the following drawings demonstrate

Figure A represents a cubic vessel measuring one centimeter on all its inside edges. The weight of pure water necessary to fill this vessel is called "one Gram," which is the unit for measures of weight.

Fig A

Fig. B

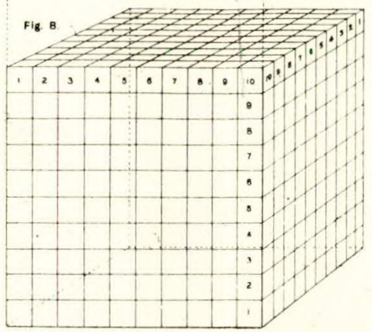


Fig C

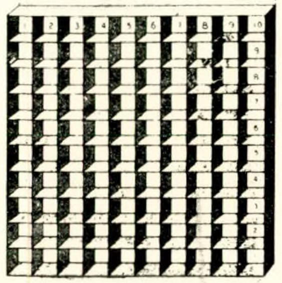


Figure B represents a cubic vessel measuring ten centimeters on all its inside edges, and

Figure C represents one side only of this cube

On examination of these figures it will be plain that each centimeter in height or thickness of Fig **B** contains 10 x 10 = 100 cubic centimeters, and that therefore, for ten centimeters in height or thickness of Fig. **B** the total contents of this vessel will be 10 x 10 x 10 = 1,000 cubic centimeters; moreover, if filled with pure cold water it will weigh 1,000 grams, or one kilogram.

Figure B, containing as shown above, 1,000 cubic centimeters, and requiring to fill it one kilogram of pure water, is the Liter, the unit for measures of capacity.

There is, therefore, direct relation between measures of length, weight and capacity

Drawn up for **The British Chamber of Commerce in Paris,**
By JOHN G. PILTER.

We highly approve of Mr Pilter's Metric Chart containing a popular explanation of the metric system of weights and measures

Kelvin Tweedmouth Oliver Lodge William Ramsay
Belhaven & Stenton H. O. Arnold-Forster William Mather Alex Siemens
Avebury John T. Brunner Guilford L. Molesworth E C Selwyn DD
Wm Ellis William Huggins W. H. Preece Herbert Branston Gray DD

Opinion of the Chairman and several Members of Select Committee of House of Commons on Weights and Measures, 1895.

This diagram is admirably suited to explain clearly the value & simplicity of the metric system of weights & measures.

Henry E Roscoe.
Samuel Montagu Thos Burt
R. F. Godson Albert Rollit

This comprehensive and interesting diagram deserves careful study by all persons interested in the establishment in this country of an improved system of weights and measures.

H Stafford Northcote
President of Associated Chambers of Commerce

Albert K. Rollit Presdt London Chamber of Commerce & Ex Presdt Association of Chambers of Commerce U.K.

We feel sure this chart will help to make the metric system understood and appreciated –

Saml Montagu President
Emerson Dowson " Chairman of Executive Committee of New Decimal Association

ISSUED BY THE DECIMAL ASSOCIATION, OXFORD COURT, CANNON STREET, E.C.

of rather less value than our present threepenny bit—would be not only a benefit *per se*, but would without doubt lead by the simplest way to the adoption of the metric system in this country, which, in turn, would lead to the universal adoption of the metric and decimal systems the world over, to the benefit of the individual and the advancement of trade throughout the world.

DISCUSSION

AT

58 ROMFORD ROAD, STRATFORD, E.,

ON

MONDAY, NOVEMBER 27th, 1905.

CHAIRMAN:

MR. T. F. AUKLAND (COMPANION).

THE CHAIRMAN: Well, gentlemen, Mr. Cooper has given us something to think about in this paper, which is full of most interesting information and will give rise to a great deal of very useful thought, especially if this scheme should be brought into operation. I shall be very glad to hear opinions on the paper.

Mr. JAMES ADAMSON (Hon. Sec.) said that as no one had risen Mr. Aukland had asked him to say a word or two on the subject. He dared say the paper, for which they were very much indebted to Mr. Cooper, carried them back to the days when it might have been considered desirable occasionally to place a piece of stout leather over a certain part of their anatomy, even to the days and recollections of learning the different tables—troy, avoirdupois, and the others—and the difficulties they then experienced with the different kinds of pounds and the different articles each was associated with, as referred to by Mr. Cooper. Those who were concerned in working out weights and prices in connection with contracts would probably bear him out when he said that they wasted hours and hours of very valuable time in working out proportions of a pound and fractions of pence. Working all such out into fractional parts of a pound in weight and then by fractional parts of pence—say $\frac{5}{8}$d.—meant a good deal of time

taken in arriving at the result, whereas by the metric system, which Mr. Cooper advocated, and which he agreed with him in advocating, an enormous amount of time would be saved. Not very long ago he saw it stated in a technical paper that one of our manufacturing firms had received a series of drawings from the Continent, involving a large contract. Those drawings were made out in mètres and millemètres, and the firm, not being accustomed to work to the millemètre, would stick to their own style, and sent in their price. It was stated that their tender was simply thrown into the waste-paper basket, as they would not conform to the system in which the firm who asked them to tender wished to have it rendered. In that case he understood that our manufacturers simply lost the chance of the contract because they would not conform to the system in vogue with the likely customer. If our customers on the Continent were accustomed to work upon a certain style it was quite right that they should have their contracts or tenders rendered in the same coinage and in the same language they themselves were in the habit of employing. They knew that there were many of our manufacturers who would stick to their own old-established system, and if any such were to see that soon the necessity would be forced upon them of adopting a new and more modern system, yet, in spite of this, clung to the old instead of adopting the new methods with improved machinery that would carry them safely through another term of prosperity, it was manifest that they could not compete in the open market, but would seek rather to hold back others to protect themselves. They also knew many firms who had buckled to when they saw the improvements being made by others, and, in order to compete with firms at home and abroad, had rearranged their factories and machinery so that they were placed in the most favourable position to do work with economy by a minimum of labour and material for each purpose, thus being able to compete with similar firms on the Continent and elsewhere. Those remarks were perhaps a little wide of the paper, but they had occurred to him in connection with the non-adaptability policy phase of it, as it was well known that no inconsiderable portion of our home requirements were got from abroad because of this very element of non-adaptability. He cordially agreed with the paper and with the arguments used by Mr. Cooper, to whom they were very much indebted for bringing the subject before them.

Mr. W. McLAREN (Vice-President) said there was one

point about which he was not quite clear. That was the $\frac{1}{25}$ that had to be made up in reference to the 6d. Who was to bear the loss of that $\frac{1}{25}$? He thought Mr. Cooper had said that the man with the six pennies in his pocket would have to bear the loss, but would get it back again. He could not see where that money came from. If that was the point in the argument the poor would be at the loss, because they dealt in so many farthings. Food and other necessaries were sold to the lowest degree with the farthing. Otherwise, he could not say that he quite disagreed with Mr. Cooper, seeing that many of our eminent engineers of the present day—even down to the workmen—had the metric system in some form or another. They could hardly buy a steel measure without the metric system being marked on one side and the ordinary system on the other. He must join with Mr. Adamson in extending their best thanks to Mr. Cooper for the trouble he had taken, and he would suggest that his paper might be sent to their present member of Parliament, and also to the members of Parliament belonging to the Institute.

Mr. E. W. Ross (Hon. Finance Secretary) said he understood Mr. Cooper to say that their present system added two years to the school life of their children. He thought it would be a good plan to add another year and make it three, and so get the metric system introduced into schools alongside of our present inadequate system. It was astonishing that they had not advanced further than they had at the present time. There were so many different names of sizes and capacities that it was really amazing that the two systems had not been brought up and gradually introduced before into the life of the nation. It was surprising that it had not been more advocated in public than it had been. They seldom heard of the metric system, either publicly advocated or condemned. They had heard from Mr. Cooper one side of the question, and he thought it would be to their benefit to have a good opponent, not necessarily to condemn the system, but to bring out its advantages better. There was nothing which brought out the truth better than to oppose it, as then they got the other side of the question, and he would be pleased to hear an opponent of the system that evening to bring out the other points. Mr. Cooper had explained it very clearly, and it was well that the ABC of the system should be put before them—at least, such was what he desired—and he thought Mr. Cooper had done that excellently. He would advocate that they have the system

pushed forward as far as they could, and that, as Mr. McLaren had suggested, they should send the paper to their member of Parliament to see if he could push it forward in Parliament for early adoption.

Mr. STOKES (Visitor) said he would like to refer to one point of the paper, where the author had said that although the mètre happened to be thirty-nine odd inches in length any other length would do as well. He presumed that as thirty-nine inches was the French system measure that was why it was mentioned. It had been a very great pleasure to him to listen to what had been said that evening, and the points in the paper had been well and logically set forth. He thought it commended itself to everyone who had listened to it. He was pleased to notice on the chart on the wall the names of some very able men who were giving the system their support. It seemed a great pity that they could not get away from their antiquated measures and get some impetus to push forward the metric system. It was rather a good point that had been mentioned that the member of Parliament for the district should be asked to help the metric system forward. After that if a new fiscal policy came along it would harmonise very well with it.

Mr. BERTRAM (Hon. Minute Secretary) said he also was going to ask Mr. Cooper if he wanted to make an English standard. He had said, as Mr. Stokes had pointed out, that the mètre happened to be thirty-nine odd inches in length. If they used any other length they would be just as far off agreeing with their Continental customers as before. There was also another point in which either Mr. Cooper or himself was a little bit out. He said that the weight of a litre of fresh water equalled one kilogram. He had also understood him to say that the cubic centimètre was the unit of weight. He must compliment Mr. Cooper on a very well thought out and well-written paper.

Mr. D. S. LEE, R.N.R. (Member), said he would like to ask Mr. Cooper how many countries had taken up the metric system at the present time. So far as he knew they were all European countries—Italy, France, Spain, and Germany to a slight extent. These countries only formed a very small proportion of the globe. The people they were doing business with at the present time were, he should say, mostly in Asia, principally China, Japan, and India. So if they changed their

system altogether he would say that in dealing with those countries they would be just as far off with the metric system as they were at the present day. The population of those Asiatic countries was a great deal more than that of the countries using the metric system.

Mr. JAS. GIRVIN (Vice-President) said he thoroughly appreciated all that Mr. Cooper had said in his paper. He had always found it a very simple matter to understand the decimal coinage of any country with which he had had anything to do. Nearly all the Continental countries had their coinage to a great extent on the decimal system. They had not got it in India, but, to a certain extent, they had it in Ceylon. There they had the 100 cents, which was one step towards it. It would be a very great advantage to all to have that system established. He remembered seeing a short time ago in a newspaper the paragraph to which Mr. Adamson had referred, which dealt with the contracts that were given out by one of the Continental countries, and it was then stated that the British manufacturer by sending his contracts in in the usual British denominations simply lost the contract by so doing. He had heard a good deal spoken on the matter on the Continent. On one occasion he went to the Continent with a ship, and what occupied his time a good deal was the fact that they had their dimensions of the different parts of machinery in the English denominations, and he had gone to the trouble of working and writing them out in the metric system for the purchasers. It took a good deal of his time to do this. It would be a very great advantage to them all to have the metric system, and it would simplify things very much. He thanked Mr. Cooper very much for his paper.

Mr. K. C. BALES (Member) said it was extremely difficult, after merely hearing a paper read, to start picking it to pieces when the paper dealt with such a subject as the decimal and metric systems, and he thought with Mr. Ross that the only way to bring out the valuable points of a paper—or, rather, those valuable points which were not so clear as they might be—was by more or less attacking the statements therein made and to contradict such as were put forward. But, without first taking the paper home and more thoroughly absorbing and digesting it, and making their remarks and correcting them, it was a very difficult matter to criticise the points raised. Therefore he would propose at the end of that meeting that such a valuable paper should not be dealt with in one evening,

and that the Institute would probably be able to afford facilities for its further discussion on another evening. There was little doubt that most of them would be in a far better position on another evening than they then were to argue and contradict the points, and they would have the benefit of a clearer understanding of the subject after thinking over it. Associating with Mr. Cooper as he did in his daily business, he knew he had the subject at his finger-ends. It had always seemed to him a remarkable thing—and at school he, like others, had learned both vulgar fractions and decimals, and he had often wondered why vulgar fractions were put considerably in advance of decimals. He could never understand why that was. Vulgar fractions were an intricate calculation to understand compared with decimals, but to make more clear to them what he meant by that he would give them an illustration. It came under his province in his business to be more or less frequently making estimates for supplying iron or steel. If he had to make estimates for supplying brass or Muntz metal he found the calculation more difficult. Take iron and steel. Suppose they were making up a tender for a quantity of either or both at £7 10s. per ton, it was fairly simple because the figures lent themselves to the calculation. At £7 12s. 6d. per ton the calculation was more difficult, and at £7 13s. 9d. per ton still more difficult. Perhaps they had a total weight, say for instance, 45 tons 18 cwt. 3 qrs. and possibly a number of pounds, made up from several lots all at different prices per ton, which gave a total money value of £363 13s. $1\frac{3}{4}$d., and the customer required an overhead price per ton. Before they could do that they had to divide their total money by their total weight, and if they were dealing with an intricate weight into an intricate sum of money as example, it was not at all an easy calculation by vulgar fractions. If they took the price of brass or Muntz metal, to which perhaps Mr. Adamson had referred when he used the expression $\frac{5}{8}$ of a penny, these metals being generally sold at so many pence and a fraction per pound, the calculation was none the less difficult. He simply did what he supposed many other people did. He converted his weights and money into decimals, and then it was a case of simple division. He most cordially agreed with everything Mr. Cooper had said, but it was very difficult at a meeting to controvert any statement on the spur of the moment, although controversy might perhaps enable Mr. Cooper to give them further elucidation of this very interesting and also instructive subject, a subject which undoubtedly was of national importance. But he

would certainly hope to be prepared to criticise certain points on another evening if the Institute were able to afford facilities for the discussion to be adjourned, and he was able to attend.

Mr. JAMES HOWIE (Member) said that if they approached the subject in the spirit of contradiction, as referred to by Mr. Bales, they would have a warm meeting. Still, it was a very good idea, because out of extremes they got some result, if they could be broad enough in mind to take the average opinion. There were one or two points in Mr. Cooper's paper to which he would like to refer. First, there was the reference to the slide rule, and he thought that perhaps Mr. Cooper's enthusiasm might have carried him away a little, because he had said that they were of comparatively little use to them. The slide rule was in very great use at the present time, in determining office work especially. Speaking of foreign contracts, he once had something to do in regard to working out the figures from the English system to the Continental system in millemètres, and when they got such figures as "7,000 millemètres" they startled one at first; it was just a little perplexing. Still, he supposed it would seem natural in time when they realised that 7,000 millemètres were so many feet. By and by they would get into the use of the system. A most inconvenient part of the business would be in respect to the Board of Trade rules, and for Lloyd's Register in working out their volumes. Possibly they would be very strongly against it. He did not know that they had yet expressed an opinion on the point, but if they knew it was coming in for final decision they might perhaps have something to say about it. He believed Lloyd's Register would be very strong opponents to any such change in their system, although they might not force the trend of ultimate public opinion. Then there was the question as to whether more trade would result from an adoption of the system. Mr. Cooper had said that they would have more trade, but he was hardly sure of that. Certainly business would be easier, and if they could make friends by its adoption it would be a little influence which he thought they would not mind having. Referring to Parliamentary publicity, he believed that if that matter were to be brought forward at all they had no better member than their own at the present time. It was also wise to let the member know that something was being done in the constituency for the benefit of reform. Mr. Cooper's paper should also be sent to other members of Parliament. On

the whole he liked the paper very much, and he supposed, from Mr. Cooper's point of view, he must support it collectively, as all progressive men were accepting the system. In initiating it he did not think there would be any difficulty whatever. The change in coinage would not cause any practical loss to the poor. After they got their weekly wage the value would be given to them the same as before, and benefit would ultimately accrue to them and to the nation at large.

Mr. BERTRAM remarked that Mr. Howie had just suggested that the adoption of decimals would affect the Board of Trade. He thought it would affect many of their conundrums. The determining of the horse-power of engines would be affected. The pressure per square inch, length of stroke in feet, and the area of piston would also be changed, and it was probable, therefore, that the Board of Trade would be somewhat opposed to the change.

Mr. BUDDING (Member), referring to the remarks of the last speaker, asked where the foot would come in with the metric system. The adoption of the metric system would affect many of their units and constants. If the value of the foot and the pound remained as at present there would be no alteration, whereas if the foot and the pound were altered it would mean altering all their units throughout in which the foot and pound figured.

Mr. W. BRITTON (Member) said he could thoroughly appreciate the remarks which had been made by the respective speakers in regard to the paper, of which he entirely approved. Mr. Adamson had pointed out that business would be facilitated by the saving of time. Personally, he questioned whether there would be that saving in the shop, because 75 per cent. of journeymen at the present time had not gone in for technical education, and therefore did not understand the decimal system. He had to explain decimals away and work them back to vulgar fractions so that the men could understand them. He had given some men the decimal ·5, and three of them did not understand that simple decimal. Those things were very simple, but he found in the shops that there were many cases of men who had very scant knowledge of technical education.

Mr. SIMPSON (Visitor) said he had come on the invitation of Mr. Adamson, and had not expected that he would be asked to say anything on the subject. Still, he must say that he

had enjoyed the reading of the paper very much indeed, and he thought that Mr. Cooper had done a good service in coming there and explaining so minutely and clearly the decimal and metric systems. He thought they must all agree with what Mr. Adamson had said in regard to their early schooldays and the barbarous system of weights and measures they had been brought through, and which they had been afflicted with all their lives—the avoirdupois, troy, and other nonsensical denominations applied to various kinds of material; and he thought that if this country could be induced to try the decimal and metric systems it would be a very great advantage to the country, both in regard to its trade and in the simplifying of the educational process. He liked very much the idea of adopting the decimal system in regard to our coinage, and then afterwards to proceed to the metric system in regard to weights and measures and so forth. He should like to ask Mr. Cooper how long he thought it would take to make the change. He had heard it mentioned that something like three years would be required to make the change. Perhaps the author could give them some idea as to whether it would take that time, or whether a few weeks or months would be sufficient. He supposed it would throw trade into confusion for a while. He had enjoyed the paper very much, and he joined in thanking the author.

Mr. HUGH POLSON (Visitor) said he had appreciated the paper very much, and he agreed with it in every way. He was surprised that there was anyone who could disagree with it. He had had a little to do with the subject in regard to vulgar fractions and decimals. They used the decimal to the third place in working out his calculations, and he knew, when they were busy towards the end of the month, what the difference was between the pounds, shillings, and pence and their ordinary figures in dealing with, say, spirits, which they worked with the decimal and with the rule as well. He must thank Mr. Adamson for inviting him to hear the paper read. He had nothing to say but praise, so logically had the points been given.

Mr. SAVAGE (Member) said that Mr. Bertram, referring to horse-power, had mentioned that if the stroke of the engine were altered it would affect the calculation. It stood to reason that if they were going to adopt the system of changing inches into the metric system they would also have to alter the formula based on the foot-pound to the metric pound—that was to say,

the pound of work and the calculation would be exactly the same, but its working would be very much simplified. Instead of being complicated it became simplified in every way. The slide rule was simply the metric rule. If they came to work in dollars or pounds, or feet and inches, before they could use the slide rule they had to reduce them to a common basis. Anyone who was quick at arithmetic had the advantage at the start over a person using the slide rule. He entirely agreed with the paper so far as he had heard it. The great thing was the educating of public opinion. It was very easy to demonstrate and to advocate the system, but it was entirely a different matter to educate public opinion, because it went off at such funny angles. English people were by nature conservative, and would tenaciously cling to any system, however antiquated and inconvenient, handed down to them from their forefathers. The revolution, when it came, would be met unconsciously, one here and there only feeling the effects.

Mr. K. C. BALES, referring to the last speaker's remarks on the slide rule, said he thought that the value of the slide rule was apparent in its correctness. A man might be very expert at mental arithmetic, but he might make a mistake, and a mistake on the slide rule was almost an impossibility. When he left the drawing-office he came out of it full of the slide rule, and when he had calculations to make he fell back on the slide rule. He remembered one of his colleagues who had been in a merchant's office all his life, and who used to calculate the weights of iron and steel plates and brass, laugh at him for using a slide rule. He made out that he was wasting time in calculating the weights. He had said to his colleague, "You may be so expert in calculating that you can get your result as quickly as I can. Suppose we take a test case." His colleague put down certain sizes of plate. He had to convert the feet and inches into decimals to apply the slide rule. Still he was able to get his answer practically at the same moment as his friend, but with this difference, that he was right and the other was wrong.

The CHAIRMAN said that a great many speakers had eulogised Mr. Cooper's paper, and he thought they had acted very rightly in doing so. It was an exceedingly good paper, and it showed that Mr. Cooper had the subject at his fingers' ends. He was sure he was deserving of a most hearty vote of thanks for it, and he should be happy to propose that such be accorded to him.

Mr. K. C. BALES seconded the Chairman's proposition, which was carried by acclamation.

The CHAIRMAN then said that the subject had elicited a good deal of discussion under circumstances which were not very favourable, that was to say they had only just listened to the paper; but now, as they would have a copy to take home with them—and, as one speaker had said, digest it—they would be able to continue the discussion on December 4th, when they would hear Mr. Cooper's reply to many of the remarks which had been made. He was sure that reply would be very interesting, and would make the whole matter very educational.

Mr. COOPER said he thanked them very much, not only for the vote of thanks, but for the way in which they had listened to the paper. It must, he thought, have been a little tiresome his reading through so many figures, and with practically the same comments running through. Several points had been raised that night which he would like to reply to, but he thought it would be better if he replied to them the following week fully and in detail. There was no point raised to which he took exception, except that he resented the paper being connected in any way with fiscal reform.

A vote of thanks to the Chairman closed the proceedings.

ADJOURNED DISCUSSION

AT

58 ROMFORD ROAD, STRATFORD,

ON

MONDAY, DECEMBER 4th, 1905.

CHAIRMAN:
MR. T. F. AUKLAND.

THE CHAIRMAN: Mr. Cooper will reply to the criticisms of last Monday evening in the first instance, and then we will continue the discussion.

Mr. COOPER said: In reply to Mr. McLaren, who asked who was going to bear all the loss entailed in changing from present money to decimal system, there is *no loss*, except on the actual day of change, and then only 4 per cent. on some

amount less than sixpence. You are now daily incurring such losses on many transactions. As to the cost of new money, that, of course, would be borne by the Government, who now bear the cost of new coinage. But the cost of coining the new decimal coins would be no more than that of our present coins. Mr. Ross, I think, misunderstood my remarks as to a gain of two years in the school life by the adoption of decimal and metric systems. Competent authorities assert that if children had only to learn a decimal system of money and a metric system of weights and measures they might be saved two complete years of "*learning*."

Mr. Stokes referred to my remark that the mètre is thirty-nine odd inches long, and that any other length would do as well. What I mean is that it is the metric "*system*" which is to be admired and followed, and that the metric system would have been just as perfect if the mètre had been decided as some length other than thirty-nine odd inches. If, for instance, the British yard of 36 in. had been adopted as the mètre, the metric system would have been none the less perfect in its divisions or ramifications. But probably it would have led to the earlier adoption of the system in this country.

In reply to Mr. Bertram, the gram is certainly considered the unit of weight—i.e., the weight of a cubic centimètre of pure cold water. For all practical purposes, however, all we need are the mètre, the litre, and the kilogram—better known as the kilo.

A cubic centimètre of water (at its maximum density) weighs 1 gram; 1,000 cubic centimètres, or 1 litre of water, weighs 1,000 grams, or 1 kilo. Hence 1 cubic mètre of water contains 1,000 litres, and weighs 1,000 kilos, or 1 metric ton. This only shows more clearly still the beauty of the system, for in describing the process in the paper I started from the decimètre, and arrived at exactly the same result.

The cube of the centimètre gives the gram. The cube of the decimètre gives the kilogram. The cube of the mètre is 1,000 kilos = the ton. Mr. Lee thinks the majority of our customers in foreign countries do not use the metric system, and that the change would not help us with such countries as China and Japan. As a matter of fact, Japan has already adopted the metric system of weights and measures, and has long had in use a decimal system of coinage. China also uses the decimal system, and our trade would certainly be facilitated with countries using the decimal (though not the metric) system if we adopted decimal coinage and the metric system of

weights and measures. A Frenchman easily understands the American coinage of dollars and cents, because it works on the same system as his own centimes and francs. He finds a difficulty with our money, because of our farthings, pence, shillings, and pounds, all divisible by different and differing denominators. What I mean is that so long as the same *system* is used there is little or no difficulty in understanding another country's money or weights. The difficulty the foreigner has with us is that not only are our weights and measures different from his own, not only is our money different from his, but neither our money nor our weights and measures work on any intelligent or intelligible system. As to the number of countries using the decimal and metric systems, all Europe, except Russia and ourselves, has adopted it—French colonies, Spanish, Portuguese, and Italian possessions, German dependencies, Java and the Dutch possessions, Egypt, Mexico, Central America, Columbia, Venezuela, Brazil, Chili, Japan, etc., making a total population of nearly 500 million people already using it. Russia has made up her mind to adopt it, our Colonies will certainly adopt it as soon as we do, if not before; and were the United States along with Great Britain and Colonies to adopt this view it would be a fair statement to say that the system was then world-wide. I was rather surprised to hear Mr. Britton's experience of workmen's ignorance of decimals. I am sure his experience is singular, for I have no doubt that the great majority of turners and machinists generally work to the decimal system now, and I do not know one who does not understand what ·5 or ·75 is. In reply to Mr. Simpson as to what time would elapse in making the change, the petitioners to the House of Lords Bill proposed that two years should elapse from the passing of the Bill until it became compulsory. This, without doubt, would be ample time. Most people would pick the whole thing up in a few weeks, and others who do not want to change would not learn it until they were forced, even if you gave them ten years to study it.

Mr. W. McLAREN (Vice-President) asked if Mr. Cooper was understood to say that the exchange could take place in one day from the present to the metric system. He could recollect when the old coppers—the 1½d. and the old farthings—were recalled, and those coins were in circulation for twelve months before it was decided that they would not pass as coins of the realm. He could not say in what year that was, but he

remembered well having those old coins at the time they would not pass. In looking up Walker's book on money he found in the seventeenth century that the poor suffered severely by a recoinage system. He was not against the new system—it had to come, and would come—but he should be sorry to hear that the poor were the sufferers.

Mr. JAMES ADAMSON said that in accordance with the resolution of the last meeting copies of the paper had been sent to several members of Parliament, and he had just received the following reply from Mr. Ernest Gray, the member for North West Ham:

"99 GROSVENOR ROAD, S.W.,
"*December 4th*, 1905.

"DEAR SIR,—I have looked through the paper you were good enough to send me—a paper which, if I may be allowed to say so, is admirably written. Your friends may be interested to know that I have always been a supporter of the introduction of the metric system as the measure of length and weight in England. Faithfully yours,

"(Signed) ERNEST GRAY.

"J. ADAMSON, Esq."

There was also a leading article in the *Shipping Gazette* of the previous Friday, the conclusion of which read as follows:

"We are glad to see that the question was raised in a practical way before the Institute of Marine Engineers a few nights ago, and that there was a suggestion that the question should be forcibly brought to the attention of members of Parliament. When marine engineers are found demanding this reform, it may be inferred that a great many of our important industries would be all the better for it. And if marine engineers will, as a body, insist upon the use of the metric system they clearly have the power of rendering great assistance to a useful movement."

Mr. W. C. ROBERTS said he had very few remarks to make on the subject, as he was entirely in favour of the systems being adopted. It would, no doubt, make a very great change, but, as Mr. Cooper had said, the difficulties would soon be overcome by a little study and reflection.

Mr. D. S. LEE, R.N.R. (Member), said: To introduce the new system would mean scrapping all our copper coinage and silver below 2s. and introducing cents and mils. To do this all the dies at the Mint would have to be converted, and to

have a cent of the value of $2\frac{2}{5}$ pence in our present-day coinage would lead to a serious "mix-up" when coming to trade with the Continental nations, as their cent is only worth 100th part of 10d., and in the United States ½d. To do away with the farthing and make the calculation of your change easier would be to do away with the small shopkeeper's profit, and very likely relegate him to the ranks of the unemployed. Mr. Cooper says we lose every time over the ¼d. deal ; but then it is not going out of the country, and if it is only one farthing that we lose occasionally we may consider ourselves public benefactors by enabling the small shopkeeper to carry on his business. I have noticed that the smaller in value the coinage gets in a country the poor seem to be correspondingly poorer, as they never get above living for one day only, and if they only have a few sous to tide them over from day to day they are contented. No doubt the decimal system is much easier than our present-day system, but I ask you if it is going to be a real benefit to introduce it. Many bank clerks and men accustomed to deal with nothing else but money can run up two, and often three, columns at one time, so that if we make it easier will they take less time to do it, or will they be as exacting as at present ? Whenever we make or take anything very easy we are apt to get careless, and I believe that it is owing to our peculiar methods of education that much of our stubbornness and grit is engendered that goes to make up the national character. In the metric system we have six prefixes to remember, to know the amount by which any quantity or measurement has been raised or lowered. In taking the British measures we need only remember three, viz., 12 in. = 1 ft., 3 ft. = 1 yd., and 1,760 yds. = 1 mile. After we leave school we are very seldom troubled with perches and furlongs, except when doing surveying work. Then in square measure it is just the same. Three terms are used; only we can go further and say that 4,840 sq. yards = 1 acre, and 640 acres = 1 sq. mile. The Frenchman who has to keep an account of his woods and forests in square mètres must go through a longer calculation than ours. We have brought all our sizes to the largest possible amount capable of being mentally grasped, and when we come to reckon one acre it is much easier than putting down 63·4 sq. mètres, or even 1 sq. kilomètre. Coming to weights, the gram is certainly a convenient quantity for scientists and chemists to use, but when large weights are required, such as weights of ships and other structures, I think the ton is much easier manipulated than 1,000 kilograms. One case in point, where I had to

work out the daily coal consumption for a five and a half months' voyage in pounds. I turned each day's consumption into tons, and then mutiplied by 2,240 at the end of the voyage, which I found much easier and quite as correct. In the use of vulgar fractions for drawings of machinery is it not much easier to measure $\frac{3}{8}$ than ·375? Suppose we had a rule marked in tenths; we would measure $\frac{3}{10}$, guess at the seventh space, and make allowance for the ·005. If we are to go in for fine measurements like that we will all require better eyesight. In gauges where a delicate measuring machine is used I can understand working to a very fine degree, but in shops that are not specialists in guns, turbines, and delicate machinery I think the fraction expresses all that we are ever required to work to. In reference to the paragraph on the page about increase of foreign trade, the countries referred to certainly do trade with us, and we do not have any difficulty in understanding their weights or measures, which are certainly much newer than ours, only dating from the time of the French Revolution, and they are certainly advanced enough in education to understand our peculiar systems and measurements, which originated with the ancient Egyptians. I have yet to learn that any of our Colonies have expressed a wish to adopt the metric system. Some years ago it was thought that everybody and all countries were to adopt the twenty-four-hours system of reckoning time. No doubt it suited astronomers, but I do not know of another instance in this country where it was adopted; this is an example of how hard it is to get Britishers to use anything they do not see the need for. In thanking Mr. Cooper for his paper, which I know has taken a great deal of time and thought, I would ask if he has not come across the facts that in the textile trades of France and Germany British measurements and quantities are still used.

Mr. W. LAWRIE (Member of Council) said he thought that when they looked into the question there could be very little doubt as to which was the best method to work upon. Mr. Lee had asked how they were to measure $\frac{3}{8}$ in. by the metric system. He understood that when they took up the metric system they were to drop the vulgar fraction. He did not know any rhyme or reason why they should have $\frac{3}{8}$ of anything, when they had another measure equally good. When they took up the metric system they came to a very easy thing. They had got no reduction; there was no such thing in their arithmetic when they came to that. Their compound rules

were as simple as the simple rules, and were just as easily worked. He saw no reason why it should not be the best system. He thought their system of weights and measures needed some little reorganisation, and he thought they ought to be thankful to Mr. Cooper for bringing the matter forward. A question had been raised as to the particular day on which the new law would come into effect, but he thought the recommendation of the House of Lords was that the new measures should be brought into force on a certain date, but should not become compulsory until something like two years afterwards. He did not see any great hardship in that. A great deal had been said about the cost of revising their coinage system. They had revised it before. At one time they had guineas, worth 21s., and they had the groat, which was 4d. Both those coins had been discarded. They also had discarded the noble, which was worth 6s. 8d., the angel, worth 13s., and the moidore, worth 27s. If they could drop those coins because they were found to be not very useful in practice, what was the reason why they should not adopt a better system than they had at present? Then, in regard to weights and measures, he thought they ought to have some legalised system enforced throughout the country. They would find that at various places the weights sanctioned by local custom were not what they should be. In some parts of England a stone was 16 lb., whilst in other places it was 14 or 24 lb. In the fruit trade he had known experts who were baffled to reconcile the fruit measure in one county with that of another county. He really thought that they ought to try and get their weights as well as their money down to the simplest possible calculation. Mr. Lee had referred to totalling up three columns of figures at once, but they could not base their calculations on the performances of such experts. They must come down to the average man, and the metric system was going to be taken up much quicker by the young man than by the old. It had been said in some cases a year's advantage would be gained at school; others had said that two years would be gained; but one thing was certain—if they could get the simpler method into vogue they would be able to give a little more extended education within the same period than they could at the present time. The subject was a very interesting one, and he thought it deserved their best attention. He was sure if they could come to look at it squarely in the face they would find the metric system had a good deal in it. But he had never seen the way out of the weights and

measures difficulty. It would be a very great hardship on a part of the community if they were compelled within two or three years to renew all their weights and measures. They were living in a material age, and if they wished to get forward such an innovation as was proposed they must show that they were going to give some material efficiency, and if they showed exactly where a material efficiency was coming in they would have a larger support. It was all very well to say it would increase their home and foreign trade. Perhaps it would; but the best thing was to show how that was to be done.

Mr. J. E. ELMSLIE (Member of Council) said the question was hardly whether the metric system was the better one. The real question was in regard to the practical difficulty in getting the metric system introduced. There was a review printed in the *Engineer* of Dec. 15, of a book which was published in the United States about a year ago on the fallacies of the metric system. He had brought that review with him. To get the metric system introduced they would have to satisfy Parliament how the difficulties were to be overcome. An Act had been passed in this country making the metric system legal, but it had never been used. He would like to read the review he had with him, but would not ask them to take the opinions therein expressed as his own remarks on the subject. The review showed the difficulties which would have to be overcome in introducing the metric system to trade generally.

Mr. ELMSLIE then read the following extract:

"*The Metric Fallacy*, by FREDERICK A. HALSEY; and *The Metric Failure in the Textile Industry*, by SAMUEL S. DALE. D. Van Nostrand Company. New York. 1904.

"The joint authors of this book have produced a volume which is the most complete indictment of the metric system that we have seen. From the preface we learn that it is an 'outgrowth of a paper presented to the American Society of Mechanical Engineers in 1892.' The second portion 'is believed to be the first critical anti-metric analysis of the system from the standpoint of the textile industry that has been made.' The book possesses the special merit that it has been written by men who understand commercial conditions. They do not argue against the metric system on abstract principles. They consider what it can do, what it would cost to introduce it, and how the price would be paid. In the main they take the same view as that which we have taken from the first—namely, that

it would be the greatest possible mistake to tie down any manufacturer to a single system of measures and weights and capacities, and that, in short, mankind is so opposed to a single system that it has never yet been adopted or enforced in any country under the sun. It must be clearly understood that this book does not deal particularly with the merits or demerits of the decimal system, which must not, indeed, be confounded with metric standards. It is very comprehensive; but the principal object of the authors is to show that the arguments of those who advocate the compulsory use of the metric system do not apply to ordinary commercial conditions either of buying or selling or making. Thus the metric advocate directs attention to what he terms a heterogeneous and confused mass of units in daily use in this and other English-speaking countries. But, as a matter of fact, the units which he criticises have no practical existence outside very narrow and strictly specialised circles. For the great mass of English-speaking people the units are very few and very simple. As units of length we have the inch, foot, yard, and mile; as units of capacity the pint, quart, and gallon; as measures of weight the ounce, pound, hundredweight, and ton. It is quite true that special trades use special units. Thus, for example, the brewer speaks of a 'hogshead' or a 'kilderkin,' and the wine merchant of a 'pipe'; but no one but the brewer or the wine merchant concerns himself with these things. We see, therefore, that the introduction of the metric system would not only affect the mercantile operations of the general public, but of the trades concerned. For example, a 'pipe' of port is a foreign, not an English standard, and unless the Portuguese wine-makers were compelled to sell by the litre the English wine merchant would be compelled to make a calculation every time he dealt in port. The fundamental error in the whole matter is based on ignorance of what takes place in the countries which are supposed to have adopted the metric system. A considerable portion of the volume before us is occupied with a statement of the true trading position held by the foreigner. The State Department of Foreign Commerce at Washington has procured for the guidance of consuls and others a table of foreign non-metric units in continual use in different countries where the metric system is nominally legally enforced. From the list we find that there are more than 300 units in daily use, and the worst of the matter is that the same names are given to different quantities in different districts. Take, for example, the 'pfund' or pound. The word has eight different meanings.

Thus the 'pfund' in Austria means 1·2347 lb. English; in Bremen its equivalent is 1·0991 lb.; in Frankfort it is 1·1141 lb., and so on. The ohm has nothing to do with the electrical unit of resistance; it is a measure, or, rather, six measures of capacity, varying between 49·8197 gallons English in Berlin and 13·4459 gallons in Basle. So long as people buy and sell by such units it is useless to assert that the English-speaking people of the world are behind the age. A favourite argument for the adoption of the metric system has been that because textile manufacturers have not adopted it their trade suffers. It will come as a surprise, perhaps, to those who argue in this way to learn that the metric system is not exclusively used by the foreigner in this class of manufacture. No more crushing attack on it has ever been made than that contained in Mr. Dale's contribution to the book before us: 'Cotton yarn is reckoned by the English hank and reel. This has been adopted by all spinners of nearly every country. The price is always given in the English pound.' This is a translation from a German ready-reckoner for textiles published in Barmen in 1901. The author tries to evolve symmetry from confusion. He gives a table of ten standards of length, nine of them 'ells,' and the tenth the Russian 'archin.' A 'Bavarian ell has $34\frac{1}{4}$ in., or 84 cm. A mètre is equal to $41\frac{1}{10}$ Bavarian inches. One thread of single yarn per centimètre in a fabric 1 Bavarian ell wide and 54 Bavarian ells, or 45 m., long gives a length of 3,780 m., and at 60 grammes per 100 m. for No. 1 yarn English a weight of 2,268 grammes.' Again, in the same book: 'The usual twist is from 25 to 30 turns per English inch. The expression so-and-so many turns always means per English inch, and this is the universal practice in the trade. In order to determine the number of turns accurately, the number in a mètre, as indicated by a twist counter, is divided by 40, as there are 40 in. in the mètre.' Here we have an attempt to secure a round number at the expense of accuracy. To quote once more: 'All plans to dispense with the English hank of 840 yd. have heretofore involved the changing of our reels and skeins. From a practical standpoint we do not regard this as possible. While theorists favour the adoption of the French system with 1,000 m., I do not believe that its introduction is possible. The cost of changing our machinery and altering the yarn numbers offers insurmountable obstacles to the project. Furthermore, we do not believe that the introduction of the metric system would be of any advantage to the spinner.' Let it be borne in mind that all this refers to a country in

which the metric system is supposed to represent the only legal standard. It would take more space than we can spare to follow this line of argument. It must suffice to say that Mr. Dale reproduces facsimiles of page after page from the table books in use abroad which bear out the statement that the evidence presented by Europe proves that a change of textile standards is a task of such difficulty as to be practically impossible, even when worked by all the might of arbitrary and despotic power, and confirms beyond a doubt the belief that an attempt to change textile standards in a free country like the United States is simply impossible, and that partial success would create confusion instead of contributing to uniformity.

"One of the most efficient arguments in the book is that urged by Mr. Halsey. If the metric system is partially adopted, that will only add another set of units to those already in use. But, judging by Continental experience extending over about 110 years, it is quite impossible either to compel or induce any nation to adopt a single uniform system of units. It would be about as easy to compel all men and all women to wear uniforms, or to eat precisely the same food, or live in the same kind of house. Experience proves that although beer might be sold by the litre in shops, brewers would continue to use hogsheads and kilderkins in the trade. All this has not even a remote connection with the merits or demerits of the metric system. It is a psychological phenomenon, and must be dealt with accordingly. Mr. Halsey has not a word to urge against the use of the metric system by the scientific man, the chemist, or the electrician. He explains in a way that is very novel the precise reason why an analytical chemist, for example, should regard the question from a standpoint quite different from that of the grocer. The chemist has to ascertain the weight of given quantities, the retail dealer has to ascertain a quantity equal to a known weight.

"Applying this to measurements, Mr. Halsey writes: 'The scientific use of measurements consists in measuring existing things; the industrial use of measurements consists in making things of a required size.' This is very neatly put. Again: 'The chemist places a substance in one pan, and proceeds to balance it with his weights and rider. This is the exact opposite of the grocer's use of the scales. The grocer places his weight in one pan first, and then proceeds to balance it with the required amount of material. The chemist finds the weight of a given mass of material; the grocer finds the mass of material which shall have a given weight. Because of

this difference the grocer has but few weights. He deals with halves and quarters of a pound or ounce, and with no other fractions whatever. The chemist, on the contrary, must be prepared to deal with all possible fractions, and with the same degree of facility in all cases.

"'A prominent fact overlooked in the controversy is that, as a rule, the weights and measures of a country are survivals of the fittest. Useful changes are always adopted. Quantities which are not favoured are not used. For example, in our own country no one outside a very narrow circle has anything to do with troy weight. No landsman uses a cable, or a knot, or a fathom, as a unit of length; but these units are valued by sailors because their mention establishes at once a mental concept which can have no existence for the landsman.' There are 231 large octavo pages in this book, and every page contains an argument against the compulsory adoption of the metric system in the United States.

"We do not believe that it is possible to write anything which can act as an efficient counterblast to this book. The case is simply overwhelming against a compulsory metric system. Even if it were conceded that the metric system was superlatively good, that would not suffice to secure its complete adoption. That it is well adapted to the language and purposes of scientific thought we freely concede. That it is desirable that all scientific men should use one system of units is highly desirable, even necessary, just as they have been driven to Greek and Latin for names. But to insist on the popular use of the metric method is as wise and as likely to succeed as an attempt to make every cottager call his vegetables and flowers by their Latin or Greek names. Finally, we heartily recommend this book alike to the enemies and the friends of the metric system. The latter will find much to think about, and will, perhaps, realise the true nature of the task which they wish to perform. The former will find their hands strengthened, and, like ourselves, will rise from a perusal of the book confirmed in the conviction that the objection to the English system is based on ignorance of its true powers, and that it is about as well to attempt to limit the range of units in use by a nation as it would be to insist that a carpenter shall use only one set of tools, a physician one kind of remedy, or a railway one type of locomotive. The mistake lies not in advocating the metric system, but in not perceiving the nature of its limitations, and in attempting to extend it into an industrial field to which it is not suited."

Mr. JAMES HOWIE (Member) said the only thing mentioned by Mr. Elmslie from the review which had attracted his attention was the German idea of sticking to the unit. They needed a general measure throughout the country to be appreciated by everybody. At present the whole system was incomprehensible. He believed the metric system would save a deal of time at school. Personally, he did not like vulgar fractions, and a man who was an expert at vulgar fractions might readily drop his vulgar fractions and go in for the decimal and metric systems. Last week they had heard the case mentioned by Mr. Britton of putting sizes out in decimals and then having to turn the figures back to vulgar fractions for workmen. Decimals were quite convenient for their general use, but they might have to change them back to vulgar fractions for some time in certain cases. It was good when they got opposition, because they never got any reform in this world without opposition, and Mr. Lee and Mr. Elmslie had done service in this way. If a thing was too easily obtained it might be dropped by the way, and its value belittled. He had heard their present member of Parliament pass an opinion on the matter, and he had said that he had advocated the metric system. Mr. Ernest Gray had been in the teaching profession himself, and appreciated the points to the utmost. Mr. Lee really believed that the metric system was the best system they could have. It might even be that they would be able to improve on the metric system in a few years' time. Their forefathers had left them some good results from their struggles in the past, and the present generation could not take things easy and say, "Very well, it will do well enough for our time," but continue the work of improvement by showing that the energies of the present day should not all be given to money-making, but in good measure also devoted to advancing the status of business ingenuity of the present time.

Mr. JOHN CLARK (Companion) said there could be no doubt that the present system of weights and measures of all descriptions had neither rhyme nor reason in them. It was a poor system that could not have some flattery said about it, and it would be a very poor system indeed if strong praise could not be given to it. But in regard to the decimal and metrical systems they were under a disadvantage, inasmuch as very few of them had experience of them in actual practice. Mr. Alexander Siemens, in his address to electrical engineers, brought out the great value of it in electrical work, more

especially the fact that it contributed greatly to the advancement of electrical science and knowledge. Referring to the change over from the present to the metric system, Mr. Siemens had said that it was like a man who went skating. At first he made no progress at all, and could get on better with his skates off. There were one or two points in Mr. Cooper's paper to which he would like to refer. He thought that the word "cent" would be very confusing. He understood that the cent was to represent the present 6d. The word, as a money value, had a different meaning in other countries, and it might perhaps be altered in some way so as to make it not so confusing. Then there was another point in the paper which, perhaps, rather took away from the spirit of the system, where it was mentioned that one of the great advantages to draughtsmen was that they were not likely to make mistakes when working with the metric system. It was said that 1′ 1½″ was likely to be read as 11½ in. He did not think that argument ought to be brought forward for or against any system. That was a failing on the part of someone, if it were so read or if it were so made. It was just as likely for the ½ in. to be rubbed out as for the dash between the 1 ft. and the 1½ in. He had very much pleasure in supporting Mr. Cooper in his paper. He thought it was an excellent subject, and he also thought it would be an excellent thing for the country when it was taken up. Everyone who had anything to do with electrical engineering understood perfectly well what a kilowatt was. The word came quite as familiar as the inch or foot.

Mr. W. McLAREN here quoted the remarks of an American gentlemen who had given his support to the system some years ago.

Mr. TIMPSON (Member) said he thought Mr. Cooper was right in respect to his remarks about Canada, for there everything was based on the pound. Then, in regard to the coinage, he knew that old Canadian friends of his had a great difficulty with our system of coinage. When they went across to France they could adapt themselves and could go shopping without difficulty. He had had some Canadian friends staying with him during the past summer, and they always had a difficulty in calculating values and weights in this country. That difficulty did not occur in France, and that showed that the metric system was easier. His friends had been quite confused when using some of our intermediate money pieces. In all indents they seemed to work on units of ten. That, no doubt, was

much simpler. The children made much more rapid progress in Canadian schools than the children in this country; they were further ahead at an earlier age. To him there did not seem the slightest doubt but that the metric system would come into vogue in due time. Anyone who had been in the States always said how much easier it was than on this side. All the railway trucks were plainly marked in pounds, and they had 33,000-lb. trucks. Then, in regard to the twenty-four-hours system, it was all worked on the twenty-four-hours system in the maritime provinces, and the people had dropped into it quite easily.

Mr. W. BRITTON said he did not wish the impression to get abroad that he was opposed to the decimal system, but he had brought certain points forward at the previous meeting for the sake, if possible, of raising a discussion. On the whole he was heartily in favour of the system if it could be adopted without material loss or waste. Personally, he did not think it could. He thought it would be a very serious loss to employers for some considerable time after adoption. He thought that any man who would adopt any system without first giving it fair consideration would very likely find himself very badly bit. With regard to the difficulty of working to decimals, a case came under his notice some seven or eight years ago. A certain firm had a large foreign order, and the drawings were in mètres. The men employed could not work to decimals, and the cost of producing that machinery was about 50 per cent. higher than it ought to have been, consequent upon the men not understanding the metric system. He ventured to suggest that that would be the trouble in many workshops. He was surprised to hear Mr. Cooper say he did not know a man who could not interpret ·75. If Mr. Cooper travelled in the Midlands he would find that very often the case. He had had the charge of some works in Herefordshire, and had had trouble on that account. Measurements were given in mètres, and those measurements were turned into decimals. The foremen in the machine shop did not understand the metric system, and after the measurements were turned into decimals they were almost as bad. Those men had not had the advantage of technical education. They did not get technical education in the country as they did in the marine centres. The time which would be saved in the office by using the metric system would be lost in waste in the shops. So far as money was concerned, he thought the French and Belgians far ahead of the English system. The American

system was, in his opinion, superior to the English. If the metric system, in regard to capacity, were adopted he did not think it would come into vogue in this country in this decade. The farmers would not go away from the old-fashioned bushels. He would be pleased to see it adopted, but he could not see how it would come without a very serious loss to all those who adopted it. He thought that if the decimal system were adopted it would mean that almost every workman would have to procure a set of micrometer callipers. He was afraid that would be a very expensive undertaking, and the workmen would fight against it.

Mr. LAWRIE asked how many large manufacturing, and particularly engineering, firms had at the present time adopted the metric system. He was not altogether surprised at what Mr. Britton had said, although it did not say much for our educational progress. He thought if it once became necessary to use the metric system we should soon work into it. He could quite appreciate what Mr. Britton had said—viz., that in the meantime there would be a loss.

Mr. D. S. LEE said that in the beginning of the evening Mr. Lawrie had referred to the number of coins that had become obsolete and out of date. He thought those coins had been put out of their place in order to render our coinage much more simple and easier to calculate than it was in those days, when they had so many coins—nobles, angels, etc. Nothing had been brought forward to take the place of those coins. It was simpler when it was recoined in pounds, shillings, and pence, and thus not have so many denominations. As our system of weights and measures dated back to the early Egyptians, he thought there must be something in it to stand the test of centuries ; and, as Mr. Lawrie had mentioned, of all the different weights in this country how many more would they get if they adopted another system ? They would not only get the existing weights and measures, but they would also get confused with the metric or decimal system of weight. Another gentleman had referred to the fact that all the measurements of weight in Canada were stated in pounds. When they came to reckon up a long train, with so many trucks at 20,000 lb. or 30,000 lb. weight per truck, they were going to add to the work of the calculation. In tons there would be much fewer figures and less chance of mistake.

Mr. W. LAWRIE explained that he had said it was an

improvement to clear out the old coins to which he had referred, and he thought it would be a further improvement to take up the decimal and metric systems.

Mr. JAMES HOWIE said that a point for Mr. Cooper to answer would be in regard to whether our educational schemes would continue to teach vulgar fractions, say, twenty years after the metric system had been adopted.

Mr. TIMPSON said that in Canada a whole train would be calculated out and the invoices sent out the same night. He thus thought that they could not take long over the calculation.

Mr. SAVAGE, referring to Mr. Timpson's remarks in respect of a train-load computed in pounds, said it seemed to be a very simple business. If they ticked off each truck and divided by the number, they then got the weight in tons per truck. No doubt this was a formidable calculation, and required a degree of intellect not easily possessed. One gentleman had also referred to the amount of waste that would arise in the shops by the adoption of the metric system, but it was his opinion that there was no occasion for such waste. One speaker had referred to ·375. At the present moment he knew of many engineering shops that worked to "$\frac{3}{4}$ bare," or "$\frac{3}{4}$ full," and he had also seen "a small 3-in. cock" specified. Referring to the preference for vulgar fractions, he would remark that a decimal was only a fraction. The part was there in reference to the whole, but it was in a simpler fashion. It would certainly simplify algebra and all mathematics. With mathematics the knowledge of decimals was imperative, and in the case of logarithms the system was entirely decimal. Then in regard to the number of years it would take for the new system to come into effect. For years past the decimal system had been taught in schools of all grades all over this country, and he thought that were legislation with a time limit brought in the results would be surprising. It was the exception, not the rule, to find people who did not understand the decimal system. There were certain parts of the Midlands where they were told the workmen were backward. For himself, he took leave to doubt this. In any case it must be remembered a new generation was arising in the shops as well as in every other walk of life. The average workman or mechanic of to-day was a vastly different man from that of yesterday, while he of to-morrow would no doubt in many ways, especially in education, be greatly ahead

of his mate in the present generation. All over the country in schools children were being taught the decimal system. In a short time a day would come when they would all be conversant with it. In scores of places it was understood. Instruments were sold by the score measuring to the $\frac{1}{1000}$ of an inch. In many shops they did not think of saying "$\frac{1}{64}$." It was not a fine enough measurement. It must be remembered they could not cater for the past, but for the future generation. As regards chemistry, it was a *sine qua non* that they should use the metric system. The only schools where the metric system would probably not be grasped were the high-class schools, where no doubt the ethics of deportment were thought of more value than mathematics. In a really go-ahead school the system was understood and was taught as part of the curriculum. The unfortunate feature of the paper was that it did not lend itself to any objection. It was a matter that must appeal to them. There was no point that they could take up and fasten on to criticise. He was firmly convinced that there would be an alteration in the system in the ordinary matter of business, although doubtless an insignificant portion of the community would fight progress in this matter up to the last ditch, and then would still protest. Nowadays people had to get more up-to-date in their methods. Competition was keener, and education had to be deeper and truer. In England he had no doubt it would be put off until the last day before people took up the system out of necessity. A paper such as the one to which they had listened made them think, and very often a paper did a lot of good in that way.

Mr. TIMPSON asked what would it matter whether the measurements were marked in inches or centimètres so long as the gauges were made to work to. There would not be much difficulty in the larger parts. It would be the smaller parts where the difficulty would arise.

Mr. W. BRITTON said he thought that would follow out quite true in a shop that was organised and accustomed to a system of using gauges. But when a new system was introduced into a shop, and metric gauges, with which the men had had no previous experience, they would soon get into trouble with them.

Mr. W. MCLAREN said he thought there was hardly a turner at the present day but that his rule was marked in

inches on one side and in millemètres on the other. Where was the man at the surface table, even after he had left the drawing office, and where was the foreman of the present day who did not know the metric system? In Brazil they had the decimal system of money, but he thought they had the British rule, because the British had dominated that place in an engineering sense.

Mr. W. BRITTON said it was in the Midlands, and not in the marine centres, that they found the men ignorant of the metric and decimal systems. It was very rare to find lads going to technical schools in the country—as, for instance, in Derbyshire, Cambridgeshire, and Herefordshire, and all the Midland counties. In a sea-port they were, as a rule, well educated, and they studied for Board of Trade certificates. Go away from the marine centres and they would find education lacking.

Mr. FRANK COOPER, in reply, said he did not know that any real, valid objection had been raised to the adoption of either the metric or the decimal system. In the first place, Mr. McLaren still harped on the cost, especially to the poor, of the change of money, and he could not say any more, except that the proposal was that an Act of Parliament should be passed that on a certain day the change would take place from the present system of farthings and pennies to the proposed system of mils and cents, whilst the shillings and pounds would remain exactly as at present. In that case they could never lose any money, except on some fraction of sixpence, and if people were making all their purchases in coppers their purchases could not be so large as to be harmful, seeing that the loss which could be entailed on any one sixpence was only 4 per cent., or, in other words, $\frac{1}{25}$ of sixpence. Mr. Aukland had very kindly handed to him a copy of the *Society of Arts Journal* for January, 1903, in which there was a paper on the metric system, in which the following appeared: "In the retail market the inconvenience due to our chaotic usages assumes an almost pathetic aspect. Let anyone who is a fairly rapid computer go of a Saturday night into those thoroughfares where the working men's wives congregate to make their little purchases, and witness the over-reachings practised on them in the calculations of their purchases. I quote actual cases: 7 lb. 11 oz. of scraps at 5d. per lb. amounts actually to 3s. $2\frac{7}{16}$d., so that 3s. $2\frac{1}{2}$d. would be an over-payment; it was charged 3s. $3\frac{1}{2}$d., and the purchaser was mulcted in 1d. A piece of

cheese weighing 2 lb. 3 oz. at 6½d. per lb. costs, accurately, 1s. $2\frac{7}{32}$d., so that 1s. 2¼d. is an over-payment; it was charged 1s. 3d. These habitual intentional over-reachings are considered, if not commendable, at least venial 'trade practice.'" So, by our present system, the poor were more likely to be over-reached than by the adoption of the decimal system. Mr. Lee had mentioned that we only had four factors to remember in our measures of length, viz., inch, foot, yard, and mile. But he supposed that Mr. Lee had forgotten that although 1,760 yards was a standard British statute mile a different number of yards was a geographical mile. Then Mr. Lee had also said that foreigners had no difficulty in understanding our weights and measures. He himself had never met a foreigner who did not find the greatest difficulty in understanding our weights and measures, and if we adopted some simple system he thought the foreigners would have less difficulty in understanding our weights and measures, and we should then be able to compete in theirs. He supposed it was a fact that quotations were sent daily to foreign countries, and those quotations were never so much as looked at, because they were quoted in tons, hundredweights, quarters, and pounds. Foreigners would first look at those quotations which were in their own weights and measures, instead of computing the British measures. It was quite true that there were many instances in France, Germany, and elsewhere where old-fashioned measures were still used, but he did not think that that affected the question. If they went to Lancashire or Ireland they would find that provincialisms were used, but that did not affect the standard language. Some of those old-fashioned measures were used, but the standard still remained, whereas we had no standard. As to Mr. Lee's remark that he was not aware that the Colonies had taken any steps towards the adoption of the metric system, he would read from the statement made by Lord Belhaven, who introduced the Metric Bill into the House of Lords. His Lordship said:

"Since that time our self-governing Colonies have taken the matter up with great earnestness. The Federal House of Representatives for Australia passed strong resolutions in its favour. In New Zealand a Weights and Measures Act was passed by the Colonial Parliament last year, Clause 25 of which empowered the Governor, by proclamation, to enforce the compulsory introduction of the metric system; such proclamation, however, was not to be issued prior to January 1st, 1906. The Chambers of Commerce of the British Empire met, again, in Montreal in 1903, and passed a similar resolution. The Cape

of Good Hope House of Assembly have agreed to a motion in favour of a communication being addressed to the Imperial Government on the subject of the adoption of the metric system. The Transvaal Chamber of Mines have also signified their cordial approval of the proposal, and their willingness to co-operate in giving effect to it. The Governors of Malta and Bermuda have intimated the desire of the inhabitants of those islands for the introduction of the metric system."

Mr. Lawrie had expressed the opinion that the renewal of our coinage would be a great hardship on the poor. Well, as he thought he had said in his paper, the very reverse would be the case. The hardship would really be on the people who had large establishments. The poor people had only a few weights—(Mr. LAWRIE: And very few pence)—and they had to have those weights renewed occasionally, and he did not think for a moment that the cost of putting in a few measures for their business would be appreciable. The people who would feel the change most would be the people with large businesses, who had a great number of weights and measures to keep up. Mr. Lawrie had also asked how many large firms in this country used the metric system. All manufacturers of motor-cars in this country used the metric system. They cut their gears to the metric system, and all their measurements were made on the metric system. It was on account of our innate conservatism that we had allowed France to get the lead in the motor-car industry. While we were preceding our motor-cars by steam-rollers, and these with a red flag, the Frenchmen were running their cars at ten and twenty miles an hour across the country. Now the standard motor-cars, even in this country, were all of French design, and the making of motor-cars was an industry that would be very much advanced in a very few years. He believed that the amount of work in hand in this country alone equalled six or seven millions sterling. Mr. Elmslie had very kindly read some extracts in reference to Mr. Halsey's book. The *American Machinist* had invited opinions from men who had tried both systems. They received hundreds of communications from such in reply to the invitation, and the result was that over 90 per cent. (he thought the actual figure was 98 per cent.) of the men declared that they would no more think of going back to inches, after having used the metric system, than they would think of flying. That, he thought, was one of the greatest testimonies to the value of the metric system that was ever made. Mr. Howie had mentioned the difficulty in

schools, and in that connection he thought a paragraph taken from the *Journal of the Society of Arts* for January, 1903, would be interesting. It was taken from a paper read by Mr. Sonnenschein—the same paper from which he had previously quoted in regard to the loss on petty purchases. The paragraph was as follows:

"In the schoolroom the children are made to learn by heart a number of certain selected tables, and have to work complicated problems on them, requiring at times the anticipation of future more advanced studies—as, for example, when they have to divide by $5\frac{1}{2}$ or $2\frac{1}{4}$ before they have studied fractions. Nine-tenths of the tables they learn they will never want, and such tables as they will require they learn best by the daily use in the business they will in future years engage in. I do not think I overstate the case if I estimate the loss thus incurred as equivalent to the waste of one year's arithmetical studies. I will say nothing now of the exclusion of the advantages derivable in the schoolroom from the introduction of the metric system, as those will be mentioned when we come to it."

Mr. Clark had mentioned that they might devise a better name than "cent" for one of the coins. He thought there was no doubt that if the decimal system of coinage were adopted better names than those proposed in the paper would be used, although he did not think they could have anything more clear than "cent" and "mil." Then, as to the remark which Mr. Clark had also made that they should not claim any advantage because it was easier to detect errors when the metric system was used, he thought it was one of the great advantages of the decimal and metric systems that when they had an error it was much easier to detect it in the decimal than in any other system. If they misplaced the decimal point they altered their amount by ten times. They either made it ten times less or ten times more, and surely it was easier to discover an error which was ten times out than it was to discover a small error which took place between $1'\ 1\frac{1}{2}''$ and $11\frac{1}{2}''$. The advantage was that it was easier to detect the error in the decimal system, and errors would occur in all systems and at all times. With regard to Mr. Adamson's remarks, he thought that what he had said about the correspondence that took place in the *American Machinist* supported what Mr. Timpson had said—that certainly everybody who had had some acquaintance with both systems preferred the metric system. He was sorry that Mr. Britton had met such

poorly-educated workmen, and he did hope he had met the worst. He did not know whether it would be possible, but he supposed they could discover how many micrometers were used in the workshops at the present time. He should think they would amount to a million, if they did not amount to more, and where all those workmen were who did not understand the decimal system he could not say. Certainly they could not be in engineering shops. Mr. Timpson had referred to gauges, and he might say that in all well-organised shops nowadays they did not work to rule. They did not put the rule across the piece, but they worked to limit gauge, and it really did not matter to the workman whether that limit gauge was on the metric, decimal, or inch system. He was only working to the gauge, so the adoption of the metric system would not affect it in any way. Mr. Lee had remarked that the coins of which Mr. Lawrie had spoken were disposed of to simplify our system of coinage. That was what they wanted to do in regard to our pennies, halfpennies, and farthings. They did not want to alter the value of the sovereign, the two-shilling piece, or the shilling or sixpence. The only ones they would have to deal with would be the copper coins under the value of sixpence. If they could simplify matters it would be to the advantage of the public. In Canada and the United States they still gave the weights of very heavy machinery in pounds, but when they did give them in tons they did use a sensible ton. It was a ton of 2,000 lb. He thought they still knew the "long" ton, which was 2,240 lb., and that was the ton we used. Mr. Howie had wanted to know whether we should still continue to teach vulgar fractions. No doubt they would continue to use such fractions. The $\frac{1}{2}$ would still be used in the metric system as in any other. In conclusion, he had to thank them for coming there, and for the criticisms that had been passed that evening. He hoped that what he had said was in answer to the remarks that had been passed.

The HON. SECRETARY then intimated that they had received an invitation to join the members of the engineers-in-charge in visiting the Velga Incandescent Gas Mantle Company's works, South Street, Wandsworth, on Thursday, December 7th, at 3 p.m.

The CHAIRMAN: This intensely interesting and valuable paper has really evoked two good evenings' discussion, and I think that a very great debt of gratitude is due to Mr. Cooper

for having brought this very interesting subject before the members of this Institute. I think again that we should like to accord to him a very hearty vote of thanks for having done so.

Mr. J. E. ELMSLIE seconded the proposition of the chairman, which was at once carried.

Mr. D. S. LEE said he thought that six days was too short a time in which to get up an argument. In future, if it depended on the Committee, he thought they ought to have a longer time to think over the subject and make any research in regard to any paper that might be read before the Institute.

The CHAIRMAN said he thought that at the previous meeting it was generally agreed that the adjourned discussion should take place on that evening—that was to say, after an interval of a week.

Mr. F. COOPER said he desired to thank them for the very hearty vote of thanks that had been accorded him for his paper. He had prepared the paper in rather a hurry, but the reading up of the system—which, of course, he had had in his mind for some considerable time—had been a great education to him.

Mr. W. C. ROBERTS proposed a vote of thanks to the Chairman for presiding, observing that they all knew the great interest which Mr. Aukland took in the Institute.

Mr. GIRVIN seconded the proposition, which was carried by acclamation.

The CHAIRMAN, in replying, said : I am very much obliged to you for the kind vote of thanks which you have accorded to me. It is a great pleasure indeed to me to be seated in the chair here, and to listen to this very important paper and the discussion which has followed. I have enjoyed these two evenings exceedingly, and I am very much obliged to you for the kind vote of thanks you have accorded me.