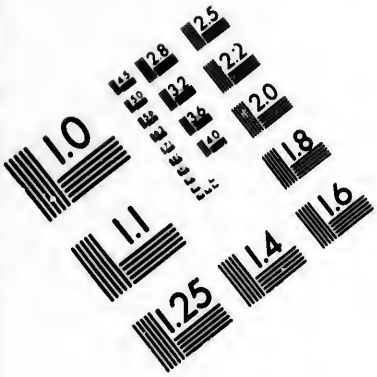

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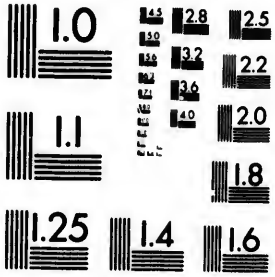

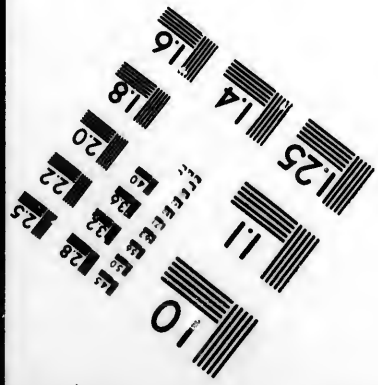

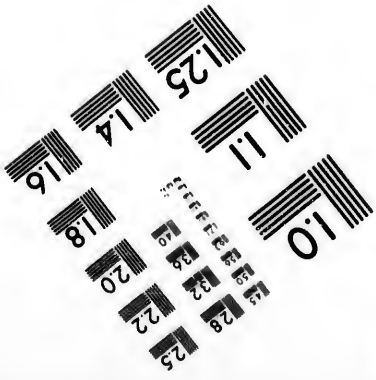

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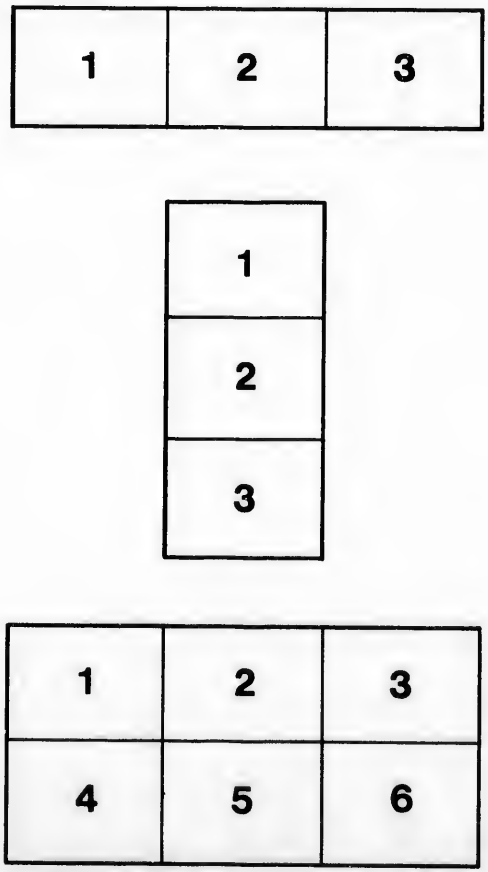

PAPERS ON TIME-RECKONING

AND

THE SELECTION

OF

A PRIME MERIDIAN

TO BE

COMMON TO ALL NATIONS.

TRANSMITTED TO THE BRITISH GOVERNMENT BY HIS EXCELLENCY THE GOVERNOR-GENERAL OF CANADA.

BY

SANDFORD FLEMING, C. M. G., ETC.

TORONTO:
COPP, CLARK & CO., PRINTERS, 67 & 69 COLBORNE STREET.
1879.

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Apl. 1914

PAPERS ON TIME-RECKONING

AND

THE SELECTION OF A PRIME MERIDIAN

TO BE COMMON TO ALL NATIONS.

Transmitted to the British Government by His Excellency the Governor-General, Canada.

The President and Council of the CANADIAN INSTITUTE (Toronto), having memorialized His Excellency the Governor-General of Canada, respecting the accompanying papers, with the special object of determining a FIRST OR PRIME MERIDIAN TO BE COMMON TO ALL NATIONS, and promoting the adoption of a UNIVERSAL SYSTEM OF TIME-RECKONING, adapted to the requirements of modern progress:

His Excellency the Governor-General, in view of the important international interests involved, has been graciously pleased to bring the subject under the notice of the Imperial Government, in order that the attention of the official and scientific authorities of Great Britain and of foreign countries may be directed to it.

The geographical circumstances of this country invest the question with special interest to the people of Canada, and the peculiar political status of the Dominion may in some respects enable the representatives of Canadian science to mediate, especially between their scientific brethren, in the various countries more immediately interested in the questions at issue. The Council of the Canadian Institute will be glad to receive, and to transmit to all the scientific bodies with which they interchange publications, any communications which may be made to them, and with the view of promoting the objects aimed at, will be happy to collate all comments, suggestions, or expressions of opinion, with which they may be favoured.

R. RAMSAY WRIGHT,
Secretary.

CANADIAN INSTITUTE,
Toronto, May, 187.

To His Excellency, the Right Honourable SIR JOHN DOUGLAS SUTHERLAND, *Marquis of Lorne, one of Her Majesty's Privy Council, Knight of the Most Ancient and Most Noble Order of the Thistle, and Knight Grand Cross of the Most Distinguished Order of Saint Michael and Saint George, Governor-General of Canada, and Vice-Admiral of the same.*

The memorial of the Council of the Canadian Institute

RESPECTFULLY SHEWETH:

That the Canadian Institute, established in Toronto for a period of thirty years, has specially aimed at promoting scientific study and research; and by means of its Journal of Proceedings has maintained communication with men of science in Europe and America.

At meetings of the Institute, during the present session, communications have been submitted to it by one of its members, Mr. Sandford Fleming, C. M. G., with the special object of determining a First or Prime Meridian, common to all nations; and promoting the adoption of a universal system of Time-reckoning, adapted alike to the requirements of an uniform historical record, and to the novel requirements of civilization, consequent on the rapid extension of railway and telegraphic lines over the globe.

While the geographical circumstances of Canada invest this subject with peculiar interest to the Dominion, its importance is not limited to Canada. In every civilized country, circumstances have tended in recent years to demonstrate the desireableness of adopting some uniform system of notation of time and space; and, as your Excellency will see by the papers herewith transmitted to you, the attention of various

scientific bodies, both in Europe and America, as well as of your memorialists, has been directed to this important subject.

Your Memorialists have accordingly welcomed, with special satisfaction, the suggestion by one of their own members whose practical experience, especially in his trans-continental surveys as Chief Engineer of the Canada Pacific Railway, peculiarly fits him for the task: the suggestion of a prime meridian, free from the objections hitherto urged against other propositions, and so offering an acceptable solution of a problem of international importance, which has long engaged the attention of leading geographers and astronomers both of Europe and America.

As the determining one initial Meridian for computing longitude, common to all nations, is an object of special interest to Great Britain, as the foremost maritime nation of the world, as well as to Canada and all the colonies of the empire: the Council of the Canadian Institute have hoped that the subject will not seem unworthy of your Excellency's consideration.

They respectfully invite your attention to the matter as set forth in accompanying papers; and in view of the important international interests involved, they beg leave, very respectfully, to ask your Excellency to bring the subject under the notice of the Imperial Government, and to use your high influence to direct the attention of official and scientific authorities in Great Britain, and of those of foreign Governments, to it.

The peculiarly favorable position which your Excellency occupies as the Governor-General, under Her Majesty, of a Dominion commanding both the Atlantic and Pacific coasts of the Continent of North America, appears to your Memorialists to furnish special facilities for promoting the simplification of a complex system, admittedly open to well-founded objections; and substituting for it one which not only

offers a solution of the evils, but is also extremely simple in its application, and free from the sources of international jealousy which have hitherto neutralized the efforts of scientific men to remedy practical evils which are universally recognized.

And your Memorialists, as in duty bound, will ever pray.

(Signed) DANIEL WILSON, LL.D.
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[*From the Proceedings of the Canadian Institute, Toronto, 1*

TIME-RECKONING

AND

THE SELECTION OF A PRIME MERIDIAN

TO BE

COMMON TO ALL NATIONS.

BY

SANDFORD FLEMING, C. M. G., ETC.

COPP, CLARK & CO.
PUBLISHERS OF THE CANADIAN JOURNAL AND THE PROCEEDINGS OF THE CANADIAN INSTITUTE.
1879.

TIME-RECKONING.

BY SANDFORD FLEMING, C.M.G., M. INST. C.E., F.G.S., F.R.G.S., LIFE M.C.I., ETC.
Engineer-in-Chief Canadian Pacific Railway.

I propose to direct the attention of the Institute to some points connected with the reckoning of time. I shall refer to the minor inconveniences which in all parts of the world are daily experienced. I shall likewise point out what strike me as the more serious difficulties arising from our present notation, and which the progressive character of the age is gradually developing. The importance of determining some means by which these inconveniences may be overcome, cannot fail to be admitted by all who recognize the presence of the difficulties of which I speak.

The subject, by its character, cannot be limited in its bearing to Canada, or indeed to any country. It is one which affects in different degrees every locality and individual on the face of the earth; and it is of particular importance to all countries in which civilization is making rapid strides, and of which the geographical features resemble those of Canada and the United States.

I propose to consider the subject under the following aspects:

1st. The difficulties which arise from the present mode of reckoning time, owing to the extension of telegraph and steam communications by land and water.

2nd. The natural and conventional divisions of time.

3rd. The systems of reckoning time, ancient and modern.

4th. The necessity of meeting the defects caused by present usages, and the useful results which would be obtained from a uniform non-local system.

5th. The practicability of securing all the advantages attainable from uniformity, without seriously interfering with existing local customs.

The division of the day into two halves, each containing 12 hours, and each numbered from 1 to 12, is a fertile source of error and inconvenience.

Travellers who have had occasion to consult railway guides and steamboat time-tables, will be familiar with the inconvenience resulting from this cause; none know better by experience how much the divisions *ante meridian* and *post meridian* have baffled their inquiries, and how often these arbitrary divisions have led to mistakes. Were it necessary, innumerable instances could be given. The evil however is one so familiar that it has come to be looked upon as unavoidable, and is, as a matter of course, silently endured.

The halving of the day has doubtless long been in use, but beyond its claim to antiquity, is a custom that confers not a single benefit, and is marked by nothing to recommend it.

Another more serious difficulty, forced on the attention by the science of the century, is mainly due to the agency of electricity, employed as a means of telegraphy; and to steam applied to locomotives. These extraordinary sister agencies having revolutionized the relations of distance and time, having bridged space, and drawn into closer affinity portions of the earth's surface previously separated by long and, in some cases, inaccessible distances.

Let us take the case of a traveller in North America. He lands at Halifax in Nova Scotia, and starts by a railway to Chicago through the eastern portions of Canada. His route is over the Intercolonial, the Grand Trunk, and other lines. He stops at St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton and Detroit. At the beginning of the journey he sets his watch by Halifax time. As he reaches each place in succession, he finds a considerable variation in the clocks by which the trains are run, and he discovers that at no two places is the same time used. Between Halifax and Chicago he finds the railways observing no less than seven different standards of time. If the traveller remains at any one of the cities referred to, he must alter his watch to avoid inconvenience, and perhaps not a few disappointments and annoyances to himself and others. If, however, he should not alter his watch, he would discover on reaching Chicago that it was an hour and thirty-five minutes faster than the clocks and watches in that city.

If his journey be made by one of the routes through the United States, the variation in time and its inconveniences will not be less.

If he extends his journey west of Chicago, travelling from place to place until he reaches San Francisco, he will meet continual change, and finally discover a loss in time of nearly four hours (3h. 56m.). Between the extreme points there are many standards of time, each city or place of importance generally being governed by its own meridian. Hence the discrepancies which perplex the traveller in moving from place to place.

On the continent of Europe, and indeed wherever lines of communication extend between points differing to any considerable extent in longitude, the same difficulty is experienced. On a journey from Paris to Vienna or to St. Petersburg, the standard time employed by the railways changes frequently, and the extreme difference in time between the first and last city is nearly two hours. As railways and telegraphs are extended in Russia, the inconveniences will become of serious importance in that country. Within the limits of Russia in Europe and Asia, the extreme variations of time is about twelve hours.

Suppose we take the case of a person travelling from London to India. He starts with Greenwich time, but he scarcely leaves the shores of England, when he finds his watch no longer right. Paris time is used for the journey, until that of Rome becomes the standard. At Brindisi there is another change. Up the Mediterranean, ships' time is used. At Alexandria, Egyptian time is the standard. At Suez, ships' time is resumed, and continues, with daily changes, until India is reached. Arriving at Bombay, the traveller will find two standards employed, local time and railway time, the latter being that of Madras. If he has not altered his watch since he left England, he will find it some five hours slow. Should he continue his journey to China, it will have fallen eight hours behind.

In the United Kingdom the difficulties due to longitude are only felt in a modified form. The greater island, embracing England and Scotland, is comparatively limited in width; one standard of time is therefore used. It is only in respect to the sister island, Ireland, that the difference in longitude calls for a difference in time. In the whole United Kingdom, consequently, there are practically only two standards, viz., Greenwich time and Irish time, the difference being twenty-five minutes. No one, therefore, whose experience has been confined to the United Kingdom, can form an adequate idea of the extent of the inconvenience arising from the causes alluded to,

where geographical circumstances render necessary the use of a multiplicity of standards.

The railway system is the principal agent in the developing of the difficulties referred to, and the still further extension of steam communications in great continental lines is forcing the subject on public attention. Canada supplies a good illustration of what is occurring. The railways built and projected will extend from the eastern coast of Newfoundland on the Atlantic, to the western coast of British Columbia on the Pacific, embracing about seventy-five degrees of longitude. Every Canadian city has its own time. Innumerable settlements are now being formed throughout the country ultimately to be traversed by railways; and in a few years, scores of populous towns and cities will spring up in the now uninhabited territories between the two oceans. Each of these places will have its own local time; and the difference between the clocks at the two extremes of Canada will be fully five hours. The difficulties which will ultimately arise from this state of things are apparent. They are already in some degree felt, they are year by year increasing, and will at no distant day become seriously inconvenient. This is the case not in Canada alone, but all the world over.

Again, there is a difficulty with regard to the determination of not only the precise hour, but even the day, of any occurrence under our present system of reckoning.

Persons who inhabit different sections of the earth, differ from each other in their reckoning of the day. At one place it is noon, at another it is midnight; at a third it is sunrise, at a fourth it is sunset. In consequence we have the elements of confusion, which involve in some cases the mistake of a whole day.

People even living in the same meridian may differ a day in their usual reckoning of time, according as the countries they inhabit have been colonized from the one side or the other of the globe. There are instances in the Pacific Ocean where islands almost adjacent reckon by different days of the month and week; a circumstance calculated to produce much confusion when intercourse becomes frequent.

In Alaska the days of the week and month were one day in advance of those in the adjacent colony of British Columbia, indeed of the whole of America. On the advent of citizens of the United States a few years ago, when that territory was transferred by Russia,

the Saturday was found to be the Sunday of the old residents. For ordinary business purposes a change became necessary, and a dispensation was granted in 1871 by the dignitaries of the Greek Church in Russia, authorizing their missionaries and adherents in Alaska to celebrate Sunday a day later, or on Monday, according to the old reckoning.

The reverse has been met in another quarter of the globe. The Philippine Islands, lying between Australia and Asia, and about 100 degrees of longitude to the west of Alaska, were discovered in 1521 by the illustrious Magellan in his memorable first circumnavigation of the globe. That navigator followed the sun in his path around the world. Legáspi succeeded him and took possession of these important Islands in the name of Philip II., king of Spain. The Philippine Islands extend for a thousand miles from north to south, they embrace Manilla, one of the oldest cities of the Indies, and they contain a population of 5,000,000. They were colonized, as well as discovered, by Spaniards coming from the east; and as a consequence the reckoning of the inhabitants has for more than three centuries remained a day behind the day in British India and the neighbouring countries in Asia.

Travellers who arrive at New Zealand or the Australian colonies, by the San Francisco route, meet the same difference, owing to the fact that the countries in the South Pacific were colonized from the west. The day of the week and of the month carried from San Francisco, never agrees with the day and date reckoned by the inhabitants at the destination of the steamer.

All travellers who have made the voyage between America and Asia have experienced the difficulty in reckoning referred to. Those who have proceeded westward have lost, while those who have travelled eastward have gained a day. In Mrs. Brassey's "Around the World in the Yacht 'Sunbeam,'" this experience is recorded. The journal of that lady passes from Wednesday, January 10th, directly to Friday, January 12th—Thursday, January 11th, having no existence with the travellers.

In sailing across the Pacific from west to east, one day has to be repeated before landing on the American coast. If, for example, the correction be made on Wednesday, 1st July, there will be two Wednesdays in the one week, and two days of the month dated July 1st.

A journey round the world is now an everyday undertaking, and is accomplished with comparative ease. Suppose two travellers set out from a given place, one going eastwardly, the other westwardly. A singular circumstance will result when they both return to the common starting point, and the reason is obvious. One man will arrive, according to his reckoning, say on Tuesday, 31st December, when in fact at that locality it is Wednesday, January 1st. The other traveller, assuming that he has kept accurately a daily journal, will enter in his diary on precisely the same day, Thursday, January 2nd. This consequence has been brought out by Edgar Allan Poe, in his amusing story of "Three Sundays in one Week," but it no longer can be held to be an imaginary contingency, since steam communication by land and water is now affording extraordinary facilities for making the tour of the globe.

To illustrate the difficulty more particularly. First, let us select points in four quarters of the globe, each about ninety degrees apart—say in Japan, Arabia, Newfoundland and Alaska. If we assume it to be Sunday midnight at the first mentioned place, it must be noon at the opposite point, Newfoundland, but on what day is it noon? Arabia being to the west of Japan, the local time there will be 6 p.m. on Sunday; and Alaska, lying to the east of Japan, the time there will be 6 a.m. on Monday. Again, when the clock indicates 6 p.m. on Sunday in Arabia, it must be Sunday noon at a point ninety degrees further west, or at Newfoundland; when it is 6 a.m. on Monday at Alaska, it must be noon on Monday ninety degrees further east, also at Newfoundland. Thus, by tracing local time east and west from a given point to its antipodes, the clock on the one hand becomes twelve hours slower, on the other hand twelve hours faster. In the case in point, while it is midnight on Sunday in Japan, at precisely the same moment it is noon at Newfoundland on two distinct days, viz., on Sunday and on Monday.

Secondly, let us trace local time only in one direction around the earth. The day does not begin everywhere at the same moment. Its commencement travels from east to west with the sun, as the earth revolves in the opposite direction, and it takes an entire revolution of the globe on its axis for the day everywhere to be entered on. Immediately on the completion of one revolution the inception of any one day ends, and at this moment the end of the day begins; and the globe must make another complete revolution before the end

of the day entirely finishes. The globe must in fact make two entire revolutions before any one week day runs out, consequently each and every day of the week runs over 48 hours; and, taking the whole globe into account, two civil days always co-exist. The first 24 hours of one day co-exist with the last 24 hours of its predecessor, while the remaining 24 hours co-exist with the first 24 hours of the day which follows.

It is difficult to accept the fact that any one day lasts more than 24 hours; but it can be demonstrated that it is the case. Let us place together several maps of the world on Mercator's "Projection," so as to represent, in consecutive order, each part of the earth's surface as it passes the sun during several diurnal revolutions. (*See Plate*).

AA^1, A^1A^2, and A^2A^3, are intended to represent each a complete map of the world. Within each of these limits every place on the earth's surface is brought under the sun during a daily revolution.

The vertical lines *E I N R V* represent meridians, for the sake of simplicity selected 60° degrees apart, and the stars or dots at their intersection denote the beginning and end of a day on each of the six meridians. As the earth revolves, the sun passes successively the meridians of those localities, with an interval of four hours elapsing between each.

Let us assume it to be 12 o'clock midnight on Thursday at meridian *A*. At that moment and at that place Friday begins and runs for 24 hours, or on the diagram from *A* to A^1.

Four hours later Friday begins on meridian *E*, and runs four hours on the second map, or into the 2nd revolution of the earth. Four hours still later Friday begins on meridian *I* and runs eight on the second map or into the 2nd revolution. This goes on from spot to spot, until at last the commencement of Friday reaches the last meridian, and at that point Friday runs entirely across the second map to A^2. Thus Friday begins at *A*, runs during two complete revolutions of the earth, as shown on the map from *A* to A^2.

The diagram will thus illustrate the duration of every day in the week, and it becomes obvious, when we take a general view of the whole globe on any given day, say Saturday, that day begins in the middle of Friday and does not end until the middle of Sunday. Friday, on the other hand, beginning in the middle of Thursday, runs into the middle of Saturday, while Sunday commences at the moment Friday ends. To state the case differently: the same moment

of absolute time which is part of Saturday in one place, is equally part of Friday and of Sunday in some other places east and west.

It is a preconceived idea with many that there is a simultaneous Sunday over the earth, and that Christians in every meridian keep the Lord's day at one and the same time. Facts, however, establish that this is a mistake. From its first commencement to its final ending, the Sunday extends over 48 hours. Indeed, if we take into account the remarkable circumstance mentioned with regard to Alaska and the Philippine Islands, Sunday has been discovered to run over some 55 hours. The same may be said of any day in the week; and as a consequence we have, taking the whole globe into view, Saturday and Monday running over the intervening Sunday to overlap each other about seven hours. We have in fact as a constant occurrence, portions of three consecutive days co-existent.

From the fact that not only are the hours of the day different in every meridian, but that different days are constantly in progress on the face of the globe, it is a difficult matter under our present system of reckoning to assign relatively the hour and day when events take place. We may learn of an occurrence, and the time assigned will be correct in the meridian of the locality. Everywhere else it will be inaccurate. Indeed, if the fact of the occurrence be transmitted over the world by telegraph, it may, in some places, be recorded on different days.* If the incident occurs at the close of a month, or a year, it may actually take place in two different months, or two distinct years.

Under our present system it is quite possible for two events to take place several hours apart, the first and older occurring in the new year in one locality; the second, although the more recent in absolute time, falling, in another locality, within the old year. The same may be said of events that occur during the period which elapses when one century merges into another. In one part of the globe the same event may transpire in the nineteenth century, while in another it falls within the twentieth century.

These explanations set forth the inconveniences and the ambiguity inseparable from the ordinary mode of reckoning. The system, besides being unscientific and inconvenient, must, as time rolls on, inevitably lead to countless mistakes. In fact, unless the geographical

* TIME AND THE TELEGRAPH.—A message dated Simla, 1.55 A.M. Wednesday, was received in London at 11.47 P.M. on Tuesday. As the clerk said, with pardonable confusion, "Why, this message was sent off to-morrow."—*Times.*

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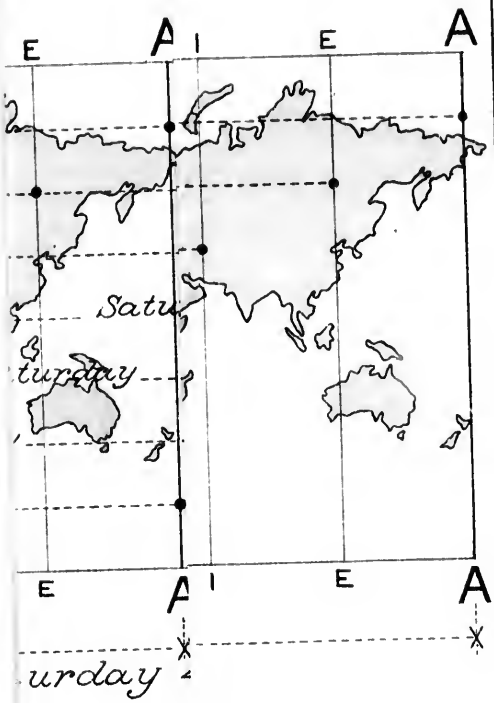

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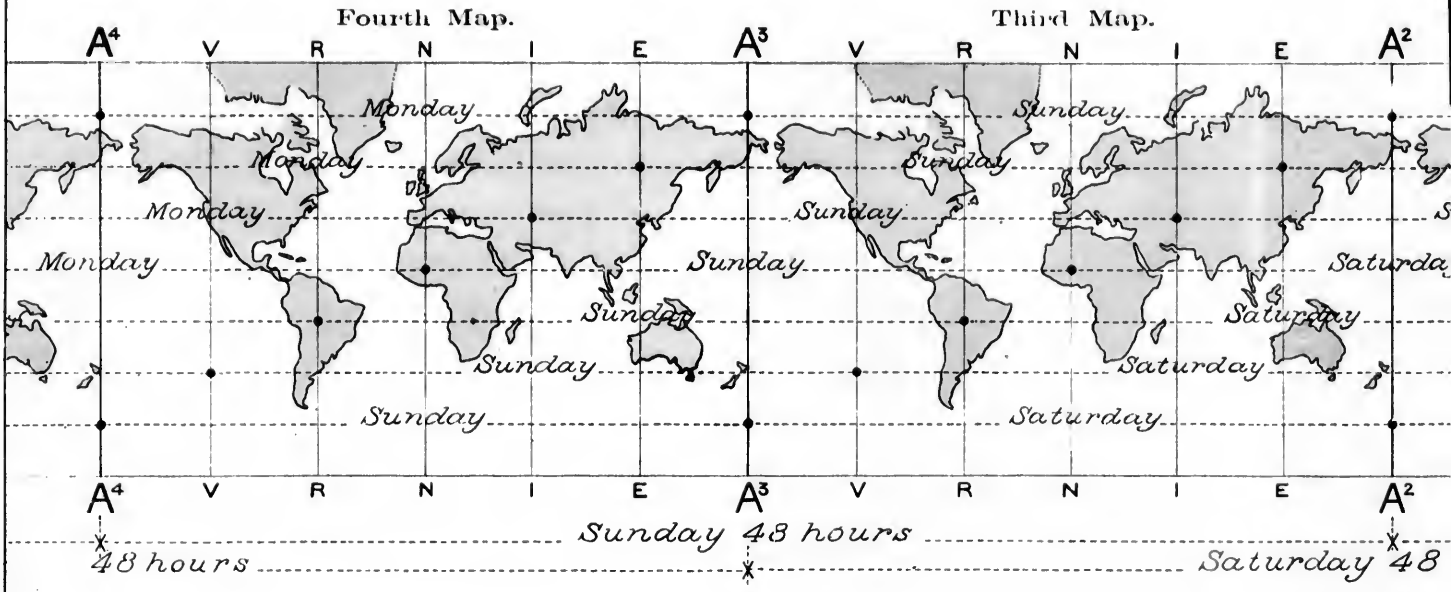

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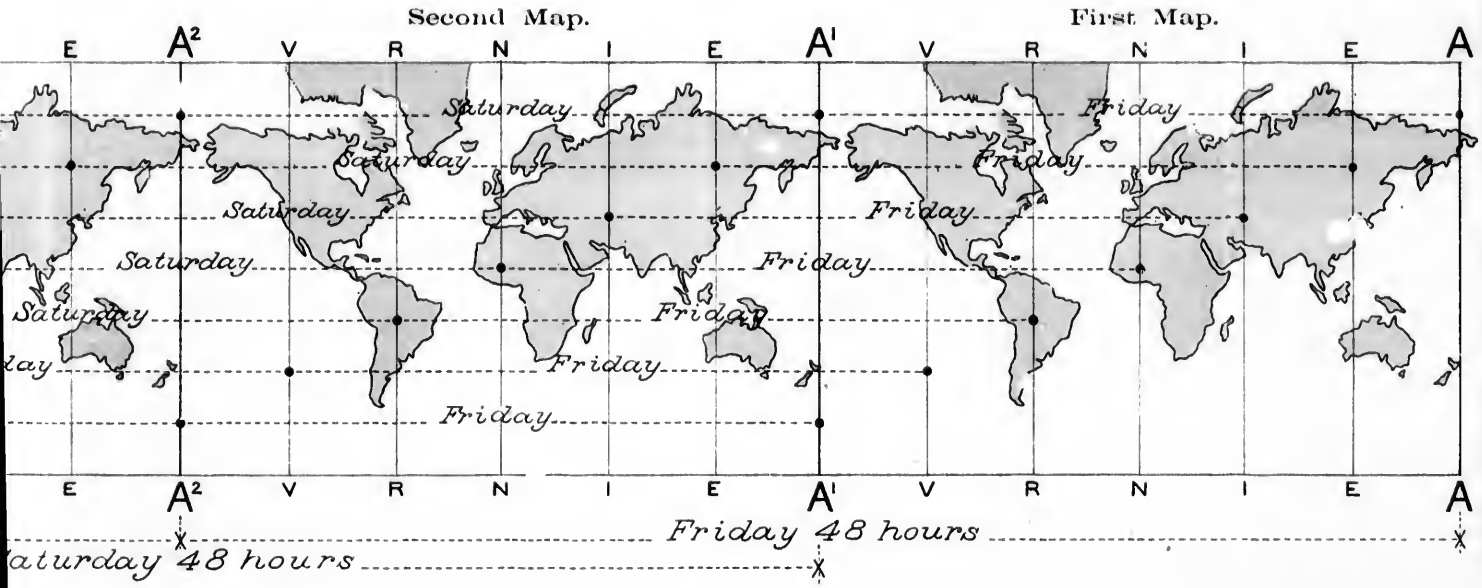


PHOTO. LITH BY THE BURLAND DESBARATS LITH. CO. MONTREAL.

position be specified as an important element of the date, there can be no absolute certainty with regard to time, as we at present note it in ordinary civil affairs.

The day is a purely local phenomenon. It begins and ends at every spot on the circumference of the globe at different instants in absolute time. From its very nature, there are as many different local days as there are points differing in longitude; and in order to make any comparison of the dates of different countries with each other, it is necessary, as in astronomical calculations, to make additions or deductions for the longitude of the places of observation. It need scarcely be argued that this process must become an exceedingly troublesome matter in the ordinary business of the world, especially when rapid and frequent intercourse between remote sections becomes general.

I need not further refer to the objections urged against the modes of keeping time, handed down to us from bygone centuries. It is clear from all experience that the customs which we still cling to, are indifferently adapted to the circumstances of the age, and that some better means of reckoning and verifying dates will soon be, if they are not already, urgently demanded.

A remedy for the evils to which your attention is directed may not generally be felt to be a pressing necessity; but the problem is obviously of no limited importance to the generation which is to succeed us, and it is not now too soon to seek for its solution. The minor inconveniences alluded to may be overcome in independent localities, as necessity dictates some arbitrary compromise; but if each country spontaneously adopted its own remedy, a want of uniformity of system, it is to be feared, will result, and increase the confusion.

The major difficulties to which I have referred are more general in their character, and in seeking for a remedy, uniformity of system is held to be of first importance, and consequently the broadest cosmopolitan view should be taken.

It is to be feared that no immediate solution to the problem may be possible; but a general inquiry into the science of chronometry may suggest means by which the difficulties may in some degree be met.

NATURAL AND ARTIFICIAL DIVISIONS OF TIME.

Time is determined in nature by the motions of the heavenly bodies. The great natural divisions are three in number: the year,

the lunar month, and the day. All other divisions of time, as the civil month, the week, the hour, the minute, and the second, although long in general use, are arbitrary, conventional and artificial.

The employment of the lunar month for reckoning time is not general, although some nations, such as the Turks, Jews and Chinese, have preferred a lunar chronology. In China the age of the moon and the day of the month are identical.

The period measured by the diurnal movement of the earth on its own axis constituted the first space of time reckoned by the human race, and is undoubtedly the most important to man in all stages of civilization. It involves the most familiar phenomena of light and darkness, and embraces the constantly recurring periods of wakefulness and sleep, of activity and rest.

A day is the shortest measure of time afforded by nature. It is denoted by the revolution of the earth, and although the motion of the earth is uniform, we have three kinds of natural days all varying in length—the solar, lunar, and sidereal.

A solar day is the period occupied by a single revolution of the earth on its axis in relation to the sun.

A lunar day is the interval of time occupied by a revolution of the earth on its axis in relation to the moon.

A sidereal day is the period required for a complete revolution of the earth on its axis in relation to any one fixed star.

Of these three natural days, the sidereal day is the only one uniform in length. The lunar day, on account of the irregular and complicated motion of the moon in the heavens, is never employed as a measure of time. The solar day is variable in length on account of the ellipticity of the earth's orbit. Solar time is that shown by a sun-dial.

Although the sidereal day is uniform in length, inasmuch as it has no relation to the daily return of light and darkness, it is not employed for civil purposes. The commencement of the sidereal day is constantly changing throughout the year; at one period it comes at midnight, at another period at high noon.

It has been found convenient, therefore, to establish an artificial day, uniform in length, designated the mean solar day.

The mean solar day, as its name implies, is the average length of all the natural solar days in a year, and is the time intended to be indicated by ordinary clocks and watches.

The natural solar day is at one season of the year 14 minutes 32 seconds shorter, and at another 16 minutes 17 seconds longer than the mean. Thus the extreme variation is half an hour and 49 seconds.

The earth revolves in its orbit in about 365¼ days. To avoid fractions of days, it has been found convenient to establish three years in succession of 365 days, and each fourth year 366 days. The latter are designated leap years.

While an ordinary solar year has but 365 days, it has 366 sidereal days.

A solar day, therefore, exceeds the length of a sidereal by about $\frac{1}{365}$th part of a day, or nearly four minutes (3 minutes 55.9094 seconds).

The mean solar day, according as it is employed for civil or astronomical purposes, is designated the civil day, or the astronomical day. The former begins and ends at midnight; the latter commences and ends at noon. The astronomical day is understood to commence twelve hours before the civil day, but its date does not appear until its completion, twelve hours after the corresponding civil date. The two dates, therefore, coincide only during the later half of the civil and the earlier half of the astronomical day.

ANCIENT AND MODERN RECKONING OF TIME.

It has been stated that all shorter periods of time than a day are conventional and arbitrary, there being no measure less than a day denoted by nature. The only exception is the interval marked by the rising and setting of the sun; a period of time varying with the latitude and changing from day to day with the seasons.

The sub-division of the day into parts has prevailed from the remotest ages; though different nations have not agreed, either with respect to the epoch of its commencement, the number of the sub-divisions, or the distribution of the several parts.

The division of the day with which we are most familiar is that which separates the whole space of time occupied by a diurnal revolution of the earth into two equal parts; one part extending from midnight to noon, the other part from noon to midnight. These half days are sub-divided into twelve portions or hours, and these again into minutes and seconds.

Astronomers do not divide the day into two sets of twelve hours. The astronomical day, extending from noon to noon, is reckoned by hours running from one to twenty-four.

In China and some other parts of the world, no half days are used. The Italians, the Bohemians and the Poles have a division of the day into twenty-four parts, numbered from the first to the twenty-fourth, from one o'clock to twenty-four o'clock. The Chinese divide the day into twelve parts, each being equal to two hours of our time; these they again divide into eight parts, thus sub-dividing the whole day into ninety-six equal parts. The Chinese astronomers, according to some authorities, divide the day into 100 parts, and each of these into 100 minutes, so that the whole contains 10,000 minutes. The inhabitants of Malabar have divided the day into six parts, each of these again into 60 parts. The ancient Tartars, Indians and Persians divided the day into eight parts, they had also a division of sixty parts.

In Japan there are four principal points of division—at noon, midnight, sunset and sunrise, dividing the natural day into four variable parts. These four parts are divided each into three equal portions, together making twelve hours. Each hour is again divided into twelve parts, thus making in all one hundred and forty-four subdivisions of the day. The six hours between sunrise and sunset differ in length, day by day, from the six hours between sunset and sunrise. During the summer the hours of the day are much longer than those of the night, and shorter, on the contrary, in the winter.

The division of that portion of the day during which the sun is above the horizon, in to parts, belongs to the remotest ages of antiquity. The division of the other portion, which embraces the period of darkness, is of more recent date. It was not introduced at Rome until the time of the Punic Wars.

In early times the only divisions recognized were sunrise and sunset. Afterwards the division of the interval of daylight into two parts was made to denote mid-day. For many ages the Romans took no public notice of any point in the diurnal revolution of the earth, excepting mid-day. The precise time was manifested when the line of the sun's shadow fell along the forum in a particular direction, and the fact was duly announced by sound of trumpet.

Before mechanical means were adopted for the division of the day, only the vague, natural divisions of forenoon, afternoon, morning, evening and night could be used. Mention is made of the erection of the first sun dial at Rome by Papirius Cursor, 293 B.C., and the division of time into hours. The employment of sun dials led to a

singular consequence, the number of hours were made constant between sunrise and sunset, and instead of being equal in length, the hour varied with the length of daylight. Whatever the moments of sunrise and sunset, the interval of light was divided into 12 parts. If the sun rose at 4 a.m. and set at 8 p.m., according to our notation, each hour would be equal in length to 80 of our minutes. Old habits are so strong that this constantly varying system was adhered to long after mechanical time-keepers were introduced, and attempts were made to regulate clocks to tell the unequal hours. Like the Romans, the Greeks divided the intervals of light between sunrise and sunset, whatever its length, into 12 equal parts, subject to change from day to day. The custom of making the hours variable is still followed by some eastern nations.

The system of dividing the day by the rising and setting of the sun makes the hours indefinite periods, as they continuously change with the seasons. Except at the equinoxes, the hours of the night and day can never be of equal length. Near the equator the variations are least; they increase with every degree of latitude until the arctic and antarctic circles are reached, within which a maximum is attained. Even in the latitude of Rome, the length of the hours of daylight and darkness under this system have an extreme difference of 75 minutes. In Spitzbergen the sun sets about the beginning of November, and remains below the horizon for more than three months. It does not set for an equal period after the middle of May.

Sun dials had two great defects, they were unserviceable at night and during cloudy weather. The clepsydra or water clock was accordingly introduced at Rome about 158 B.C., by Scipio Nasica Corculum. It measured time by allowing water to escape through an orifice in a vessel, as sand flows through a modern sand glass. Subsequently some sort of toothed-wheel work was applied to the clepsydra by Ctesibius (A. D. 120). Diurnal and nocturnal time was measured in this or some other rude manner for many centuries. Besides sun dials, gnomons and clepsydræ, all of which appear to have been known to the Egyptians, Indians, Chaldeans, Babylonians and Persians long before their Introduction at Rome, mention is made of a contrivance by which a mechanical figure dropped a stone into a brazen basin every hour, producing a loud sound which for a great distance announced the divisions of time. King Alfred employed as a time-keeper six wax candles, each 12 inches long. Three

inches burned in about an hour, and thus the six candles lasted 24 hours, each being lighted in succession by an attendant. The system of measuring time by the burning of candles was subsequently used in monasteries. About the time of the eleventh century clocks moved by weights and wheels were first introduced. The pendulum clock was invented in the 17th century.

The Babylonians, Persians, Indians, Syrians, Greeks and other ancient nations, began their day at sunrise, and had divisions corresponding to morning, forenoon, mid-day, afternoon, evening and night. The Jews had four divisions, viz., evening, morning, noon and midnight, the two first being much longer than noon and midnight. The civil day of the Jews began at sunrise, their sacred day at sunset. The latter mode was followed by the Athenians and ancient Gauls.

The ancient, like the modern, Arabians began their day at noon.

The Chaldean astronomers divided the day into sixty parts; like the modern Chinese, they also had a division of the day into twelve hours.

The ancient Egyptians (probably B.C. 1000) divided the day equally into day and night, and again sub-divided each half into twelve hours, numbered from 1 to 12; the night with them commenced six hours before and terminated six hours after midnight; the day began six hours before noon and lasted twelve hours, or until six hours after noon. It is probable that the Egyptians had different modes of computing the day in different provinces. According to Pliny, they reckoned it from one midnight to another. The astronomers of Cathay and the East Indies reckoned it in the same manner. The Mohammedans from one twilight to another.

The day is reckoned to begin in China before midnight, the first hour extending from 11 p.m. to 1 a.m. of our mode of reckoning. The Jews, Turks, Austrians and others, with some of the Italians, have begun their day at sunset. The Arabians begin their day at noon, and in this respect they resemble the astronomers and navigators of modern nations. In Japan it has been customary to adhere to the practice of the ancient Babylonians in beginning their day at sunrise.

The above are some of the customs, gleaned from history, which have prevailed at various times in different countries with respect to the day and its sub-division. To these may be added the custom practised at sea by navigators. Mariners of different nations have had

different customs, but the most common practice on shipboard is to divide the 24 hours into six equal portions called "watches," and these again into eight equal parts known as "bells," and numbered from 1 to 8. Thus, the whole day is sub-divided into 48 equal parts. The period of time called a "watch" is four hours in length, the reckoning being as follows:

From noon to 4 p.m., the afternoon watch.
" 4 p.m. to 8 p.m., the dog watches (from 4 to 6 being the first dog watch; from 6 to 8 being the second dog watch).
" 8 p.m. to midnight, the first (night) watch.
" midnight to 4 a.m., the middle (or second night) watch.
" 4 a.m. to 8 a.m., the morning watch.
" 8 a.m., to noon, the forenoon watch.

This division into watches has a remarkable similarity to the practice followed by the Jews before the captivity. They divided the night into three watches, the first lasting till midnight, the middle watch lasting till cock-crow, the morning watch lasting until sunrise.

From what has been set forth, it would appear that the sub-divisions of the day have not been less varied than the computations of the day itself. Man has reckoned the day to begin at sunrise, at sunset, at noon, at midnight, at twilight, at one hour before midnight, at six hours before midnight, and at six hours before noon. He has divided it in a great variety of ways, viz.: *First*, into two, four, twelve, twenty-four and one hundred and forty-four unequal parts; *second*, into two, four, six, eight, twelve, twenty-four, forty-eight, sixty, ninety-six and into one hundred equal parts, without including the small sub-divisions of minutes and seconds. The common practice at present with most civilized nations is to divide the day into two series of twelve hours each, a custom which corresponds very closely with that followed by the ancient Egyptians long before the Christian era. Thus, while we have made extraordinary advances in all the arts and sciences, and in their application to everyday life, we find ourselves clinging to a conventional and inconvenient mode of computing time; one not materially different from that practised by the Egyptians perhaps thirty centuries ago—a custom which answered every purpose when the world was young and its inhabited portion of narrow limit, but now indefensible in theory and inconvenient in practice.

The Chinese system would, without a doubt, suit the requirements of this age much better than that which we now follow. The halving of the day is one source of difficulty which ought not to exist, and it would be an important step to imitate the custom of computing time which is followed by that old oriental civilization. The adoption of the Chinese system, by which half days would be thrown out of use, would not, however, obviate the other very serious objections which have been raised. To overcome at once all the difficulties is the problem which presents itself for solution.

A SCHEME OF UNIFORM TIME-RECKONING.

It has been stated that the period occupied by a diurnal revolution of the earth, is the shortest measure of time which we find in nature. As a consequence, man is left to reckon and sub-divide this measure in the way best calculated to promote his own convenience. There can be no doubt whatever that all smaller divisions, except that produced by the rising and setting of the sun, must be artificial and arbitrary.

When the decimal system was adopted by the French, it was proposed to divide the day into ten and a hundred parts; a scheme which would probably be the best at this age of the world, had the whole system of horology to be established *de novo*. In view of generally prevailing customs, however, it will doubtless be felt that any attempt to introduce the decimal division of the day would be unwise; that it would be futile to propose a change which could only succeed by seriously interfering with the present notations.

The progress of the world may indeed before long demand a radical change in our chronometry; but the present method of computing time in the more civilized parts of the earth is so interwoven with every day life, that it cannot in the meantime be disregarded. It will be evident that the consideration of any change should be based on the full recognition of established customs. Instead of attempting to uproot and supersede the present system, it is considered that any new scheme to meet the requirements of the age should rather be engrafted on and be in as complete harmony as possible with the old one.

In this view the following suggestions are offered:

Our first effort should be to find a suitable unit measure of time, uniform in length, and for obvious reasons, the shortest to be found in nature.

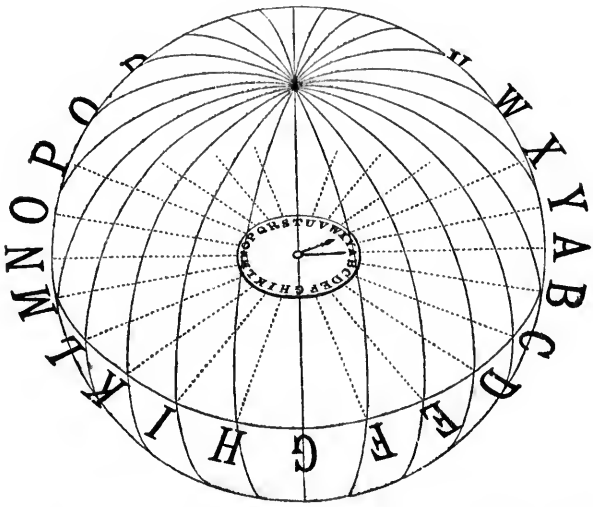
The sidereal day fulfils these conditions, and therefore suggests itself as being suited for the standard required.

The sidereal day is not, however, sufficiently marked for the ordinary purposes of life. The generality of mankind could not easily note the culmination of a star. On the other hand, the diurnal return of the sun in the heavens is a more striking and easier observed phenomenon. Accordingly, there is everything to suggest the adoption for the unit measure, not the solar day on account of its variable length, but the mean period occupied by a revolution of the earth on its axis, in relation to the sun.

That period would be precisely equal in length to the artificial day, known as the mean solar day. The unit measure proposed should not, however, be considered in the light of an ordinary day, but rather as a known period of abstract time—"day" being the name given to denote certain local phenomena successively and continuously occurring at the earth's surface.

It is proposed to divide the unit measure into twenty-four equal parts, and these again into minutes and seconds, by a standard time-keeper or chronometer, hypothetically stationed at the centre of the globe.

Fig. 1.



It is proposed that, in relation to the whole globe, the dial plate of the central chronometer shall be a fixture, as in Fig. 1; that each

of the twenty-four divisions into which the unit of time is divided, shall be assumed to correspond with certain known meridians of longitude, and that the machinery of the instrument shall be arranged and regulated so that the index or hour hand shall point in succession to each of the twenty-four divisions as it became noon at the corresponding meridian. In fact, the hour hand shall revolve from east to west with precisely the same speed as the earth on its axis, and shall therefore point directly and constantly towards the sun, while the earth moves round from west to east.

Each of the twenty-four parts into which the time-unit is proposed, as above, to be divided, would be exactly equal in length to an hour; but they ought not to be considered hours in the ordinary sense, but simply twenty-fourth parts of the mean time occupied in the diurnal revolution of the earth. Hours, as we usually refer to them, have a distinct relation to noon or to midnight at some particular place on the earth's surface, while the time indicated by the standard chronometer would have no special relation to any particular locality or longitude. It would be common and equally related to all places, and the twenty-four sub-divisions of the unit-measure would be simply portions of abstract time.

The standard time-keeper is referred to the centre of the earth, in order clearly to bring out the idea that it is equally related to every point on the surface of the globe. The standard might be stationed anywhere—at Yokohama, at Cairo, at St. Petersburg, at Greenwich, or at Washington. Indeed, the proposed system, if carried into force, would result in establishing many keepers of standard time, perhaps in every country, the electric telegraph affording the means of securing perfect synchronism all over the earth.

In order properly to distinguish the new unit measure and its sub-divisions from ordinary days and ordinary hours, a new nomenclature might be advisable. The employment of the letters of the alphabet for the twenty-four divisions would in most civilized countries completely distinguish them from local hours, and the twenty-four meridians, which on the surface of the globe would correspond with the sub-divisions, might also be so known. It would farther be expedient to distinguish the proposed new system from sidereal, astronomical, civil or local time. For this purpose either of the designations, "common," "universal," "non-local," "uniform," "absolute," "all world," "terrestrial," or "cosmopolitan," might be employed. For the present it may be convenient to use the latter term.

Besides the standard keepers of "cosmopolitan" time, established at many places possibly in every civilized country, it is suggested that every clock and watch should, as far as practicable, move synchronically, all indicating the same time.

As a theory, it is proposed that when the hands of any one timepiece point to *A* or to *G*, the hands of each and every other horological instrument in use throughout the globe should point to *A* or to *G* at the same moment.

It is proposed that, in establishing the zero of the sub-divisions and its corresponding meridian in relation to the surface of the earth, regard be had to the general convenience, and that the views and interests of all nations should, as far as practicable, be equally consulted.

Under the system of cosmopolitan time, the meridian which corresponds with zero would practically become the initial or prime meridian of the globe. The establishment of this meridian must necessarily be arbitrary. It affects all countries, more especially maritime countries, and in consequence of prejudice and national sentiment, it is possible that delicacy and tact and judgment may have to be exercised in the consideration of the subject. There ought not, however, to be much difficulty in dealing with the question. Matters of scientific concern are not and should not be made subservient to national jealousy. Science is cosmopolitan, and no question can be more thoroughly so than that which we are attempting to investigate.

In a separate paper, I have at some length discussed this branch of the subject, and I trust I have succeeded in pointing out a convenient and suitable position for a prime meridian, common to all the world, a selection which would offend no prejudice, and when carefully considered would, I feel assured, commend itself as well calculated to meet all the purposes for which a common initial meridian has for a great many years back been proposed, and likewise those special objects for which it is now suggested.

COSMOPOLITAN AND LOCAL TIME.

Assuming a common zero of longitude established by general concurrence, each rotation of the earth on its axis may be noted by all nations simultaneously. Under the system of cosmopolitan time, it would be everywhere practicable to keep an accurate chronological reckoning without complication or confusion. It is necessary, how-

ever, to consider the points in which all parts of the earth have equally an interest; and it is important to inquire how the scheme of reckoning proposed can be generally adapted to the ordinary requirements of life.

The diurnal return of the prime meridian to a point in the heavens opposite the sun, would mark the common unit-measure of time throughout the world. Its beginning and ending, its twenty-four divisions and its sub-divisions, would each in turn prevail everywhere at the same moment of absolute time. This common measure would, however, completely coincide with the local day of only one meridian. The local days of countless other longitudes would have as little coincidence with the unit-measure as with each other. At the same moment they would all differ; while it would be noon with one, it would be midnight with another, sunrise with a third; and so on.

Men and nations may agree to establish for convenience a common unit-measure of time; but dawn and dusk, light and darkness, will sweep round the globe, following each other in silent yet certain succession, as long as the world lasts—phenomena to prescribe in every land when men shall sleep, and when return to active life. The position of the sun in every local sky will always control domestic usages and continue to govern social customs. Do what we may, the ever changing local day, as it continually progresses from longitude to longitude, will everywhere assert itself and exact recognition.

How then are we to derive any practical good from the advantages which, as a theory, the system of cosmopolitan time appears to promise?

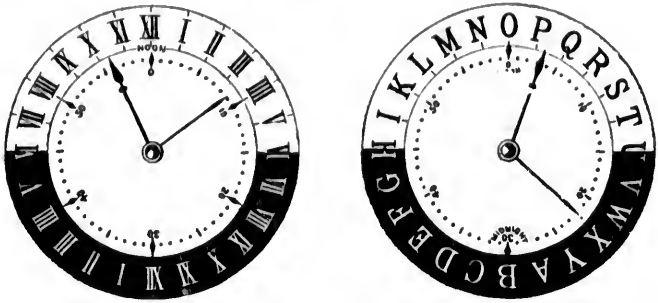
(1) All old customs may be retained for local purposes as at present, the new system being introduced as the means of more accurately reckoning time in connection with telegraphs and steam communication by land and water, and in describing events in which all mankind have a common interest.

(2) On the other hand, the new system may to some extent supersede present customs, and be employed for reckoning local as well as general time.

(3) A compromise may be suggested by which we would have cosmopolitan time as a common measure for reckoning dates and periods of general interest, and a number of sub-standards, each equally related to the common standard, for distinct local time.

It is obvious that to retain the old custom of reckoning hours, and at the same time secure the advantages of the cosmopolitan or non-local system, dual time-keepers, but not necessarily two distinct sets of time-keepers, would be required. This object is attained by having two dials to the one time-keeper, placed, in the case of a watch, back to back, or in the case of a stationary clock, side by side, as in Fig. 2;

FIG. 2.



LOCAL TIME. COSMOPOLITAN TIME.

the instruments being constructed so that the same wheel-work would move the hands of both dials. The figure No. 2 is suggested for a stationary clock; the night half of the dials are shaded.

The dial with the Roman numerals is designed for local time, while the lettered dial is for cosmopolitan or non-local time, to be used in connection with railways, steamboats and telegraphs, and as a record of passing historical events.

It is obvious that if clocks and watches were constructed on these principles, the difficulties and inconveniences which have been alluded to, and which seem inseparable from the present system, would be fully met. Assuming the scheme to be in general use: while local time would be employed for all domestic and ordinary purposes, cosmopolitan time would be used for all purposes not local; every telegraph, every steam line, indeed every communication on the face of the earth, would be worked by the same standard. Every traveller having a good watch, would carry with him the precise time that he would find observed elsewhere. *Post meridian* could never be mistaken for *ante meridian*. Railway and steamboat time-tables would be simplified and rendered intelligible, and no one can claim that such now is the rule.

As an illustration, I present condensed time-tables of the great railway route now being established from London to the Pacific through Canada. Table A is prepared in accordance with the present system. Tables B and C are two different modes of applying the system of cosmopolitan time, and illustrate the simplicity of that system for such purposes. (*Vide* Appendix, No. 1.)

It has been said that the 24 sub-divisions of the unit-measure may be known by letters, in order to be distinguished from local hours. But why use numerals for local hours? Numerals have no special advantage over letters; habit has undoubtedly rendered the former familiar to the mind of this generation in connection with the hour of the day; but if the 24 divisions had to be again named, and letters instead of numerals were adopted, the time of day could be as well expressed and as easily comprehended as at present. On the other hand, letters when arranged in a circle, as on the dial of a clock, have at least this advantage over numerals: they are all symbols of equal importance, and any one letter could be taken to represent the beginning of the series of the 24 which make up the day; while in the case of numerals, the lowest number can only represent the first of the series.

Let us take an illustration of the advantages of letters in connection with the scheme. Suppose *G* to be the noon letter at a particular place, how easy it would be for a resident to comprehend that it was always noon when the hour hands of the clock pointed to *G*; that it was always midnight when they pointed to *T*, the letter on the dial plate opposite to *G*; or, in speaking of any particular time of day, say four hours before mid-day, it would be as easy to comprehend the time referred to by the use of the letter *C* as by the numeral 8. Persons living in that locality would soon become familiar with the relation which the several letters had to the time of day.

Again, if we pass to a locality where another letter *O* becomes the meridian or noon letter, there could be no misunderstanding the meaning of the expression, *Time P. 22.* It could have but one meaning, viz., 1 hour and 22 minutes after mid-day, while 1.22 has a double meaning, undetermined without the addition of "*ante meridian*" or "*post meridian.*"

Thus it may be shown, if we could entirely ignore old practices and begin *de novo*, the nomenclature proposed for cosmopolitan time might very readily be employed for local purposes.

To render the dial plates of time-pieces perfectly intelligible in each place when used for local time, the expedient shown in Fig. 3 might be adopted.

FIG. 3.

LOCAL AND COSMOPOLITAN TIME.

Here the noon and midnight letters are easily distinguished, and that portion of the day which includes the hours of darkness cannot be mistaken. These or similar expedients could be employed with the same effect in the clocks and watches used in every place on the surface of the earth.

It would, however, be vain to assume that the present system could be at once abolished and disregarded. It becomes expedient, therefore, to consider how the advantages of the scheme of cosmopolitan time could be secured in everyday life. It is perfectly obvious that the present system cannot be overlooked; and that, although it may not be always maintained, it must for some time be continued. We must therefore look for some means by which the new notation may be employed in conjunction with the old, until the latter would fall into disuse.

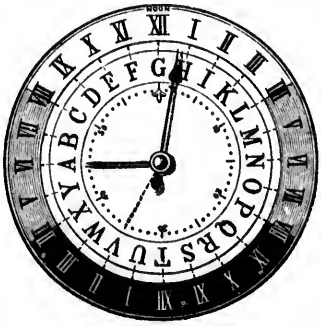
It may be said that local time is almost always more or less arbitrarily established. Our clocks but rarely indicate true local time, and the most perfect time-pieces are for the greater portion of the year either faster or slower than the sun. In fact, correct ordinary time-keepers must necessarily at certain seasons be about 15 minutes faster or slower than true solar time, and no inconvenience whatever is found to result. The adoption of Irish time in England, or English time in Ireland, could not be felt in civil affairs. The difference between English and Irish time, as arbitrarily established, is twenty-five minutes; but in the west of Ireland local mean time is forty minutes, and solar time sometimes fifty-five minutes behind English time (Greenwich). Greenwich time is used

throughout England and Scotland, although it is half an hour faster than local mean time, and sometimes forty-five minutes faster than solar time on the west coast of the latter country.

In every country, local time is more or less arbitrarily established; it could not be otherwise, without causing great confusion, as no two places, unless in the same meridian, have the same true local time. In considering the whole subject, it is felt that if some simple rule could be agreed upon for defining local time everywhere, it would materially add to general convenience.

It is suggested that each of the twenty-four lettered meridians (Fig. 1) should be taken as standards for establishing approximate local time, and that as a general rule all places should adopt the local time of the nearest of these meridians. This would divide the surface of the globe into twenty-four "lunes," forming distinct local sections. Although the twenty-four fixed meridians would be at one hour's distance from each other, only in extreme cases would the difference between the true and approximate local time be as much as half an hour. In many cases there would be no difference, and in no case could the difference be of the slightest moment in the ordinary business of civil life. Whenever exact time was required for any purpose, cosmopolitan time, assuming it to be in general use, would be available, or a third hand, such as shown by the dotted line in the figure, might in certain cases be used.

Fig. 4.



Cosmopolitan Watch Dial.

Fig. No. 4 represents a compound dial designed to indicate non-local as well as local time, on the same face of a clock or watch, by means of one set of hands. In this arrangement it is proposed to have the Roman numerals for local time inscribed on a movable disc,

adjustable for each separate hour, and may thus be set for any one of the twenty-four fixed meridians referred to. The adjustment would be effected without in the least disturbing the machinery of the instrument, or interfering with the index hands.

Church clocks and other stationary time-pieces would have the local time disc permanently secured in the proper position. Only in the case of persons travelling beyond any particular local time section would the local time disc of their watch require to be changed. Its adjustment under such circumstances would be simple; it would only be necessary to move the disc round until 12 o'clock noon coincided with the meridional letter of the new locality. Suppose, for example, the letter *G* represented the longitude of the new position of the watch: 12 noon placed in conjunction with *G* would complete the adjustment of the instrument. For every other new position the same operation would be repeated. Notwithstanding every change that may be made for local time, the machinery of the watch need not be interfered with, and the hands would continue to indicate correct cosmopolitan time. The distinction between cosmopolitan time and local time would always be perfect; the former would invariably be known by letters; the latter, as at present, by the Roman numerals.

As in the diagrams, it is proposed to denote that portion of the day which includes the hours of darkness by a black or dark ground, in order that the night hours could never be mistaken for the hours in the middle of the day, which have the same numerals. The several "watches" into which the day is divided on shipboard might be distinguished. The local time disc exhibits a light portion between 8 a.m. and 4 p.m.; this includes and represents the forenoon and afternoon watches, noon being the dividing point. The dark portion, extending four hours before and four hours after midnight, embraces the two night watches; while the shaded portions, from 4 p.m. to 8 p.m., and from 4 a.m. to 8 a.m., represent the dog watches and the morning watch. This arrangement would perhaps prove useful, in view of the hundreds of thousands who navigate the ocean, and the yearly increasing number of ships that adopt and constantly use this division of the day into "watches," finding it, as they appear to do, the most convenient scheme of division for daily routine at sea.

Other modes of carrying into execution the principles of construction proposed will readily suggest themselves to practical men. (*Vide* Appendix No. 2.) It seems only here necessary to allude to one point. It may be objected that the change of system would render

the clocks and watches in use valueless. But the remedy is simple, as local time may be retained and indicated side by side with cosmopolitan time by altering the dial plates or substituting new ones.

The establishment of twenty-four fixed meridians, as proposed, at one hour's distance from each other, as standards for local time, would secure complete uniformity in the indication of the minutes in all the clocks of the world; the hours of local time only differing. Appendix No. 3 illustrates this feature; it shows simultaneous time at each of the twenty-four standard meridians; local time varying one hour in each case; cosmopolitan time remaining constant.

In this communication I have endeavoured to submit the inconveniences and difficulties inseparable from our present mode of reckoning dates, and from our system of keeping and noting smaller divisions of time. I have referred to the various usages and customs which prevail, and I have drawn special attention to the fact that the application of steam to locomotion by land and sea, and of electricity to the telegraph, literally without limit, has rendered the present practice of reckoning time ill suited to modern life.

It cannot be supposed that these agents of progress have completed their mission. We may rather assume that these extraordinary powers have but commenced their wonderful career, and that they will achieve further triumphs in civilization.

It is in America these agents have been introduced to the greatest relative extent, as the subjoined estimate of the length of railways constructed will show:

	Population.	Miles of Railway.
Asia	824,548,500	7,643
Europe	309,178,300	88,748
Africa	199,921,600	1,451
N. and S. America	85,519,800	83,655
Australasia	4,748,600	1,752
Totals	1,423,917,800	183,248

It has been suggested, that the difficulties already met in portions of America threaten to become increased as the railway system is extended. It may therefore be assumed, that any practicable scheme to effect a remedy would be favourably received. The importance of the subject is not confined to America, for the other quarters of the globe are now or will be similarly interested. Australia and Africa will before long be pierced, perhaps girdled, by railways. Asia, with more than half the population of the world, must in due time follow in the general progress. In North and South America, there is room

for a great increase of railways; but taking the present mileage and population of that continent as a basis, the proportion would give to Europe and Asia together more than one million miles of lines. These two great continents have as yet only 96,000 miles of railway, and it would probably be taking too sanguine a view to suppose that so great an increase will speedily be realized. No one, however, can doubt that the network of railways in Western and Central Europe will before long be greatly enlarged; that branches will extend to Asia; and that off-shoots will ultimately be prolonged to the farthest shores of the Chinese and Russian Empires. A comparatively few years may indeed witness extraordinary progress in this direction, to bring into prominence the difficulties alluded to, and which cannot fail to make themselves felt.

The subject which we are now considering, in different degrees clearly concerns all countries; it is especially important to the United States, Brazil, Canada, indeed to the whole of America. It is important to France, Germany, Austria, and to every nation in Europe. It is of peculiar interest to the gigantic empire of Russia, extending over nearly 180 degrees of longitude, and with a total variation in local time of about twelve hours. It is of still greater importance to the Colonial Empire of Great Britain, with its settlements and stations in nearly every meridian around the entire globe, and with vast territories to be occupied in both hemispheres.

Before the introduction of railways in England, every town and village kept its own time. The traveller found his watch constantly at variance with the local clocks. On the establishment of the railway system this state of things could not be tolerated, as local time could only lead to complication and confusion. The railways demanded uniform time, and Greenwich time came to be used. This was looked upon as an innovation, and was for a considerable period vigorously opposed. At last the advantages of uniform time became so manifest, that Greenwich time came into general use throughout Great Britain.

But for the employment of uniform time in England, Scotland and Ireland, it would be an extremely difficult task to regulate safely the great number of daily trains. The safe working of the railways in the United Kingdom is indeed a problem sufficiently difficult even with uniform time; and we can scarcely conceive how much the problem would be complicated if in Great Britain they were to revert to the system of local time as it prevailed in the days of stage coaches, when every town and hamlet kept its own time.

Among the several objects which the scheme of cosmopolitan time has in view, not the least important is to extend to the world similar advantages to those which have been conferred on Great Britain by the general adoption of uniform time since the commencement of the railway era.

Meteorologists have felt the necessity of some general scheme of reckoning by non-local time, such as that now proposed. The enormous number of meteorological observations recorded in every part of the world are of but little value until accurate allowances are made for the differences in local time. The immense labour involved will be understood when the number of stations and the number of daily and hourly observations are considered. Accordingly, it will be seen that meteorological science would derive great advantages from the general adoption of uniform time.

Navigators are required to employ a standard time to enable them from day to day, when on long voyages, to compute their longitude. For this purpose it is a practice with ships to carry the local time of the national observatory of the country to which they respectively belong. For example: French ships reckon their longitude by Paris time; British ships by Greenwich time. Cosmopolitan time would serve precisely the same purpose as a standard for geographical reckoning, and it would be some advantage to the marine of the world to have a uniform standard established—the common property of all nations, and in common use by land and water everywhere. It has already been said that the telegraph provides the means of securing perfect accuracy at all stations, however remote; indeed, through this agency, time-keepers may be made to beat time synchronously all over the globe. Already the length of telegraph lines in operation approaches 400,000 miles; and we are warranted in believing that ultimately the means of instantaneous communication will ramify through every habitable country, and find its way to every port of commercial importance.

I take the ground that we have entered upon a remarkable period in the history of the human race. Discoveries and inventions continue to crowd upon each other in almost magical succession, and who can tell what progress will be made within the coming fifty years? Steam and electricity are really narrowing the limits of the world. Lines of telegraph and steam communications, the creations of but yesterday, are girdling the earth and bringing the most distant countries into close neighbourhood. In a few years the wire and the

rail will have brought men of all races face to face to intercommunicate knowledge and dispel prejudices. Sooner or later the barbarous custom of dividing the day into two sets of twelve hours, as if 12 was the limit of arithmetical knowledge, will be judged at its right value. The hands of time-keepers pointing in all conceivable directions at the same instant of absolute time will be held as an extraordinary anomaly, and steps will be taken to avoid the spectacle of men at the one moment nominally living in different hours, in different days, and in some extreme cases in different months and years.

The system of chronometry which we have inherited may have been well suited to the purpose for which it was designed long centuries ago, when the known world was confined within the pillars of Hercules, or it may even have answered all the requirements of man a few generations back, before the great modern civilizers, steam and electricity, began their work. Now we realize the fact that the system is awkward and inconvenient. In a few years—and who can count them—may we not find a radical change imperatively demanded by the new conditions of the human race.

It is probably not now unseasonable to discuss the subject. It would be a vain task to attempt at once to abolish a custom so hoary with age, and so generally practised as our system of computing time. But the necessity of change once admitted, the public mind will gradually become familiar with the idea, and will learn to welcome any modification in the system when its expediency is established.

But it will be important first to determine the extent of the required modification. The scheme should be well considered so as to be free from the imperfections which result from haste. It should be rendered generally acceptable, so that whenever the necessity arises in any country or community for its introduction, it may be spontaneously adopted; the inhabitants feeling assured that they were selecting a system eventually to become universal.

The suggestions I have ventured to offer are presented with the view of drawing attention to the subject. They point to the establishment of a common prime meridian as the first important step, and as the key to any cosmopolitan scheme of reckoning. This step taken, the more progressive nations would probably promote the establishment of a comprehensive system of chronometry suitable to every condition of civilization, and advantageous to the inhabitants of the globe on every line of longitude and on every parallel of latitude.

APPENDIX No. 1.

Condensed time-tables, illustrative of the application of the cosmopolitan system of time-reckoning, to railway and steamboat communications. The great mail and passenger route now being established through Canada is selected as an example. Table A is arranged according to the present system. Table B is arranged for cosmopolitan time. Table C is arranged for local time standards, established by lettered meridians 15° of longitude apart, each varying one hour. The hours of the day are numbered from 1 to 24 instead of two sets from 1 to 12.

TABLE A.—*Arranged according to the present system.*

Principal Stations.	Local Time.		Slower than Greenwich.
London	8.00 p.m.	Greenwich time	0.00
Dublin	8.00 a.m.	Irish time	0.25
(*en route*)	1st noon	Irish time	"
W. Coast Ireland	1.00 p.m.	Irish time	"
(*at sea*)	2nd noon	Ship's time	1.00
(*at sea*)	3rd noon	Ship's time	1.40
(*at sea*)	4th noon	Ship's time	2.20
(*at sea*)	5th noon	Ship's time	3.00
St. John, Newfoundland	9.00 a.m.	Newfoundland time	3.30
(*en route*)	6th noon	Newfoundland time	"
St. George, Newfoundland	6.00 p.m.	Newfoundland time	"
Shippigan	10.00 a.m.	New Brunswick	4.30
(*en route*)	7th noon	New Brunswick	"
Riv. du Loup	10.00 p.m.	Quebec time	5.00
Quebec	2.00 a.m.	Quebec time	"
Montreal	8.00 a.m.	Quebec time	"
(*en route*)	8th noon	Quebec time	"
Ottawa	1.00 p.m.	Quebec time	"
Nippising	8.30 p.m.	Huron time	5.30
L. Superior	10.00 a.m.	Superior time	6.00
(*en route*)	9th noon	Superior time	"
Fort William	3.30 p.m.	Superior time	"
Keewatin	1.30 a.m.	Manitobah time	6.30
Selkirk	6.00 a.m.	Mantiobah time	"
(*en route*)	10th noon	Mantiobah time	"
Livingston	3.00 p.m,	Saskatchewan time.	7.00
Saskatchewan	9.30 p.m.	Saskatchewan time.	"
Battleford	1.00 a.m.	Athabasca time	7.30
Edmonton	9.20 a.m.	Athabasca time	"
(*en route*)	11th noon	Athabasca time	"
Montbrun	2.15 p.m.	Athabasca time	"
Yellow Head Pass	7.00 p.m.	Rocky Mount'n time	8.00
Tete Jaune Cache	8.15 p.m.	Rocky Mount'n time	"
(*en route*)	12th noon	Rocky Mount'n time	"
Pacific Ocean	11.30 p.m.	B. Columbia time	8.30

TABLE B.

Arranged for Cosmoplitan Time.

Principal Stations.	Cosmopolitan Time.
London	P. 00
Dublin	C. 25
1st *Noon* (*en route*)	G. 25
W. Coast Ireland	H. 25
2nd *Noon* (*at sea*)	H. 00
3rd *Noon* (*at sea*)	H. 40
4th *Noon* (*at sea*)	I. 20
5th *Noon* (*at sea*)	K. 00
St. John, Newfoundland	G. 30
6th *Noon* (*en route*)	K. 39
St. George, Newfoundland	R. 00
Shippigan	I. 30
7th *Noon* (*en route*)	L. 30
Riv. du Loup	W. 00
Quebec	B. 00
Montreal	H. 00
8th *Noon* (*en route*)	M. 00
Ottawa	N. 00
Nippising	V. 00
L. Superior	L. 00
9th *Noon* (*en route*)	N. 00
Fort William	Q. 30
Keewatin	C. 00
Selkirk	G. 30
10th *Noon* (*en route*)	O. 00
Livingston	R. 00
Saskatchewan	X. 30
Battleford	C. 30
Edmonton	M. 00
11th *Noon* (*en route*)	P. 00
Montbrun	Q. 45
Yellow Head Pass	W. 00
Tete Jaune Cache	X. 15
12th *Noon* (*en route*)	P. 30
Pacific Ocean	W. 30

TABLE C.

Local Time Standards, established one hour apart.

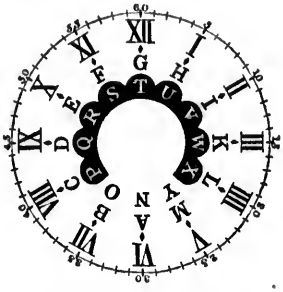
Principal Stations.	Local Time.	
	Hours.	By Standard.
London	20.00	M.
Dublin	8.25	"
1st *Noon* (*en route*)	12.00	"
W. Coast Ireland	13.25	"
2nd *Noon* (*at sea*)	12.00	N.
3rd *Noon* (*at sea*)	12.00	O.
4th *Noon* (*at sea*)	12.00	O.
5th *Noon* (*at sea*)	12.00	P.
St. John, Newf'dland	8.30	Q.
6th *Noon* (*en route*)	12.00	"
St. George, Newf'dland	17.30	"
Shippigan	9.30	R.
7th *Noon* (*en route*)	12.00	"
Riv. du Loup	22.00	"
Quebec	2.00	"
Montreal	8.00	"
8th *Noon* (*en route*)	12.00	"
Ottawa	13.00	"
Nippising	20.30	"
L. Superior	10.00	S.
9th *Noon* (*en route*)	12.00	"
Fort William	15.30	"
Keewatin	1.00	T.
Selkirk	5.30	"
10th *Noon* (*en route*)	12.00	"
Livingston	15.00	"
Saskatchewan	21.30	"
Battleford	1.30	"
Edmonton	10.00	"
11th *Noon* (*en route*)	12.00	V.
Montbrun	13.45	"
Yellow Head Pass	19.00	"
Tete Jaune Cache	20.15	"
12th *Noon* (*en route*)	12.00	"
Pacific Ocean	11.00	"

APPENDIX No. 2.

The application of the proposed Scheme of Time-reckoning to the practice of Daily Life.

Reference has been made to the means by which cosmopolitan time may be indicated by ordinary time-pieces. This may be accomplished by inscribing the proper letters on the dials of clocks and watches now in use. A still better expedient would be to substitute new dials, such as Fig. 5. In this, the letters which represent the night hours in any particular locality are on a dark ground.

Fig. 5.



By a simple expedient of this description it could be practicable, without superceding the old time-keepers, to secure the advantages of the new scheme, in any country of comparatively limited extent.

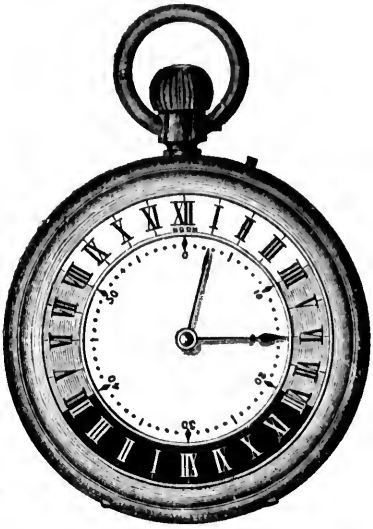
Clocks and watches in use might thus be utilized and made to show cosmopolitan, in addition to local time. It would be only necessary to prepare railway and steam-boat time-tables in accordance with the new system, to bring its advantages into common use. But this would apply only to stationary clocks, or to watches in use in countries limited in extent. The improvement would not be general until time-keepers for ordinary purposes, and especially watches, were constructed on new principles. A general change could only be gradually effected; but as there are hundreds of thousands of watches and chronometers made every year, in the event of the subject being deemed worthy of attention, it would be well for manufacturers to consider the expediency of introducing some change in the construction of them.

There are various methods by which the principles set forth may be applied, and these will readily suggest themselves to prac-

tical men. Simply to illustrate one mode, Figures 6 and 7 are supplied.

Fig. 6.

Fig. 7.



The object is to indicate cosmopolitan and local time by the same watch. Fig. 6 shows the watch case open, with the dial for cosmopolitan time exposed. Fig. 7 shows the watch case closed, with the local time numerals engraved on the face of the case, the latter being pierced in order that the hands may be seen. The local time disc is designed to be adjustable for any one of the 24 lettered meridians. By this arrangement only the local hours would vary; there would be a complete coincidence in the minutes of cosmopolitan and local time at every station. The application of double dials to a watch may be effected in another manner. The watch may have two faces back to back; one for for cosmopolitan time, the reverse for local time, the hands in both instances being moved by the same wheelwork, and those for local time supplied with the means of adjustment for change of longitude.

The latter plan has advantages peculiar to itself. Other methods of construction may be proposed, but it is unnecessary; the present object is simply to show that there is no practical difficulty in the way of carrying the scheme of time reckoning set forth in the accompanying paper into the practice of daily life.

APPENDIX No. 3.

Illustrating Simultaneous Time at each of the twenty-four lettered meridians proposed as Local Standards; Local Time differing one hour in each case; Cosmopolitan Time remaining constant.

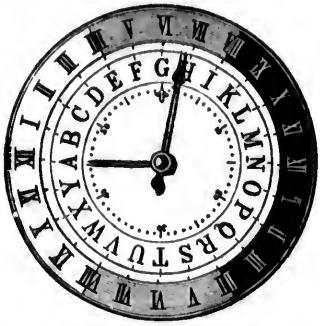
MERIDIAN A.

Local time ..... 6.45 p.m.

Cosmopolitan time ..... G. 45

Longitude (proposed new reckoning) ..... 15°

Longitude, old style ..... 165° East.



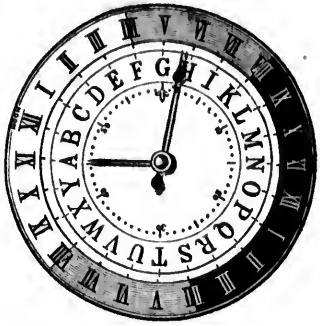
MERIDIAN B.

Local time ..... 5.45 p.m.

Cosmopolitan time..... G. 45

Longitude ..... 30°

Longitude, old style . 150° East.



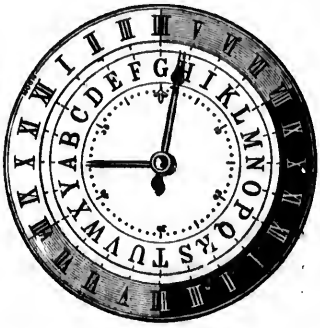
MERIDIAN C.

Local time ..... 4.45 p.m.

Cosmopolitan time..... G. 45

Longitude ..... 45°

Longitude, old style ..... 135° East.



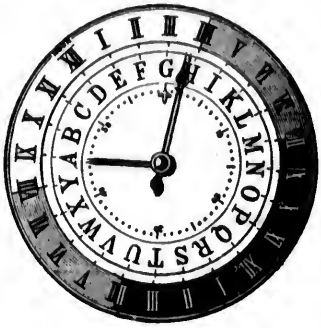
MERIDIAN D.

Local time ..... 3.45 p.m.

Cosmopolitan time..... G. 45

Longitude ..... 60°

Longitude, old style ..... 120° East.



MERIDIAN E.

Local time ..... 2.45 p.m.

Cosmopolitan time..... G. 45

Longitude ..... 75°

Longitude, old style ..... 105° East.

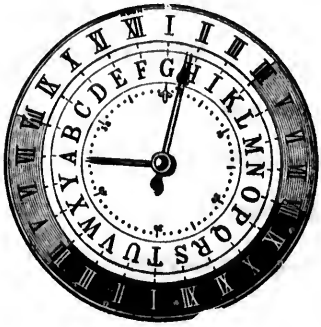
MERIDIAN F.

Local time ..... 1.45 p.m.

Cosmopolitan time..... G. 45

Longitude ..... 90°

Longitude, old style ..... 90° East.



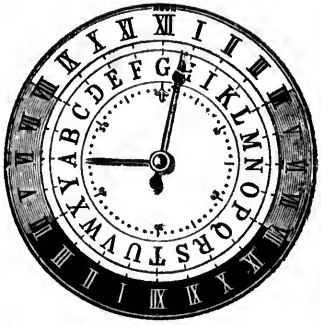
MERIDIAN G.

Local time ..... 12.45 p.m.

Cosmopolitan time..... G.

Longitude ..... 105°

Longitude, old style ..... 75° East.



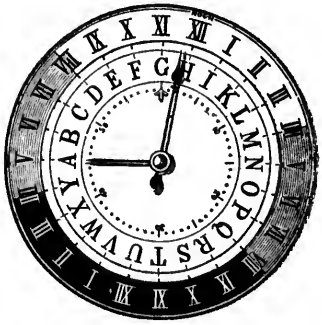
MERIDIAN H.

Local time ..... 11.45 a.m.

Cosmopolitan time..... G. 45

Longitude ..... 120°

Longitude, old style .... 60° East.



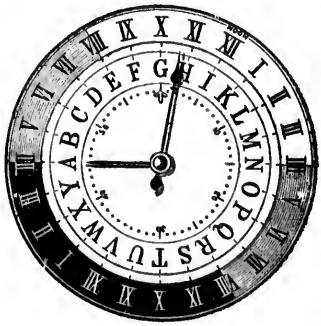
MERIDIAN I.

Local time ..... 10.45 a.m.

Cosmopolitan time..... G. 45

Longitude ..... 135°

Longitude, old style ..... 45° East.



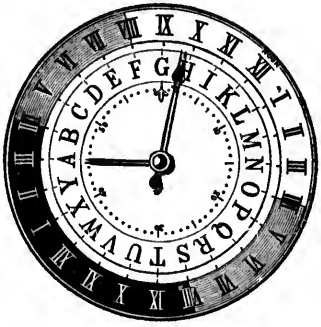
MERIDIAN K.

Local time..... 9.45 a.m.

Cosmopolitan time ..... G. 45

Longitude ..... 150°

Longitude, old style ..... 30° East.



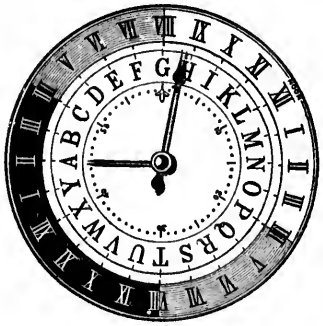
MERIDIAN L.

Local time..... 8.45 a.m.

Cosmopolitan time ..... G. 45

Longitude ..... 165°

Longitude, old style ..... 15° East.



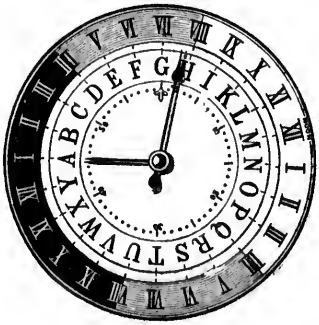
MERIDIAN M.

Local time..... 7.45 a.m.

Cosmopolitan time ..... G. 45

Longitude ..... 180°

Longitude, old style..... 0° Greenwich



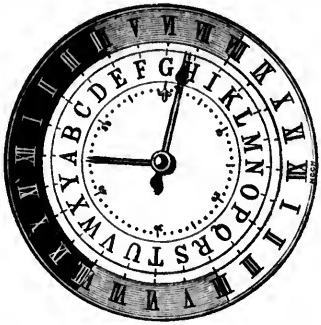
MERIDIAN N.

Local time ..... 6.45 a.m.

Cosmopolitan time..... G. 45

Longitude ..... 195°

Longitude, old style ..... 15° West.



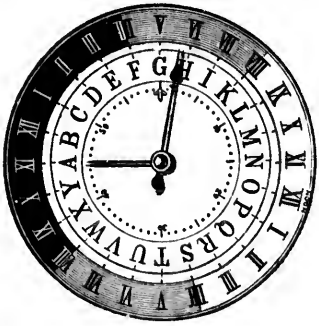
MERIDIAN O.

Local time ..... 5.45 a.m.

Cosmopolitan time..... G. 45

Longitude ..... 210°

Longitude, old style ..... 30° West.



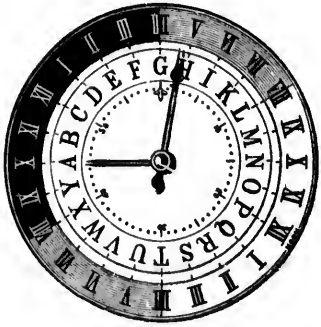
MERIDIAN P.

Local time ..... 4.45 a.m.

Cosmopolitan time..... G. 45

Longitude ..... 225°

Longitude, old style ..... 45° West.



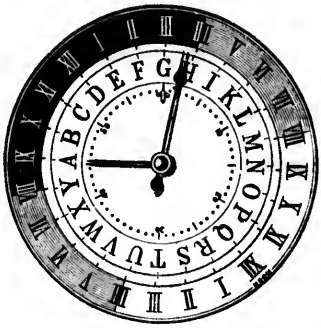
MERIDIAN Q.

Local time ..... 3.45 a.m.

Cosmopolitan time..... G. 45

Longitude ..... 240°

Longitude, old style ..... 60° West.



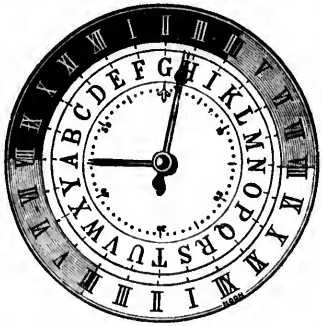
MERIDIAN R.

Local time ..... 2.45 a.m.

Cosmopolitan time..... G. 45

Longitude ..... 255°

Longitude, old style..... 75° West.



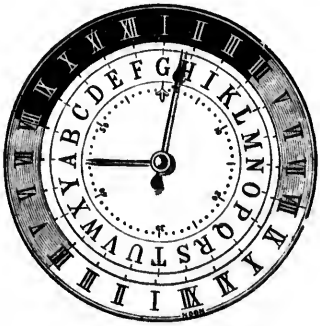
MERIDIAN S.

Local time ..... 1.45 a.m.

Cosmopolitan time..... G. 45

Longitude ..... 270°

Longitude, old style ..... 90° West.



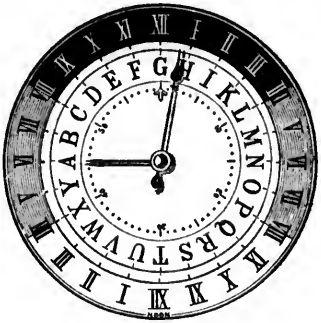
MERIDIAN T.

Local time..... 12.45 a.m.

Cosmopolitan time ..... G. 45

Longitude ..... 285°

Longitude, old style..... 105° West.



MERIDIAN U.

Local time..... 11.45 p.m.

Cosmopolitan time ..... G. 45

Longitude ..... 300°

Longitude, old style..... 120° West.

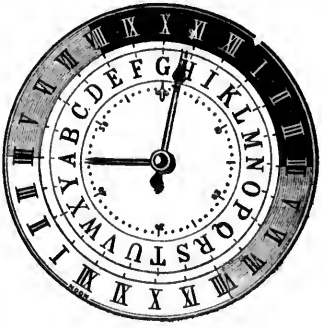
MERIDIAN V.

Local time..... 10.45 p.m.

Cosmopolitan time ..... G. 45

Longitude ..... 315°

Longitude, old style..... 135° West.



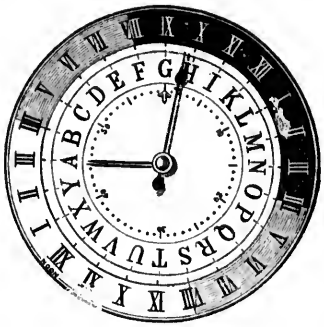
MERIDIAN W.

Local time..... 9.45 p.m.

Cosmopolitan time ..... G. 45

Longitude ..... 330°

Longitude, old style ..... 150° West.



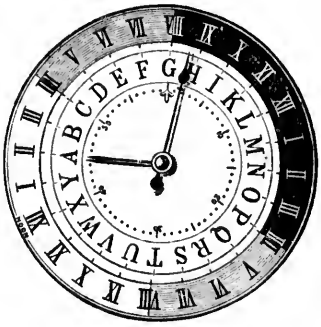
MERIDIAN X.

Local time..... 8.45 p.m.

Cosmopolitan time ..... G. 45

Longitude ..... 345°

Longitude, old style ..... 165° West.



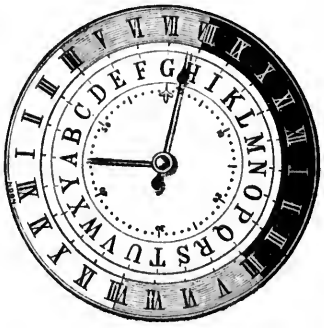
THE PRIME MERIDIAN.

Local time..... 7.45 p.m.

Cosmopolitan time ..... G 45.

The Common Zero of Longitude 0°

Longitude, old style, 180° East & West.



LONGITUDE AND TIME-RECKONING.

A FEW WORDS ON THE SELECTION OF A PRIME MERIDIAN TO BE COMMON TO ALL NATIONS, IN CONNECTION WITH TIME-RECKONING.

BY SANDFORD FLEMING, C.M.G., ETC.

In another paper which I have submitted to the Institute, it has been stated that the only means of obviating the confusion inseparable from the present system of reckoning dates, is to measure time by the absolute diurnal revolutions of the earth.

By the system now followed, we count days by the consecutive passage of the sun over the meridian of each spot on the earth's surface. The number of spots around the globe may be said to be infinite, and accordingly the duration of the day, as it is locally distinguished, considered in relation to absolute time, is marked by an equally infinite variety.

It has been argued that the earth should be considered as a whole, and that its mean diurnal revolution should be the unit measure for reckoning dates; and this theory points to the consideration of the necessity of establishing a common prime meridian.

If we were placed in some neutral position, such as the earth's centre, or its poles, and were called upon to determine the time occupied by a diurnal revolution, we could fix on a point arbitrarily chosen in a circle inscribing the earth's axis, and note the time between two consecutive passages of the sun over that point. A plane passing through that point and the poles, extended to the surface of the globe, would establish a first or prime meridian from which longitude may be reckoned.

The establishment of an initial or prime meridian as the recognized starting point of time-reckoning by all nations, affects the whole area of civilization, and conflicting opinions may arise concerning its position. Its consideration must therefore be approached in a broad, cosmopolitan spirit, so as to avoid offence to national feeling and prejudice.

As far as practicable, the interests of all nations should be consulted in its choice, and the principle should be recognized, that the first meridian should be determined in accordance with the views of the greatest possible number.

Although the general acceptance of a common meridian for reckoning longitude has long been desired, unanimity has in no way been attained.

The meridians passing through the following points are more or less in use at the present time, viz.: Cadiz, Christiania, Copenhagen, Ferro, Greenwich, Lisbon, Naples, Paris, Pulkova, Rio de Janeiro, Stockholm, and Washington.

Several other meridians have at different times been used, or proposed to be used, for the computation of longitude. Ptolemy, to whom we are indebted, along with Marinus, for introducing the terms 'longitude' and 'latitude,' drew the first meridian through the Insulæ Fortunatæ, or Canary Islands, as the western limit of the earth's boundaries of his time; the exact position is not known with certainty.

According to Malte Brun, Louis XIII. of France, in order to render the manner of expressing longitude in French geography uniform, ordered, by an express declaration, that the first meridian should be placed in the Isle of Ferro, the most western of the Canaries. Delisle, one of the first who endeavoured to give precision to geographical determinations, fixed the longitude of Paris 20 degrees east of that meridian. When, by more rigorous observations, it was known that the difference of longitude between Paris and the principal town of the Isle of Ferro was 20° 5′ 50″, it was necessary to advance the first meridian 5′ 50″ to the east of that point, so that it is now a circle of mere convention, which passes through no remarkable point.

Geographers at one time established the first meridian at the island of St. Nicholas, near Cape Verd; others at the isle of St. James. Gerard Mercator, who lived in the sixteenth century, selected the meridian passing through the Island del Corvo, one of the Azores, on account, it is said, of the magnetic needle pointing due north at that time. It was not then known that the needle itself was subject to variations. The Dutch placed their first meridian at the Peak of Teneriffe. The Spaniards have chosen Cadiz. The British formerly used Cape Lizard, but subsequently selected Greenwich Observatory, near London. The Russians, Pul-

kova, near St. Petersburg. Washington was adopted by the United States, and the charts of that country are still constructed with Washington as a first meridian, although Greenwich is now used for reckoning longitude by all sea-going ships carrying the United States flag. The Italians selected Naples; and ships of the empire of Brazil reckon in part from Rio de Janeiro.

An earnest desire has frequently been expressed for the determination of one prime meridian common to all nations, but all attempts for its establishment have failed. On all sides there has been an adherence, with more or less tenacity, to the arbitrary zeros adopted or suggested by the national navigators. Recommendations have however from time to time been made in the general interests of science, which is unconfined by national boundaries and unprejudiced by national vanity. Some astronomers have proposed Alexandria, from its being the place to which Ptolemy's observations and computations were reduced. The Great Pyramid has also been proposed as the point through which the world's prime meridian should be drawn; it has found an earnest advocate in Professor Piazzi Smyth, Astronomer Royal for Scotland.

Other astronomers have proposed that a meridian should be established from celestial phenomena, so that national sensitiveness shall in no way be hurt. Laplace recommended the adoption of a universal first meridian, upon which it was 12 o'clock when the sun entered the point of the vernal equinox in the year 1250, in which the apogee of the earth's orbit coincided with the solsticial point in Cancer. According to Maury, such a universal meridian would pass about 8 miles west of Cape Mesurada, on the coast of Africa.

This initial meridian was favoured by Herschel. It is certainly suggested by no local circumstances such as noon or midnight, or by the observatory or metropolis of any nation. Its determination is made solely by the motion of the sun among the stars, in which all the nations of the earth have a common interest. Herschel designated the time reckoned by this meridian "Equinoctial time." But this meridian possesses no one advantage not common to all other meridians, beyond being perfectly free from national relationships.

The initial meridian for the world should be chosen for other reasons than any of those which, as far as I know, have yet been advanced. In another place I have shown that it would be the separating line on the surface of the earth, between two consecutive

diurnal revolutions; that is to say, between one cosmopolitan date (or day) and another. It would be, therefore, inexpedient to have it passing through London or Washington, or Paris, or St. Petersburg, or indeed through the heart of any populous or even inhabited country. We must seek for a position free from this characteristic.

We should look for a meridian, if possible, to pass through no great extent of habitable land, so that hereafter the whole population of the world would follow a common time-reckoning; and simultaneous human events would be chronicled by concurrent dates. If we examine the terrestrial globe, we shall find that two, and only two, limited sections of the sphere present themselves with these qualifications.

A meridian may be drawn through the Atlantic Ocean, so as to pass Africa on the one side and South America on the other without touching any portion of either continent, avoiding all islands and all land except a portion of eastern Greenland.

The configuration of the continents will also admit of a meridian being similarly drawn in the opposite hemisphere so as to pass through Behring's Strait, and through the whole extent of the Pacific Ocean without touching dry land.

Either of these meridians would serve the desired purpose, but a meridian in close proximity to Behring's Strait suggests itself as the most eligible.

It must be admitted that the establishment of a common prime meridian should be so determined that, if at all practicable, one of the several systems of the divisions of longitude now employed might be maintained. It would be a still greater advantage if the new initial meridian could harmonize with the longitudinal divisions most in use in the navigation of the high seas.

If we refer to the map of the world, we find that the *anti* or *nether* meridians of some of the capitals of Europe pass at no great distance from Behring's Strait, and the addition or subtraction of 180° would, in any one case, be a ready means of harmonizing the proposed new zero with the old reckoning of longitude. Six of these places are at present employed as prime meridians, viz.:

1. Christiania.
2. Copenhagen.
3. Greenwich.
4. Naples.
5. Paris.
6. Stockholm.

The following table, prepared from the latest authorities within reach, gives an estimate of the number and tonnage of steamers and

sailing ships belonging to the several nations of the world; likewise the first meridians which they use in ascertaining their longitude:

Country.	Ships of all Sorts.		First Meridians Used.
	Number.	Tonnage.	
Great Britain and the British Colonies	20,938	8,696,532	Greenwich.
United States ..	6,935	2,739,348	Greenwich.
Norway	4,257	1,391,877	Christiania and Greenwich.
Italy	4,526	1,430,895	Naples and Greenwich.
Germany	3,380	1,142,640	Ferro, Greenwich and Paris.
France	3,625	1,118,145	Paris.
Spain	2,968	666,643	Cadiz.
Russia.....	1,976	577,282	Pulkova, Greenwich and Ferro.
Sweden	2,151	462,541	Stockholm, Greenwich and Paris.
Holland	1,385	476,193	Greenwich.
Greece.....	2,036	424,418	
Austria	740	363,622	Greenwich and Ferro.
Denmark	1,306	245,664	Copenhagen, Paris and Greenwich.
Portugal.....	491	164,050	Lisbon.
Turkey	348	140,130	
Brazil, &c., S. America	507	194,091	Rio de Janeiro and Greenwich.
Belgium	50	38,631	Greenwich.
Japan, &c., Asia.	78	39,391	Greenwich.
	57,697	20,312,093	

Taking these returns as a basis, it is roughly estimated that the shipping of the world reckon their longitude from the meridian of the several points mentioned in the following proportions, viz.:

From	Ships of all Kinds.		Per Cent.	
	Number.	Tonnage.	Ships.	Tonnage.
Greenwich	37,663	14,600,972	65	72
Paris	5,914	1,735,083	10	8
Cadiz	2,468	666,602	5	3
Naples.....	2,263	715,448	4	4
Christiania.....	2,128	695,988	4	3
Ferro	1,497	567,682	2	3
Pulkova	987	298,641	1½	1½
Stockholm	717	154,180	1½	1
Lisbon.....	491	164,000	1	1
Copenhagen	435	81,888	1	½
Rio de Janeiro	253	97,040	½	½
Miscellaneous	2,881	534,569	4½	2½
	57,697	20,312,093	100	100

It thus appears that of the total commerce of the world which in a greater or less degree bases its system of navigation on eleven different first meridians for the reckoning of longitude, 65 per cent. of the number of ships, and 72 per cent. of the total tonnage, compute their longitude east and west of Greenwich.

The United States of America at one time used the meridian of Washington. But the importance of having a common zero of measurement has been felt to be so great, that practical effect has been given to the idea, on the part of the United States, by all sea-going ships of the Republic, giving up Washington, and adopting the meridian of Greenwich. Russia, Norway, Holland, Belgium and Japan have taken the same course, and Germany, Sweden, Austria and Denmark have partially done so.

It is accordingly clear that of the six places mentioned, the nether meridians of which are convenient to Behring's Strait, Greenwich takes the first position with respect to the number and tonnage of ships navigating by it. The six several places, as far as known, seem to stand in the following order, viz.:

	SHIPS.	TONNAGE.
Greenwich	37,663	14,600,972
Paris	5,914	1,735,083
Naples	2,263	715,448
Christiania	2,128	695,988
Stockholm	717	154,180
Copenhagen	435	81,888

The meridian drawn 180° east and west of Greenwich crosses a small angle of Kamtschatka, immediately on the western side of Behring's Strait; with this exception, it passes over no land between the Arctic and Antarctic circles. The foregoing shows clearly that it is, of all the meridians, the one which would best accommodate the greatest number and tonnage of the world's shipping. By the adoption of this as a common prime meridian, there would be no disarrangement in the charts, the nautical tables, or the descriptive nomenclature of nearly three-fourths of the ships navigating the high seas. The same lines of longitude would be traced on the maps, although differently notated. The necessity would simply arise of falling back on the familiar phrases of 'new style' and 'old style,' first applied in connection with chronological dates in England in

1752—the year when popular prejudice was met, and the calendar reformed.

The following table will show all the change that would be callep for in notating the degrees of longitude. It will be observed that the table is limited to the twenty-four lettered meridians elsewhere alluded to:

Hour Meridian.	Longitude.	
	New Style.	Old Style.
Prime Meridian	Zero	180° E. & W. of Greenwich
A	15°	165° E. of Greenwich.
B	30°	150° E. "
C	45°	135° E. "
D	60°	120° E. "
E	75°	105° E. "
F	90°	90° E. "
G	105°	75° E. "
H	120°	60° E. "
I	135°	45° E. "
K	150°	30° E. "
L	165°	15° E. "
M	180°	0° Greenwich
N	195°	15° W. of Greenwich.
O	210°	30° W. "
P	225°	45° W. "
Q	240°	60° W. "
R	255°	75° W. "
S	270°	90° W. "
T	285°	105° W. "
U	300°	120° W. "
V	315°	135° W. "
W	330°	150° W. "
X	345°	165° W. "
Prime Meridian	360 or Zero	180° W. "

But a proposal of this character cannot be effected without much discussion. Such a change must be the work of time, for it is to be feared that much passive if not active opposition would have to be overcome before general concurrence be obtained. Whatever benefits a measure may promise, there will always be those who fail to recognize the anticipated advantages; and there are generally not a few who consider it a duty to combat the least innovation on existing practices. The object of these remarks, however, is to show that there is no impediment to the establishment of a prime meridian for the world unmarked by national pre-eminence, a meridian in itself admirably adapted for the important purposes referred to in connection

with the notation of time, and the accurate reckoning of chronological dates in every country on the surface of the earth.

The advantages to be derived, with the complications and confusion to be avoided, have been elsewhere set forth. Suffice it to say here, the object to be attained is the establishment of a more accurate and more convenient system of time-reckoning than now obtains. It is not proposed to interfere in the least with the local divisions—the weeks and the days of the week. The week is an arbitrary division, but it has been recognized by man from remote antiquity, and it is a period recorded in the earliest teachings of religion and history.

Amongst the many changes which were violently enforced by the French Revolution, there was perhaps none that more shocked public sentiment than the alteration of the ancient calendar by the substitution of a ten-day period for a seven day period. The week, as well as the week day, has become an integral part of our civilization, and we must accept both as unalterable. As regards the earth as a whole, both are governed by local and superficial phenomena occurring in perpetual succession around the circumference of the sphere; yet this is no barrier to the establishment of a mode of scientific reckoning determined in harmony with them, and cosmopolitan in its character. The aim is to introduce a scheme whereby years and months, hours, minutes and seconds, at all the meridians of the globe, shall be practically as well as theoretically concurrent; for the division will be based on the one unit measure, an established period in absolute time. However variable may be the ordinary weeks and week days as they occur in different localities around the globe, the effort is to secure to mankind, by a simple uniform system of universal application, the means of truly notating dates, and recording events as they transpire.

To accomplish this end, the first requisite is that each revolution of the globe on its axis be defined by a line of demarcation on the earth's surface acceptable to all nations. The interval of time between two consecutive passages of the sun over this line would denote the unit measure. By whatever name they may be known, the number of these units, from the commencement of a month or of a year, would indicate any particular date, common to all. The unit measure would be divided into twenty-four. These divisions repre-

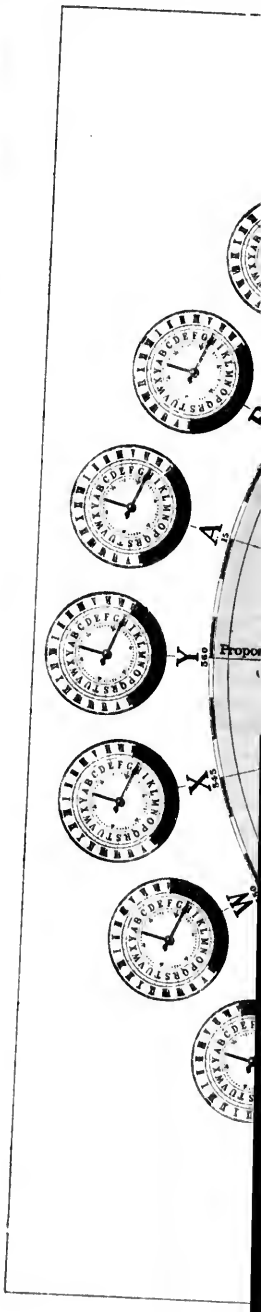
sented on the surface of the globe by twenty-four fixed meridional lines, at one hour's distance from each other, would establish the standards for local time everywhere. Perfect uniformity would thus be secured in all the clocks in the world. The minutes, and indeed all the sub-divisions of time, would be concurrent; the local numbers of the hours only would differ.*

The position of the twenty-four secondary meridians is governed by the selection of a primary meridian; and hence the first step to the consummation of the scheme is the establishment of an initial meridian as a common starting point.

Is it too much to affirm that the meridian suggested will fully meet every requirement? To the writer it seems, that with the concurrence of those nations acknowledged as the fountain heads of civilization, it might at once take the place of all other initial meridians which have hitherto been employed. It could be established without any clashing with existing customs, or any violent departure from the rules and practices and traditions of the great majority of mariners. By its adoption the expression so familiar to us, "the longitude of Greenwich," would simply pass out of usage, and some other name take its place. There would be no favoured nation, no gratification of any geographical vanity. A new prime meridian so established would be essentially cosmopolitan, and would tend towards the general benefit of humanity. As the line of demarcation between one date and another it would be of universal interest, and a property common to the hundreds of millions who live on the land, and the hundreds of thousands who sail on the sea.

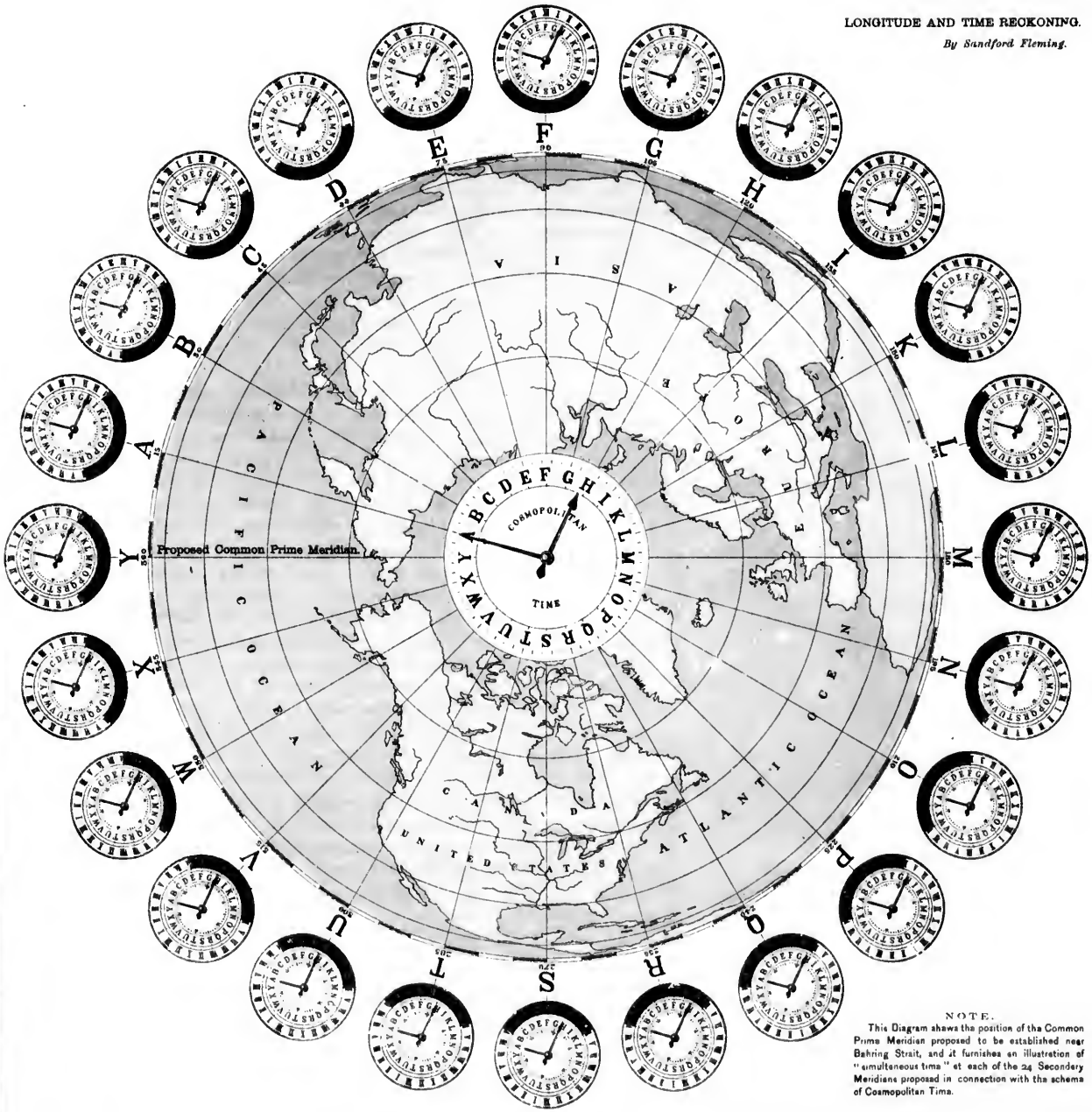
Since the foregoing was written, I have seen the weekly edition of the *Times* of the 17th ultimo. (Jan. '79). The following extract

* One of the unavoidable, results might be held to be objectionable, but, it may prove less disadvantageous than anticipated. Only on one meridian would the ordinary local day correspond with the unit of time. 15° west of that meridian it would be one hour later, 30° west it would be two hours later; and for each 15° degrees of westing one hour later still. Thus the epoch of change from one cosmopolitan date to another would occur at midnight in one locality, at noon in another, at six a.m. at a third, and at every hour of the 24, as the longitude would determine. This peculiarity would doubtless be felt to be an inconvenience during a brief interval of transition from the present to the new system. The accompanying plate illustrates the variation of changes, and shows that, while cosmopolitan time would be absolutely identical in every locality, local time would vary one hour at each fixed local standard around the circumference of the globe.



LONGITUDE AND TIME RECKONING.

By Sandford Fleming.



NOTE.

This Diagram shows the position of the Common Prime Meridian proposed to be established near Behring Strait, and it furnishes an illustration of "simultaneous time" at each of the 24 Secondary Meridians proposed in connection with the scheme of Cosmopolitan Time.

PHOTO. LITH. BY THE BURLAND DESBARATS LITH. CO. MONTREAL.

which it contains shows that the subject we have been considering is engaging the attention of eminent geographers in Europe:

"A New First Meridian.—It is admitted by geographers that the present variety of 'first meridians' is extremely embarrassing and not conducive to accuracy. A good many proposals have been made recently for the establishment of a common first meridian for all countries, but, as one might expect, there is a want of agreement as to what line should be chosen. The question was taken up at the last International Congress of Geography at Paris, and among the contributions to the subject was a paper by M. Bouthillier de Beaumont, President of the Geographical Society of Geneva. The subject was brought on a former occasion before the Antwerp Geographical Congress, where it was very thoroughly discussed by competent geographers. The proposal, however, did not receive more than expressions of sympathy and encouragement. To propose, as M. de Beaumont says, to take the meridian of Greenwich or any other national meridian as the initial one, is not to advance the question; rather, it leaves it *in statu quo*. Nor would it be a happy solution to take the old meridian of Ferro, abandoned by the chief maritime nations and presenting peculiar difficulties in its actual position. At the Congress of Paris of 1875 Jerusalem was proposed, a proposal more creditable to the heart than the head of the professor. Now M. de Beaumont asks: 'Does there exist and can we find a meridian which, by its position on the earth, is sufficiently determined to be taken as the initial meridian, solely on account of its natural and individual character?' In reply he draws attention to the meridian passing through Behring's Strait, as satisfying beyond any other this demand. It is now the 150th meridian west of the island of Ferro, or 30 deg. E., or 10 deg. E. of Paris. This meridian, M. de Beaumont maintains, can be very easily connected with works based on the principal meridians of Ferro, Paris, Greenwich, &c. It touches the extremity of the American continent at Cape Prince of Wales; traverses, on the one hand, the whole length of the Pacific without touching any land, and, on the other, all Europe, through its centre, from the top of Spitzbergen, passing Copenhagen, Leipsic, Venice and Rome; then cuts the African continent from Tripoli to Cape Frio, about 18 deg. S. lat. M. de Beaumont urges several advantages on behalf of this new meridian. It would cut Europe into east and west, thus giving emphasis to a division which has been tacitly recognized for ages; it presents about the largest possible terrestrial arc, from 79 deg. N. to 18 deg. S. lat., 97 degrees altogether, thus giving to science the longest continuous line of land as a basis for astronomical, geodetic, and meteorological observations, and other important scientific researches. Passing as it would through a great number of States, it would become a really international meridian, as each nation might establish a station or observatory on the line of its circumference. Such a meridian M. de Beaumont proposes to call mediator, on the analogy of equator. This proposal of M. de Beaumont is strongly approved by the eminent French geographer, M. E. Cortambert, and has received considerable support from other continental geographers. Whether M. de Beaumont's particular proposal be generally accepted or not, there can be no doubt of the

advantage of having some common international arrangement as to a common meridian for geographical purposes at least."

It is somewhat remarkable that the important query of M. de Beaumont is one which, without the slightest idea that it had been asked by him, I have anticipated by my reply. The coincidence, however, is less strange, that we have arrived substantially at the same conclusions. A Behring's Strait meridian is almost the only one which, by its position, may be taken as the initial meridian, on account of its natural and individual character.

It is not a little satisfactory to discover that the views which I have expressed are confirmed in the main by so distinguished an authority. What difference exists is in matters of detail. M. de Beaumont proposes that the common meridian should be established 150° west of Ferro, or nearly 180° from a meridian passing through or at no great distance from Copenhagen, Leipsic, Venice and Rome. This would throw the initial meridian a little to the east of Behring's Strait; while the one suggested by the writer is to the west in the same locality. Either would perfectly serve the desired purpose. The only question remaining is, which of the two would least interfere with present practices; least disarrange charts, tables and nautical nomenclature; which would most accommodate and best satisfy the greatest number of those who use and are governed by the maps and forms and astronomical almanacs now in use;—in fact, which of the two lines would most readily meet with general concurrence? I think the answer is conclusive. The anti-meridian of the one proposed by M. de Beaumont, passes through Copenhagen—a meridian recognized probably by less than one per cent. of ocean-going vessels; while the anti-meridian of the line advocated in this paper is in use for reckoning longitude by at least 72 per cent. of the floating tonnage of the world.

The proposal of the President of the Geographical Society of Geneva, supported as it is by M. E. Cortambert and other continental geographers, advances the settlement of an extremely embarrassing question, and encourages the hope that at no distant day there may be an international arrangement, through which mankind may secure the advantages of a common first meridian for geographical, chronometrical and all other general purposes; one that in its actual and in its astronomical sense will be indeed cosmopolitan.

Two communications on the subject have lately appeared in the "Bulletin de la Société Geographie, Paris, 6th Series, Vol. 9."

The first, originally submitted to the Imperial Geographical Society of Russia by M. Otto Struve, Director of the Pulkova Observatory, was subsequently read before the Geographical Society, Paris, by M. le Comte Guidoboni Visconte. The second, was communicated to the same society by M. A. Germain, Ingénieur Hydrographie.

The recommendation of M. Germain is that the meridian of Paris should be maintained. He takes an essentially national and non-cosmopolitan view of the subject. The line of argument adopted by him does not call for refutation, even if controversy in this instance fell within the province of the writer.

M. Germain seems to think, for his opinions are not positively expressed, that if England would adopt the metrical measurement of France, it would be a gracious act for France to accept the prime meridian of England.

The communication of M. Otto Struve is of a different character. He argues for the necessity of a common first meridian, in the general interests of navigation, of geography and of astronomy. He points out that national vanity seems to have been the sole cause that up to the present time, to the great detriment of scientific advancement. different first meridians are in use. He very correctly writes: "La question de l'unification des méridiens ne dépend d'aucune considération d'économie politique, elle intéresse uniquement le monde savant. Sa réalisation n 'exige pas certains sacrifices de la part du public; elle demande seulement quelques concessions d'habitudes et de préjugés nationaux, et cela, de la part de ceux-là mêmes qui, après une courte période de transition, en tireront les plus grands profits. Cela est exclusivement l'affaire du monde scientifique, et nous espérons qu 'aucun de ses membres ne refusera de faire les insignifiantes concessions dont nous parlions pour parvenir à cette entente d'une utilité générale."

M. Struve's paper will well repay perusal. His remarks are totally free from national bias; he favours the adoption of the Greenwich meridian in preference to any other, mainly on account of the fact that the exact and the most useful ephemerides published, known under the name of the "Nautical Almanac," are calculated to correspond with it. He admits, however, that it is impossible to disregard the influence of national jealousies, and he points out how much they stand in the way of obtaining a general recognition of any first meridian established on national grounds.

The conclusions to be drawn from the valuable paper of M. Otto Struve are, that although he gives the preference to Greenwich as a common first meridian, that a meridian passing through the ocean, away from every country, and an exact multiple of 15° from Greenwich, would be a simple and desirable alternative.

The Pacific meridian advocated in the present paper meets these conditions, and in itself offers many positive advantages. It passes through the ocean without meeting any continent, except uninhabited land on the Arctic circle. The Nautical Almanac, recognized by M. Struve, and by the leading astronomers of the world, to be the most complete work of the kind published, and in consequence the most generally used, would apply to it without interpolation. And as no national jealousy would be awakened, all national objections to the initial meridian proposed would entirely disappear, and its general acceptance be considered a ready and harmonious solution to an embarrassing difficulty in a matter of the greatest scientific importance.