WILLIAM BARCLAY STEPHENS, M. D.
1880 BAY STREET
ALAMEDA, CALIFORNIA

March 6,1946

Dr. Robert C. Miller
Director of California Academy of Science
Golden Gate Park
San Francisco, California

Dear Doctor Miller:

In view of the fact that you and Dr. Hanna, after a recent inspection of my horological collection, deem it worthy of a place in the California Academy of Sciences, and in view of the further fact that it has long been my desire and wish that the collection be kept intact in some suitable institution, preferably on the Pacific Coast, I am herewith tendering the collection to the Academy as a gift.

As you noted from your visit, my collection consists of clocks, watches, sundials, books, old tools and many other items of horological interest. The collection has been assembled with the idea in mind of illustrating the development of time telling apparatus from the early beginnings to the present time, and thus is both historical and educational.

The tender is made upon the following general terms:

(a) That as soon as a mutually suitable location can be provided, and as soon as I can prepare it for installation, a representative portion of my collection be delivered to the Academy, title vesting in the Academy upon delivery.

(b) That the balance of the collection remain in my possession with unlimited authority to sell, trade or acquire items of my own choosing with the idea in mind, of course, of enhancing the value of the collection.

(c) To deliver from time to time other and further items from the balance of my collection to the Academy as may seem mutually advantageous.

(d) That it be understood that there shall not be included in the collection any items which I have by any will or codicils to will bequeathed to my family.

(e) That the balance of any remaining items of the collection in my possession at the time of my death be delivered to the Academy forthwith.

(f) That it be further understood that the old tools referred to above be considered those of historical interest, and shall not include, for the present, my working equipment, but that the disposition of these be left to future decision.

(g) That I reserve the right to otherwise dispose of duplicate items, should I see fit.

(h) Should opportunity arise for the sale or exchange of items in the possession of the Academy, which in the judgment of the Academy and myself would be advantageous to the collection, then such sale or exchange could be effected. In case of sale, the returns to be applied for the benefit of the collection.

Please understand that it will be my pleasure to assist the Academy during my remaining years in arranging or placing any items of the collection for display, or otherwise, should my aid and assistance be desired.

I have discussed the matter of this gift fully with my wife and children, and they approve unanimously.

Very truly yours,

W. B. [signature]

March 14, 1946

Dr. William B. Stephens
1250 Bay Street
Alameda, California

Dear Dr. Stephens:

I was very much gratified to receive your letter of March 6 confirming your intention to make a gift to the Academy of your horological collection. On behalf of the Academy I am happy to accept your generous offer and to state that we are fully in accord with the terms you suggest.

We have a certain limited amount of space immediately available for the display of such items as you may wish to install at this time and we shall plan to make a larger and more suitable space available as soon as our building program permits. We greatly appreciate your willingness to assist in arranging the collection for display.

We are very glad to acquire this collection for the Academy and I believe that it will make an exhibit of permanent interest and value to the public.

Sincerely yours,

Robert C. Miller
Director

RCM vh

WELLS FARGO BANK

OAKLAND MAIN OFFICE
BROADWAY AT FOURTEENTH STREET
OAKLAND 4, CALIFORNIA

Please address your reply to
WELLS FARGO BANK
Attention of

Trust Department
July 22, 1963

California Academy of Science
Golden Gate Park
San Francisco, California

Re: 5-22778 - William Barclay Stephens

Gentlemen:

As you may know, Dr. William Barclay Stephens passed away on February 28, 1962, and prior to his passing created a living trust in which Wells Fargo Bank was named trustee.

Under the terms of the above mentioned trust, Dr. Stephens provided a bequest to the California Academy of Science in the sum of $5,000.00 ....."to be used by said Academy for the maintenance of the William Barclay Stephens Horological collection."

The purpose of this letter is to advise you that we are preparing to distribute the various bequests in the trust within the next 30 to 60 days and will be forwarding to you a Receipt to be signed by the authorized signatories of your organization and would appreciate your advising us whether or not you wish us to forward the Receipt directly to you or through your bank depositary for payment.

Very truly yours,

G. A. Wardhaugh
Assistant Vice President and
Trust Officer

GAW:dr

The Search for Great Watch Collections

An Opportunity to See One of the Great Watch Collections from the Past—and a Search for Other Vintage American Collections.

Kathleen H. Pritchard (MD)

Also at the NAWCC Museum, on a loan basis, is the Stephens Collection. Dr. William Barclay Stephens (1869-1962)[12] was a San Francisco doctor from the same era as the Proctors. He did not have quite their family wealth but he pursued his many interests diligently and lived to a very old age. From 1917 on he attempted to collect all models of American horology. After retiring from his career as an ophthalmologist, he devoted himself to his hobbies. He was a founder of NAWCC and one of its directors from 1946 to 1951. He was particularly devoted to the California Academy of Sciences. In the 1950s he placed his extensive watch and clock collection with the Academy, personally overseeing its display and supervision. The collection was open to the public and viewed without charge. After years of neglect, the collection has been lent to NAWCC; some of the pieces were in the exhibition at the NAWCC 2000 National Convention in Philadelphia. (The Bishop Museum in Honolulu also was given a collection of watches and clocks by Dr. Stephens.)

Bulletin of the National Association of Watch and Clock Collectors, April 2001, Vol. 43/2, Number 331, p 214.

Bulletin of the National Association of Watch and Clock Collectors, February 1998, Vol. 40/1, Number 312, pp 67-68.

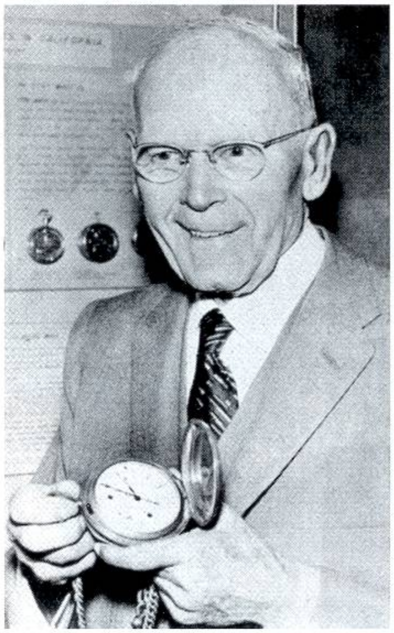
THE PAPERS OF DR. WILLIAM BARCLAY STEPHENS, 35 YEARS AFTER HIS DEATH

by Kathleen H. Pritchard

The papers of a number of the NAWCC giants have been donated to the NAWCC Library. Now sorted, catalogued and boxed, they are available for consultation. Of particular interest are those of Dr. William Barclay Stephens. Our four boxes contain personal material and photographs, the catalog of his enormous collection of timepieces and books, copies of his many writings, and many records of his relations with the NAWCC, with Chapter #5, now called the W. Barclay Stephens Memorial Chapter, with the California Academy of Science, and with many California societies. He was a man of protean interests and incredible energy. Almost everything he saw interested him and led him to pursue it until he knew enough to write or give a talk about it.

Dr. Stephens was born in Paris, Kentucky, in 1869. He went to Georgetown College in Kentucky and received a Master's Degree in history in 1890. He then went to Columbia University's College of Physicians and Surgeons to study medicine; he graduated from there with honors in 1893. He began at once to practice medicine in San Francisco, with a second office in Alameda, in the San Francisco area, finally specializing in ophthalmology and otolaryngology. At the same time, he attended Dublin University in Ireland for additional studies. He received a LL.D. from Georgetown in 1920. He developed interests in the Boy and Girl Scouts and in many societies and philanthropies. He continued the active practice of medicine until the 1940s when he was in his seventies.

Dr. Stephens felt that every man should have a consuming hobby and among his many, the chief was horology. He described it thus, "My hobby is time-telling apparatus from the early times to the present, as represented by a collection



Dr. W. Barclay Stephens.

of clocks, watches, sun dials, sand glasses, various tools used by artisans, and a horological library." He continues,

"Why Clocks and Watches? First, I have always been interested in mechanical things. Second, Clocks and Watches seem to have almost life and soul. Third, they have an appeal as objects of art. Fourth, the mechanism is fascinating in its oft-times wonderful detail and workmanship. Fifth, interest in learning about the master workmen who have contrived and made these mechanical marvels; men usually of superior intelligence. Sixth, in the legends and stories connected with the various pieces. Seventh, my hobby has been the source of many delightful friendships with collectors and old-time Watch and Clock Makers. Eighth, taking these delicate mechanisms apart, repairing broken parts, replacing missing portions—afford a diversion for the mind that is complete."

Among his papers in our library are the histories of almost every one of his horological pieces. As an accessory to his hobby, he contributed more than 20 scholarly studies to horological and historical journals.

Dr. Stephens gave his collection to the California Academy of Sciences in 1946, catalogued each piece, oversaw the placement in cases, and provided informational material for each display. He became the Honorary Curator of Horology at the Academy and while keeping an eye almost daily on his collection, he traveled as well to many other museums to learn more about display techniques. He also gave a collection of watches and clocks to the Bernice E. Bishop Museum in Honolulu and traveled there to catalog and arrange the opening exhibition.

Dr. Stephens was a founding member of the NAWCC; his early membership number, 22, was chosen as the number for the Old Timers' Chapter of which he was president. He served our Association as director (1946–1951) and vice-president (1949-1957) and was on many of its committees. Among his papers are programs for all the National Conventions that he attended and correspondence with many of the other early "greats" of the Association. He founded Chapter #5 in 1948 and was also its chairman for many terms. (Chapter #5 will be observing its fiftieth anniversary this year.)

Dr. Stephens died in his sleep on February 28, 1962, 35 years ago this month, at the age of 93.

For those interested in the writings of Dr. Stephens, many of his articles can be found in the NAWCC BULLETIN. A listing of a few of these articles includes: "Method of Cataloguing Watch and Clock Collections" (July, 1946); "The Wenzel Air Clock" (October, 1947); "An Edward Howard Clock" (July, 1948); "The Hamilton Seven Jewel Watch" (July, 1949); "The Newark Watch Co. and Its Career" (February, 1950); "The United States Watch Company, Marion, New Jersey" (June, 1950); "The New York Watch Company" (February, 1951); "The Horological Collection of Dr. William Barclay Stephens" (December, 1951); "The Foucault Pendulum" (December, 1952); "Charles S. Crossman 1856 – 1930" (June, 1953); "The Adventure of the Lord's Prayer" (April, 1954); "J. P. Stevens His Watch Company and Inventions" (December, 1954); "Antide Janvier and One of His Clocks" (December, 1956); "A Watch Commemorative of the American Revolution" (June, 1957); "A Skull Watch" (April, 1959); "Next Year In Jerusalem A Hebrew Clock and Watch" (October, 1959); "A Clock of Jade" (December, 1959); "Time Balls" (December, 1961); and "My Hobby Philosophy" (August, 1962). Two brief biographical articles about Dr. Stephens also appeared: "Autobiography of Dr. W. Barclay Stephens Wherein He Reminisces of His Early Years In A Letter to Harry S. Blaine Dated October 30, 1950" (April, 1967); and "Early Giants: Dr. W. Barclay Stephens" by Urban Thielmann (April, 1984).

Personal papers of NAWCC members provide historical information about the NAWCC and about the areas of horology that were of interest to these members. The NAWCC Library is interested in obtaining other such material for our collection.

First article by W. Barclay Stephens to appear in an NAWCC related publication

The Time Keeper No. 4, March 1945

THE CHRONOSCOPE

by Dr. W. B. Stephens (#22)

Opinions differ among horological writers as to just what is meant by a Chronoscope. Likewise this difference of opinion is found among the writers on physics, from which branch of science the word was introduced into horology.

Edward J. Wood in his book "Curiosities of Clocks and Watches" (1866) describes under the heading of Chronoscope a certain ornate clock with three sides of glass through which the movement could be seen.

The French call it a "Pendule aux Giuchets," a clock with little windows; and the Germans, "Die Uhr mit springenden Zahlen," a clock with springing or jumping numbers.

A frequent application of the name is made to the Chronograph or what is commonly known as the stop watch or timer. Britten thinks that it should be so applied and in the three editions of his "The Watch & Clockmakers Handbook" which I have, viz., the seventh (1889), the tenth (1902), and the fourteenth and last (1938), there is a section under the heading "Chronoscope" which reads as follows: "This word, which from its derivation appears to be a more suitable title for the watches generally known as the Chronograph, is used to denote a clock in which the time is shown by figures presented through holes in the dial."

I do not agree with Mr. Britten in this statement. On the contrary, I think that from its derivation the word Chronoscope is a more suitable title for the clock with the hole in the dial, presenting the changing figures, than for the Chronograph.

Both Chronograph and Chronoscope are derived from Greek words. Chronograph is from Chronos, time, and graphein, to write or record.

When the hand of a stop watch is arrested as the result of the action of the "stopping" mechanism, the "stopped" hand is in itself a record, despite the fact that no mark is made on the dial. However, as a matter of fact, some of the earlier stop watches had a small ink receptacle upon the tip of the hand which made a mark at the stopping point. Furthermore, the Chronograph used by the astronomer makes a mark at the instant the star or other observed heavenly body passes the Zenith. Thus the idea of recording seems definitely associated with the Chronograph.

The derivation of Chronoscope is Chronos, time, and skopein, to see or show. This same "scope" is familiar, in many other words, e.g., telescope, microscope, etc., all carrying the idea of seeing or showing.

All these things would seem to make Chronoscope a much more suitable appellation for the clock or watch with figures presenting through a window or windows in the dial than for the Chronograph.

The last edition of Britten's Handbook was revised by J. W. Player, who has inserted an entirely new section, entitled "Jumping-figure Watches" (sometimes called "Chronoscopes" and "Secometers") (the word secometer is unfamiliar to me, nor do I find it in any available dictionary). The first sentence of this section reads as follows: "A revival in a modified form of the old idea of indicating the time by means of moving figures showing through openings in the dial." (page 229). Such a mechanism with its jumping figures catches the eye and would seem well fitted to carry the title Chronoscope, i.e., seeing or showing time.

To clarify some of the confusion relative to these two terms, I propose that we members of the Association place under the category of Chronograph all those time pieces which can be denominated stop watches, whether the "stopping" is by the arresting of the motion of the balance wheel or only the hand or hands: and under Chronoscope those which show both hours and minutes by the changing figures or the hours only by the changing figures, and the minutes and seconds by the conventional hands. I have for some time followed this plan with my own collection.

The idea of the Chronoscope is by no means new, as I learned twenty-five or more years ago from one of my earlier horological adventures, when from an old striking movement, I made a chronoscope, though I did not know it at the time. In making this Chronoscope the old dial was replaced by a square sheet of brass with a three-inch opening in the center. Hour numerals and a minute circle were painted on as an ordinary dial. A disk of brass was then made of such diameter as to cover the hour numerals but not the minute circle. Twelve pins, evenly spaced, project backward from the disk. A rectangular window was cut in the disk of a size and position to expose one hour numeral at a time. On the hour the window is shifted by the striking mechanism to the next succeeding hour and locked by its pin. Several months after "inventing" this mechanism, I saw in the Metropolitan Museum in New York a watch which had shifting hour numerals much like the last watch described in this paper. Since the watch in the Museum bore the date of about 1750, I was disabused of the idea that I had made a new discovery. Despite the fact that I found that the idea was not new, I did have the fun of discovery and of becoming Chronoscope conscious. I have never seen one like mine; and furthermore, mine has the point in its favor that one does not have to see the numeral itself, as the position of the window marks the hour. Shown in Fig. 30.

Chronoscopes, like many other novelties, seem to appear in cycles, only to be replaced by conventional timepieces. At the present time the electric clock may be responsible for helping to cause one of these cycles. In some of the larger and newer railroad stations and other public buildings are to be seen the time being flashed or jumped before your eyes; and for the home are being made small clocks on exactly the same principle – such as shown in Fig. 31.

In 1902 and 1903 appeared the "Plato" (Fig. 32) which had rather an ephemeral existence, probably largely due to its cheap construction, its proneness to get out of order, and the difficulty the average watchmaker had in readjusting the flitting numerals.

The remaining items are all watches. The two illustrated in Figs. 33 and 34 show the time in a similar manner, but differ under the dial and in the form of the third wheel, which wheel helps to give the "shift" to the numerals. The one in Fig. 33 has a sector of the teeth omitted, while the piece shown in Fig. 34 has one of the teeth prolonged downward. Neither bears a name, though the one shown in Fig. 33 has a monogram "C.W." and Fig. 34 has "A & L" on the dial. Nor is there any mark showing where the watches were made. They are well made with lever escapements and I suspect they are Swiss. Perhaps some member of the Association may know their origin. The date "Feby. 24, 1885" on the one in Fig. 33 would probably apply pretty closely to the one in Fig. 34.

The one in Fig. 35 is marked "Swiss," but no name of maker. It is a 24-hour watch, the 1-12 numerals shifting to 13-24. It is an ordinary train, lever escapement, with the center wheel planted to one side of the center. The shifting of the numerals is accomplished by a cam and levers under the dials. The under dial carries the sets of numerals with the figures alternating as is shown in Fig. 36. Fig. 37 shows the mechanism operating the shift. I have not been able to learn the date of this watch.

The last item is by Perrins Freres, Neuchatel, and is such an exquisite little watch that I am including a picture (Fig. 38) of the back of the case, which is of gold, decorated with black and white enamel. It is a cylinder escapement and was made early in the 19th century. The hour is shown through the little window; the minutes and seconds by ordinary hands. The shifting mechanism is of simple design and located under the dial. This is shown in Fig. 39.

More extensive descriptions of the mechanisms of these various timepieces would have made this paper too long.

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Time
and Time-Telling

by

Dr. William Barclay Stephens
HONORARY CURATOR OF HOROLOGY
CALIFORNIA ACADEMY OF SCIENCES

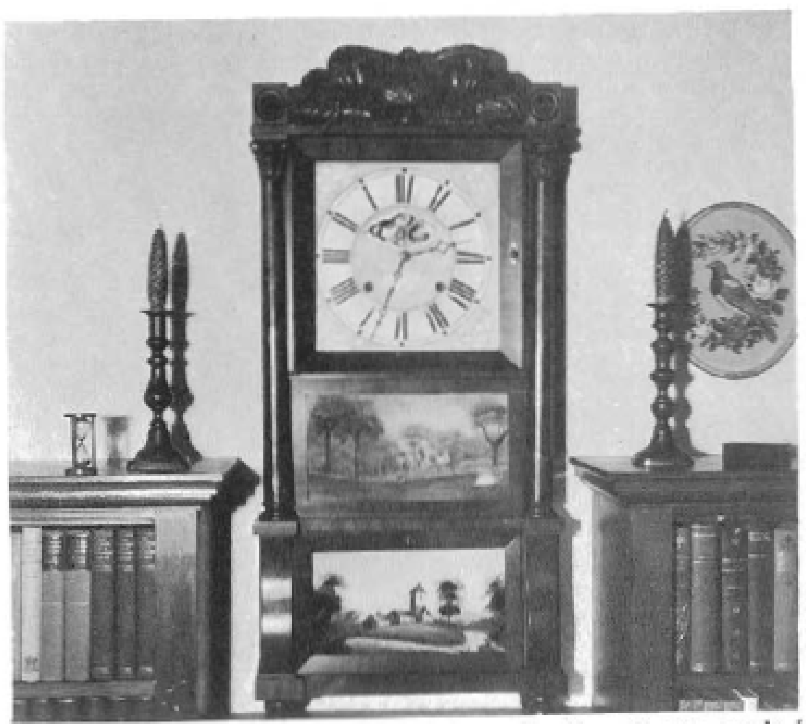
California Academy of Sciences
San Francisco
March 1954

PREFACE

This brochure owes its existence to the presence of the horological collection in the California Academy of Sciences, and the collection to a hobby which had its beginning when I was a lad in Kentucky. In the attic of the old home were two old clocks which had a great fascination for me and which were eventually turned over to my tender mercies. The smaller one I finally got to ticking, but the larger one, proving too much for my early horological efforts, was made into a cabinet for my boyhood curios.

Then there occurred the interlude of the college years, the graduation in medicine, and the starting of practice in California. During these years the hobby lay dormant. Then about forty years ago upon a trip to Kentucky, I found in the storeroom at the old home place the clock-cabinet. My interest in it as a clock was revived, and I decided to restore it to its original form. All of the formerly removed parts that could be found in the attic were assembled, and the clock shipped to California where it was meticulously restored and given a place of honor.

This clock of my maternal grandparents seemed to act as a magnet, and gradually a large tick-tok family was gathered about it, until as the years passed there were clocks, watches, and other horological items from the four quarters of the globe. And, too, there was an horological library of about 300 volumes and numerous journals.



This clock was the beginning of the collection. It was made by C. & L. Ives, Bristol, Conn., about 1839.

As the collection grew the range of interest widened; no longer was it just old clocks and watches, but time itself and all the various methods of time-telling both past and present were embraced. This required more extensive study and research. Thereby my hobby had become the occasion for me to delve into history, biography, geography, mythology, various branches of science, mechanics, and mechanical manipulations.

Through my reading, correspondence, and personal interviews, I have been brought into friendly relations with astronomers and other scientists, clergymen, philosophers, engineers, statesmen, and artisans. All these different classes have made definite contributions to horology, and many have even made clocks and watches with their own hands.

My hobby has given me relaxation and respite in the midst of a rather strenuous professional life. It has taken me for outings both in the physical and intellectual world. There have been occasions for familiarizing myself with certain phases of art. It has opened new vistas and increased my interests and added zest and purpose to my reading. Delight and interest added to travel, and many an otherwise prosaic trip has been raised to an adventure. But most of all it has provided new friends to take the place of those whom death has been rapidly removing.

These personal experiences have left me firmly convinced that every man should have a hobby and learn to ride it before he has reached middle life. In this day of short hours and early retirement age, hobbies seem all the more necessary. The provident man lays aside a portion of his earnings against the day when his earning capacity ceases. Is it not equally important that provision should be made for the intellectual and spiritual welfare during the declining years as for mere food and raiment? I regard it as a duty to prepare for an orderly, useful, and enjoyable old age, and so to be able to profit by the leisure which has come; otherwise the last years are apt to be dour and mere vegetation.

The hobby or hobbies should be adapted to the temperament, tastes, and needs of the individual. The ideal is one that satisfies the physical, mental, and spiritual cravings of his nature.

We can not hinder the passage of the years, but we can do much by so ordering our lives as to keep from prematurely growing biologically old.

In a properly chosen hobby or hobbies and faithfully practiced may be found one of the best assurances of keeping mentally and physically fit to the end of life — the brain and body giving out together and like the Deacon's One-Hoss Shay going up in a puff of dust.

The Author

Photo of "cross case" for watches and W.B.S.

"What is time? The shadow on the dial, the striking of the clock, the running of the sand, day and night, summer and winter, months, years, centuries — these are but arbitrary and outward signs, the measure of time, not time itself.

Time is the life of the soul."

-- Henry W. Longfellow

TIME AND TIME-TELLING

Time is one of those basic concepts of which we have a fairly clear understanding, but for which we find it difficult to formulate an adequate definition.

The most striking characteristic of time is motion, and in many of our aphorisms or sayings about time there appears this idea of motion. "Tempus fugit," said the old Roman; "time flies," say the aged of today; and the young, "time drags."

"Nae man can tether time or tide," said Robert Burns.

"Panting Time toiled after him in vain," was said of Samuel Johnson; and Shakespeare says in As You Like It: "Time travels in divers paces with divers persons. I'll tell you who Time ambles withal, who Time trots withal, who Time gallops withal, and who he stands still withal."

In this quotation Shakespeare not only attributes motion to time, but with his usual keen insight into human nature points out how time apparently passes with varying speeds. We have all experienced this apparent variation in the rapidity of the passage of time. Depending upon age, state of mind or body, or circumstances it apparently passes slowly or rapidly. When we are deeply absorbed in some intensely interesting project or some joyous affair time slips by swiftly and unobserved. But when we are occupied in an uninteresting and humdrum task, awaiting a late train, or awaiting the culmination of some happy event, time may seem to drag along almost interminably.

Notwithstanding Shakespeare's testimony and our own personal experiences, time does not vary in its pace, but moves along uniformly and relentlessly, and always forward, never backward.

In view of the close association of time and motion it is most fitting that a moving body should be the unit of measurement of time; viz., the daily rotation of the earth, which as long as man has been able to measure it has been found to vary its average time of rotation by only 1/1000 of a second per century. The rotation is usually said to be in 24 hours, but it is in actuality 23 hours 56 minutes 4.091 seconds of mean solar time.

Now having established the unit of measurement for time we can turn to the kinds of time of which, in ordinary civilian life, there are five. Two of these are gotten by observation of natural bodies; the other three are artificial, or man-made. The two observed ones are: Sidereal, or Star Time, and True Solar Time. The artificial are Mean Solar Time, Standard Time, and Daylight Saving Time.

Sidereal time is both the most accurate and important time and is ultimately the source from which all the others are calculated. It is the time used by the astronomers. In determining sidereal time the stars generally chosen for observation are the ones which cross the meridian at Washington with the greatest regularity, thus enabling the observer to recheck them night after night. These stars change with the changing seasons. They are so many hundreds of light years beyond our solar system that they are, to all intents and purposes, fixed and therefore can be sighted with greater accuracy than a moving body. For the observation a transit — a form of telescope — is set in the north and south line of the place where the observation is being made. One of the chosen stars is sighted and the time of passing the cross wire of the transit is noted; the following night it is again sighted and noted as it passes the cross wire. This marks one rotation of the earth, and the time elapsed is a sidereal day. Usually several stars are noted during the course of the evening and an average taken, thus making for greater accuracy. The star being approximately a mere point can be sighted with great precision, to an accuracy of a few thousandths of a second.

When taking true solar time the sun is observed at noon. Unlike the star, it is large and can not be pinpointed as can the star, and therefore the observation is less accurate, about 1/10 of a second. Furthermore, the glare of the sun tends to dazzle the eye and its heat to distort the lens of the transit. Since there is but one sun a double check is not possible. But the most serious source of error is the fact that the earth is hurtling through its elliptical orbit at great speed, and by the time the second observation is being made the relative positions of the earth and sun have so altered that the earth must turn a trifle more than a full rotation for the sun to be centered and the time noted. This of course means that the true solar day is a little longer than the sidereal.

Another factor altering the length of the true solar day, and one which is not uniform, is that the speed of travel of the earth about the sun is not uniform by reason of the orbit being elliptical and thereby at times bringing the earth closer to the sun than at others. The closer the earth to the sun the greater the attraction of gravitation, and therefore the greater the speed and consequently a further alteration in the length of the day. As a result true solar time can differ from mean time from zero to a little over 16 minutes. There are, during the course of the year, three phases of decrease and three of increase, thus making three waves. This variation is called the equation of time.

Since the true solar day averages a little longer than the sidereal we find there are 365.24 true solar days and 366.24 sidereal days in the year, a difference of just one day. If we equalize, or average, all the true solar days in a year we will have converted them into mean solar days, each day of the same length. Thus we have mean solar time. The ordinary sundial records true solar time, whereas our ordinary household clocks record mean solar time.

This difference between true and mean solar time is called the Equation of Time. A clock to keep true solar time has to be a complicated one. As mentioned above, mean solar time is calculated from sidereal because of the greater accuracy of the sidereal.

The time at any specific place is determined by its longitude. Thus two places only a short distance east or west of each other would have different times. With the coming of railroads and other forms of rapid transportation and the spreading out of population over wide areas, these local times made transportation hazardous and caused confusion in business and social relations. To remedy this situation standard time was introduced in 1883. This time is based upon the fact that 15 degrees of longitude equals one hour of time. Therefore, by dividing the world into time zones of 15 degrees each and making the time throughout each zone uniform, each zone would differ from its adjoining zones by one hour; the zone to the east being one hour faster and the one on the west one hour slower. The zoning was started at the Greenwich Observatory in England. In the United States there are four zones. Beginning at the east they are: Eastern Standard Time, Central Standard Time, Mountain Standard Time, and Pacific Standard Time. To meet such exigencies as the line passing through a city or for other reasons, the line is offset one way or the other. The accompanying map will show the zones in the United States and the offsets.

Map of Standard Time in the United States.

The adoption of Standard Time was one of the greatest aids to transportation and commerce throughout the whole world. When the International Meridian Conference met in 1884 and established Greenwich as the Prime Meridian from which to start the zoning for standard time, the zoning was started in both directions; i.e., east and west. It therefore followed that in circling the earth the two would meet half way around, 180 degrees from Greenwich. The point of meeting is called the International Date Line. Upon crossing the line when going west the date is advanced one day, and when going east it is set back one day. This line like some of the ordinary 15-degree lines is not perfectly straight, but shifts from side to side to avoid or to include certain islands which lie in that part of the Pacific Ocean.

Daylight Saving Time, while proposed many years back, did not come into general use until the time of World War II. It is of very doubtful value. In this the clock is set ahead one hour during the summer days when the sun rises early. Since this is not adopted throughout the whole country it is a source of much confusion and an especial plague to the traveler who is on standard time.

This brief outline gives something of the nature and characteristics of time, its unit of measurement, and the various kinds of time which have arisen in response to the demands and needs of advancing civilization. It has required many centuries for time-telling to have reached its present state of accuracy and importance.

So accustomed are we in these hurried, busy days to associate the passage of time with clocks that we may at times lose sight of the fact that primitive man did not start his time-telling with clocks, but with nature's timekeepers: the sun, the moon, and the stars. His unhurried nomadic life gave him ample opportunity to observe, to ponder, and to learn the value and use of these denizens of the sky as time-tellers.

It is likely that the first two things to arouse primitive man's consciousness of time were the regular recurrence of day and night, and his stomach through its regular and insistent demand for food. As he gradually turned to agriculture and a more settled form of life he began to divide the day by the sun's position in the sky and by the moving shadows cast by a tree, a rock, or even a stick purposely placed upright. This was the birth of the sundial, the first manmade timekeeper, and one which was destined to serve for thousands of years.

Despite the appearance of many other time-telling inventions the sundial has not been entirely discarded; however, nowadays it is used chiefly for its artistic and aesthetic effect. For its long service and its important place in the history of time-telling apparatus it deserves more than a passing mention. Only a book would suffice for adequate description and recognition. Here a brief account will have to serve. Through its long career it has gone through a great number of different forms from its crude beginning to some of the scientifically constructed instruments of the present day; and from the strictly utilitarian to the artistic. In all the forms the basic principle has been preserved.

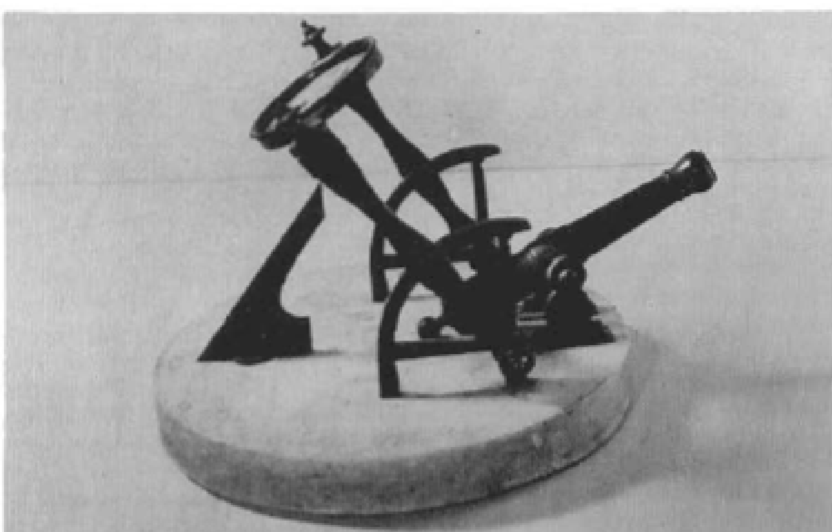
The early Egyptian, Assyrian, Babylonian, and Chaldean priest-astrologers played an important part in the development of the sundial. The first description of the construction of a sundial was given in 540 B.C. by Berosus, a Chaldean. The first authentic written record of a sundial is in the Bible, II Kings, Chapter 20, and also in the 38th chapter of Isaiah. In these two places Isaiah is stated to have performed the miracle of turning back the shadow on the dial of Ahaz 10 degrees, or steps. This was about 720 B.C.

Sundials fall into two main categories: the stationary and the portable.

In England are found some of the best examples of the stationary type, and they usually are placed in most fitting settings. Most of them carry mottoes or inscriptions varying in their tenor from the somber to the joyous.

In Egypt one of the functions of the obelisks was to serve as sundials, and probably the Pyramids also.

The portable dials were of various shapes, e.g. dials in the form of a napkin ring. Shakespeare at times refers to dials of this form. Handsome dials of two plates of ivory and called book dials were made on the continent, and in the Pyrenees were many in the form of cylinders, called shephard dials. Many of the portable dials had upon them notations of the latitude of the principal cities so that they could be "set" for the latitude of the place where the time was being taken. The style, or gnomon, had to be at the angle, or latitude, of the place. In some of the portable forms instead of the gnomon there was a small hole at the proper latitude which was turned toward the sun; the ray of light passing through falling upon the hour scale marked the time, the ray of light serving in place of the usual shadow.



Noon Gun Sundial

The gun is fired at noon by the focusing of the sun upon the touchhole.

So inaccurate were the early watches that portable dials were long carried to check the watches.

Sundials have recently been constructed to record mean solar time.

Those who may be interested in sundials will find in Sundials, by Mayall and Mayall, an excellent general work on the subject and in The Book of Old Sundials & Their Mottoes, by Warrington Hogg, a short dissertation followed by many interesting mottoes. T. Geoffrey Henslow gives in his book Ye Sundial Booke fine pictures of a great number of the English dials and their mottoes.

For the night hours primitive man had the stars with their regularly changing positions as a night clock.

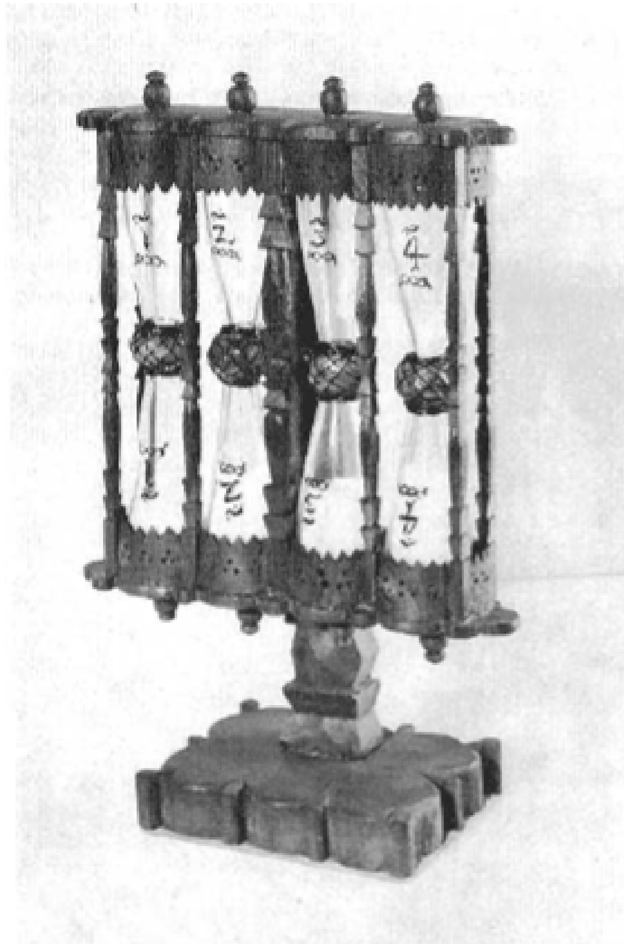
About 1520 there was made an instrument for taking star time. It was called a Nocturnal. (One of these is in the case along with the sundials and other early forms of timekeepers.)

With the further advance of civilization there arose the need of a timekeeper for the dark days when the sundial could not function. For this purpose there was used a tightly twisted, dampened grass rope with knots at regular intervals and which when lighted burned at a fairly uniform rate, the knots marking the time intervals.

A later refinement of this idea was King Alfred's marked candles. Another of the primitive methods was a basin with a small hole drilled through the bottom and placed upon water. A watcher stood by and when the basin sank he would strike a gong, thus calling attention to the hour. He would then retrieve the basin, place it again upon the water and resume his watching. This might be called the first town clock.

There is a record of the sinking basin being used in Egypt in 4000 B.C., and some evidence of an even earlier use in China. In some parts of India this method was in use up to modern times. This crude method gradually developed into the water clock, called by the Greeks a clepsydra, meaning a water stealer. (One of these is shown in the Horological Collection.) In the 2nd century B.C. one was made in Alexandria which, by means of wheels, raised up a figure which pointed to the hour. This is the first record of the use of wheels in a time-telling apparatus. Some of the clepsydras made by the Greeks were very elaborate affairs. They were very commonly used in the Roman Forum and in the Greek Agora for timing the speeches of the senators and other speakers. It was chiefly with the clepsydra that the monks in the monasteries during the dark ages timed their canonical hours, announcing them with a bell. Water clocks were in use in England well up into the 17th century. They were inaccurate due to the uneven flow of the water, wearing of the hole, and evaporation, especially in the hot dry climates. This occurrence of evaporation was one of the reasons giving rise to sandglasses. These are still a familiar sight in our kitchens as egg timers.

Some of the early sandglasses were very elaborate, having as many as four glasses, marking 1/4, 1/2, 3/4, and 1 hour. The most frequent use of these was in the churches to time the sermons. A 28-second glass was long used aboard ship for calculating the number of knots per hour, and only in recent years has it been replaced by more modern methods. The earliest authoritative record we have of the use of the sandglass is in the 13th century, but it was probably in use before that time.



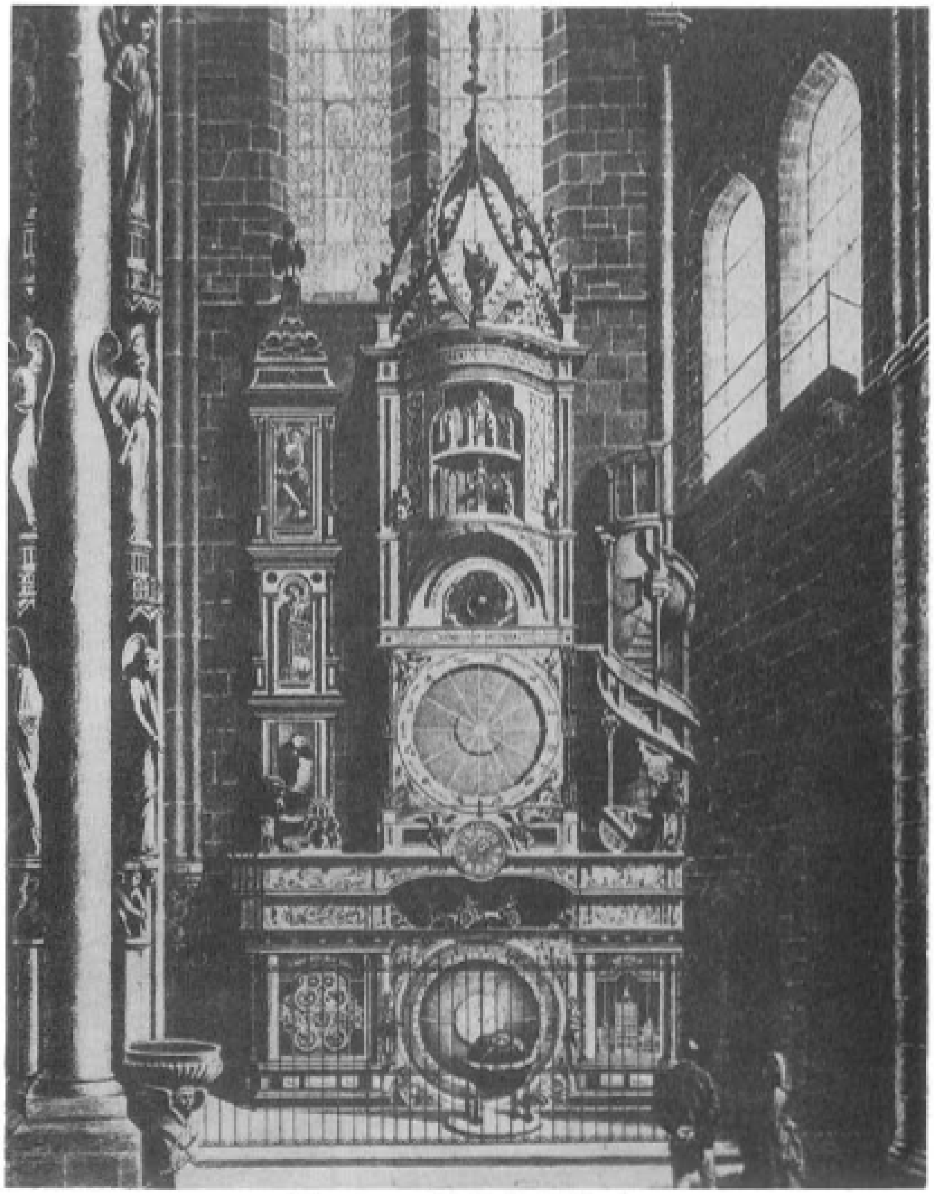
Reproduction of a German 14th century Sandglass. Made by W.B.S. in 1953.

One more type of time-teller should be mentioned before discussing mechanical clocks, though as a matter of fact it did not come into use until after mechanical clocks were made. This is the Oil Clock, which like King Alfred's candles gave light as well as time. The level of the gradually consumed oil marked the time.

Weights and geared wheels were in use before the Christian era, but what we know as clocks could not be until a method was found to permit the falling weight to release its power gradually and uniformly; i.e., until an escapement was invented, an arrangement by which one tooth at a time of the escape wheel is let off, or allowed to "escape," at a uniform rate.

When and by whom the first escapement was made has never been determined with any degree of certainty, but it is probable that it was in the latter part of the 13th century by a monk in one of the Italian monasteries. It was also in Italy, according to our best records, that the first tower, striking clock was built and installed in the tower of a cathedral in Milan in the year 1335. At this period Italy stood at the head of all other countries in the sciences and the arts.

Strong claims are made that two tower clocks were made in England about 1280, but without striking mechanisms.

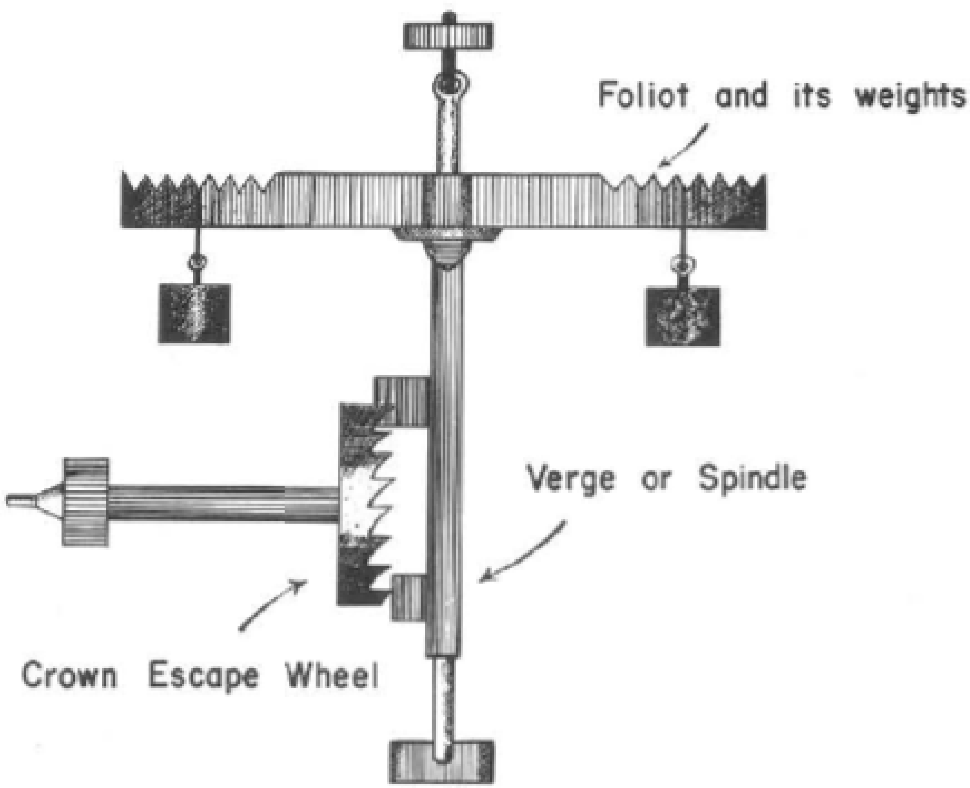


Strasbourg Cathedral Clock

Of all the early clocks the most famous and most complicated is the Strasbourg Cathedral clock. It was begun in 1352 and completed in 1370, rebuilt in 1571 and again in 1842. This clock in addition to giving the time shows many astronomical phenomena such as the moon's phases, time of rising and setting of the sun, dates of religious festivals like Easter and others. At noon each day the twelve Apostles march out, and the cock crows three times, recalling Peter's denial of Christ.

The most frequently mentioned nowadays of the great modern clocks is Big Ben in London.

The earliest clock of which we have the date and a description of its construction is the one which Charles V of France had built by a German mechanic whose German name was altered to Henry de Vick. This clock was begun in 1362 and finished in 1370. In many of the books on horology this clock is cited as the prototype of early clocks, and its escapement is widely pictured.



Verge Escapement and its parts

This first form of escapement was called a verge, or spindle, escapement, a crude and inaccurate affair, yet to remain without practical improvement for over 300 years.

The clocks of this period were most inaccurate according to our present-day standards. The first step toward an improvement in their timekeeping was the discovery in the year 1581 of the law of the vibration of the pendulum by Galileo, and later its practical application to clocks in 1657 by the Dutch astronomer Christian Huygens.

The account of Galileo's discovery of the isochronism of the pendulum is worth repeating. While in the cathedral in Pisa he became interested in the swaying of the great chandelier which was suspended overhead. The air currents were causing it to swing in long and short swings. Using his pulse, in the absence of a watch, to time the vibrations he found that the swings, or vibrations, were performed in exactly the same time whether they were long or short. This is what is termed the isochronism of the pendulum. This law and the further one that the time of the swings is determined by the length of the pendulum form the basis upon which the value of the pendulum as an accurate timekeeper rests. All pendulums of the same length swing in the same time. By reason of these two qualities of the pendulum it was the most important single discovery toward making the clock an accurate time keeper.

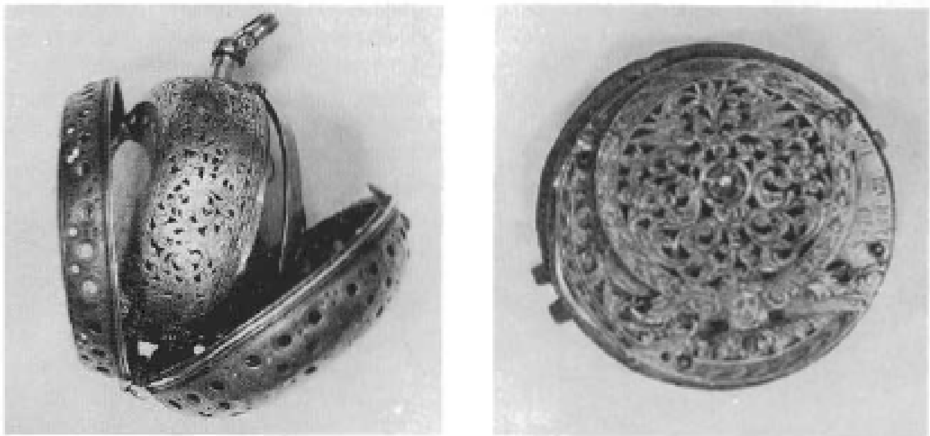
The great improvement which followed the application of the pendulum seemed to release the inventive genius of the clockmakers and soon the 300-year-old verge escapement was replaced by more efficient ones. A steady stream of new escapements and other horological inventions began which by modern times made possible the building of astronomical clocks keeping time with an accuracy of one second a year.

Not long after the successful application of the pendulum to the clock, a coiled spring was added to the balance wheel of the watch — called a balance, or hair, spring — doing for the watch almost what the pendulum had done for the clock. Also as in the clock the verge escapement was gradually replaced by much more accurate ones. (This evolution of the watch is shown in one of the watch cases at the Academy.) Until recently it was fairly definitely thought that the first watch was made shortly after 1500 by Peter Henlein, a locksmith of Nuremberg, and was jocularly called Peter's turnip because of its shape and size. However, documents have recently been found in Italy which tend to prove that watches were made in that country many years before the ones by Henlein.

The early watches were even more inaccurate than the clocks, for in addition to the inefficient verge escapement, springs were used for the motive power, weights of course being impossible in a watch. These early springs were crude and short and very uneven in their strength, being very strong when wound up and rapidly losing in power as they ran down. This added greatly to their inaccuracy.

Many of the old watches had very beautiful cases. Some were of very bizarre design, as in the form of a skull, a cross, or other odd shape. The material used in their construction was often unusual, such as crystal or semiprecious stones. These efforts at beautifying them may have been in part an effort to compensate for their unreliability as timekeepers.

Modern clocks and watches are largely a product of exact science, the laboratory, and automatic machinery — things at which we may marvel, but from which a large part of the personal element is eliminated; whereas in the old clock and more particularly in the old watch, where it is practically all hand work, there is shown the care and pride of the artisan as evidenced by the beautiful hand carving and chasing upon the dial, the case, and even the movement which



Repeating Watch and its Movement by Daniel Quare, London, about 1700.

is not usually open to inspection. He has poured his soul into his masterpiece. These artistic decorations did not add to the timekeeping qualities of the watch, but did reveal the personality and pride of the workman and gave to the owner a work of art and a thing of beauty. Such watches as these seem almost to have a soul and personality. The watch is one of our most prideful and intimate possessions.

By the year 1700 clocks and watches could be dignified as real timekeepers and the Golden Age of Horology began in England, lasting during the greater portion of the 18th century. During this period nearly all the escapements which have endured were invented: the anchor, or recoil, the dead beat, the cylinder, the chronometer, and the detached lever. The inventive genius of the people which had apparently been dammed up seemed to burst forth, and a flood of inventions appeared.

In the early portion of the period were Daniel Quare, Thomas Tompion, often called the father of watchmaking, and George Graham. The latter two were honored by burial in Westminster Abbey. Then came Thomas Mudge, to whom we are indebted for the detached lever escapement which is found in practically all modern watches and in millions of clocks. Following along was John Harrison, who constructed a marine timepiece of such accuracy that longitude could be determined by it at sea within one half a degree. This invention was of inestimable aid to navigation and enabled ships at sea to find their position with so much greater accuracy than by former methods that much of the hazard of sea voyages was removed and thousands of ships and countless numbers of sailors and passengers were saved from loss at sea. For this invaluable invention Harrison was finally granted, in 1772, the reward of 20,000 pounds which Britain had offered for a timepiece of such accuracy.

John Arnold and Thomas Earnshaw were the two main contenders for the award. The latter subsequently made an improved escapement which is found in most of the chronometers of the present day. (Chronometer is the name given these marine timepieces.) The decision upon this award extended over several years and was attended by most acrimonious debates. The making of the chronometer is one of the most outstanding achievements of horology.

In the last quarter of the century the English began to lose their place in the sun to the French and the Swiss. In France there were LeRoy, Berthoud, and Breguet; and by the close of the century the Swiss had surpassed England in production and were shipping large quantities of watches into England. The workmanship of the English was fine, but they were too conservative, clinging to old methods and ideas.

At the opening of the 18th century clockmaking in America was in its infancy, and England had been the source of most of the clocks and practically all the watches. However, the infant industry found a fertile soil in the United States, and soon clocks were made in large quantities. Efforts at watchmaking were more or less futile in the United States until the 1860's, when automatic machinery was introduced and mass production begun. Today the highest grades of watches are made and in large quantities. Here originated the dollar watch, thus making it possible for nearly everyone to have a watch.

Clockmaking in the United States is too important an industry and the early makers and their products too interesting to be passed over with the preceding resume, so there now follows a brief account or history of some of the most notable makers and their most outstanding productions.

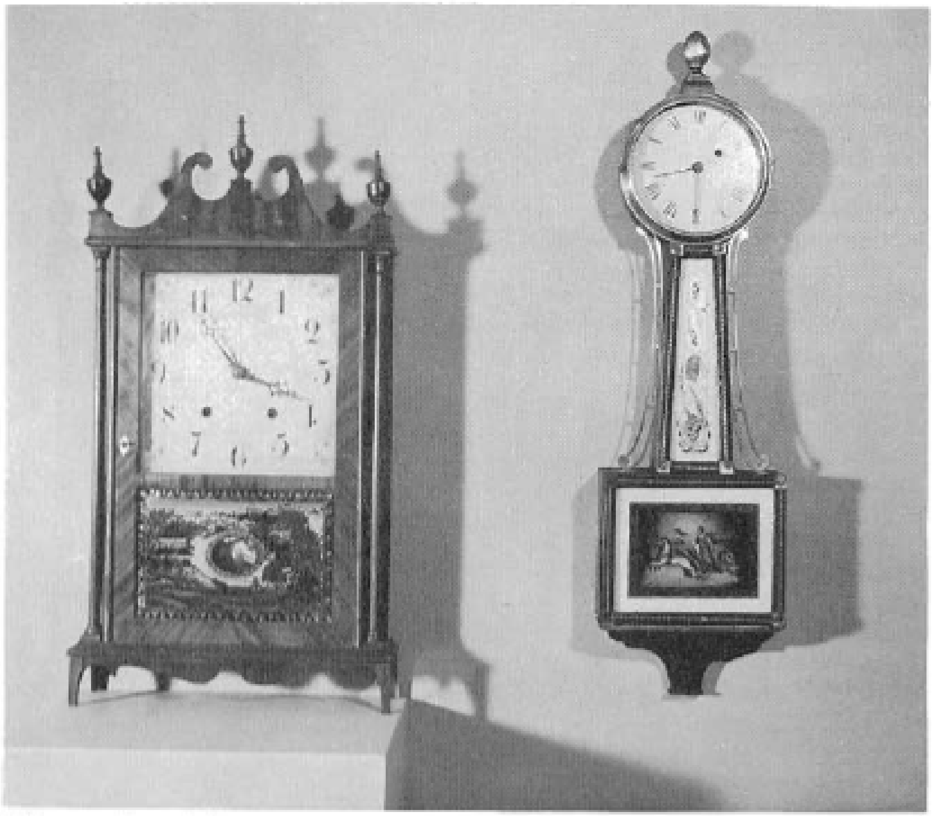
The most interesting period of clockmaking in America was in the first 60 years of the 19th century. The actors in that scene are now all gone, but not forgotten. These men had, to a remarkable degree, vision, initiative, inventive genius, and great courage and perseverance in the face of repeated failures and discouragements. As a result of their labors with their brains and skilled hands, large numbers of clocks of attractive and now most desirable designs were made.

By the time of the 1860's these clocks had begun to lose their popularity and in many instances were pushed aside into closets or attics and replaced by clocks of more ornate design. The grandfather clocks seem to have retained their popularity even to the present.

Little did the makers of these clocks realize the high regard in which they were destined to be held or the avidity with which they were later to be sought. How amazed, too, they would have been had they known the prices the clocks were later to bring — often a price many times their original purchase price.

This period which was more or less a romantic one and characterized by much individual handwork is gone forever, and we are now in the midst of what may be termed the electric and electronic age. I think it can safely be said that the dominating clock today is the electric. It has great accuracy and many other utilitarian points in its favor, but it has no personality or will of its own. It is a mere robot connected by wire with its master, the dynamo in the power house. Disconnected, it is lifeless and useless. If it is just a timekeeper that is wished, it is certainly the most accurate, practical, and inexpensive clock you can have. Too, you do not have to wind it. But if you wish a clock which is

Grandfather Clock by Simon Willard, about 1800.



Pillar and Scroll Clock, by Eli Terry, Jr., wood movement, probably about 1835. Banjo Clock by Aaron Willard, brother of Simon; probably about 1825.

to give you joy and to appeal to your aesthetic nature, then you should have one by Simon Willard, Eli Terry, or other of the grand old makers.

That the watchmakers, and through them the general public, may have a reliable source for setting their clocks and watches in this time-conscious age, the U. S. Naval Observatory sends out at stated intervals each day short wave broadcasts of the time. These time signals are accurate to within a few thousandths of a second.

For the benefit of scientists and others working on radar, loran, television, transmission of photographs, depthing apparatus, and other things requiring accuracy to the millionths, the Bureau of Standards broadcasts time signals continuously, each of which is exactly one second in length, thus providing a standard measure of one second for the use of those doing meticulous split-second work. It is this standard second which the engineer in the power house uses in keeping the electric current to exactly 60 cycles per second, otherwise the electric clocks would not keep accurate time. The clocks which are the source of these standard seconds are controlled not by pendulums, but by quartz crystals vibrating at the rate of 100,000 cycles per second.

One of the more amazing clocks of the present which has no electrical connections and needs no winding is the Atmos clock. This clock has as its motive power the changes of temperature. A change of two degrees is sufficient to wind it.

The evolution of time-telling apparatus forms an instructive, fascinating, and thrilling chapter in the history of civilization.

Few realize the almost total dependence of industry, the railroads, and the ships at sea upon accurate time-telling machines in these modern times. A sudden stoppage of all clocks and watches would cause an almost complete paralysis of industrial life.

APPENDIX

Those who may be interested in the further pursuit of time will find an excellent general discussion in Prof. Willis I. Milham's book Time and Timekeepers (Macmillan, New York) and in the appendix an extensive bibliography.

For technical descriptions of various timepieces and for interesting biographies of many notable watchmakers, Maj. Paul M. Chamberlain's It's About Time (Richard R. Smith, New York) is splendid.

For early American clocks and clockmakers Carl W. Drepperd's American Clocks and Clockmakers (Doubleday, Garden City, New York) and Brooks Palmer's The Book of American Clocks (Macmillan, New York) are recommended.

The statements concerning time and its interrelations with astronomy apply as of the year 1953. With the constant widening of our knowledge of the universe and advance in the methods of determining time some of the statements may have to be modified in the light of future findings.