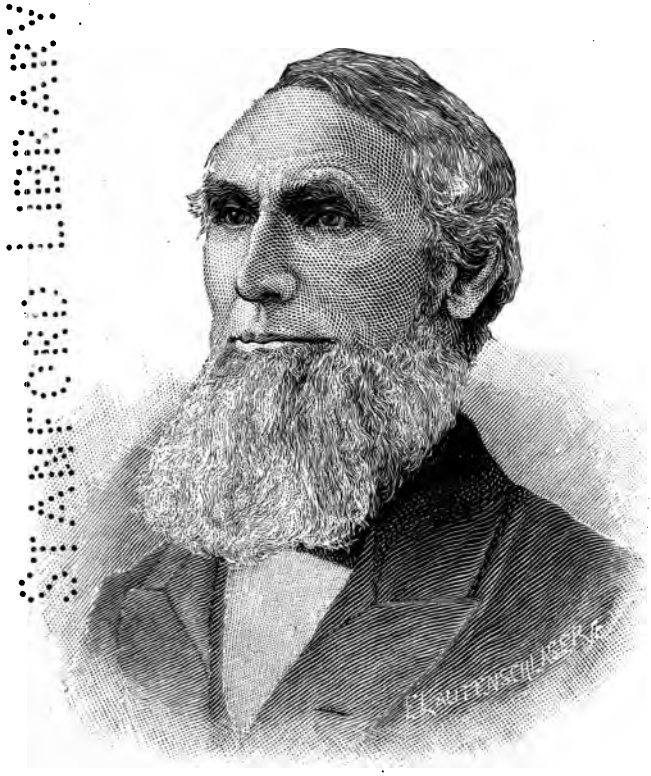
A PIONEER



AARON L. DENNISON
The Father of Interchangeable Watch Material.

HISTORY OF THE

American Waltham Watch Company

OF WALTHAM, MASS.

Reprinted from the History of

THE WATCH FACTORIES OF AMERICA

BY HENRY G. ABBOTT.

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FOREWORD.

Under the title, "Watch Factories of America," sixteen years ago, the writer prepared a series of articles for THE AMERICAN JEWELER, and it was later published in book form. The edition was a limited one of one thousand copies and the book has long been out of print, but the demand for it has been steadily going on.

During the lapse of time new factories have been started and many of the old ones have failed and gone out of business or been given a new lease of life under other names. Men who were then prominent in the trade have passed away and new men taken their places. Factories have been expanded, new machines and methods have taken the places of the old, and so great have been the changes taking place that a new volume must needs take the place of the old to accurately chronicle the changes of sixteen years.

This work presents nothing that is new or startling, but is simply a collection of facts, recorded in presentable shape, in connection with the rise and development of one of the most marvelous growths of a mechanical business that the world has ever seen. In less than one hundred years this branch of industry has grown from the humble factory of Luther Goddard of Shrewsbury, with its weekly product of two watches, to the mammoth Waltham and Elgin factories, with their daily output of as many thousands of the finest productions of mechanical precision that has ever been seen. Surely such a development deserves a history.

The first watches were made in 1500 in Nuremberg and were round, not oval, as has been erroneously stated. They

were made of iron; the staffs, pinions, wheels, cocks, pillars, plates and even the dial being made of this material. The fuzee was not employed until 1509; brass plates were substituted for iron ones in 1530 and oval or egg-shaped watches, known as "Nuremberg eggs," came into vogue in 1550. In 1570 watches of hexagonal and octagonal shape began to be fashionable and in 1575 the mechanism for taking up the mainspring was first applied. It was not until 1587 that the Swiss began the industry of watchmaking,

A Watch of 1500.

and the fuzee chain was the first important improvement made by that nation, it being invented by Gruet in 1590, though not generally used until 1600, a catgut cord being employed up to this time. Watch crystals of glass were first made in 1615; enamel dials were invented in 1635. The balance spring was invented in 1676, the minute mechanism and hand in 1687, and watch jewels and the first keyless watches did not make their appearance until 1700. The

compensation balance was invented in 1749, the duplex escapement in 1750, the chronometer escapement in 1760 and the lever escapement in 1765. The very thin watches of Lepine were first marketed in 1776, the helical balance spring and the seconds hand were first used in 1780

From the above it will be seen that important rudimentary inventions in connection with the watch were not of American origin, and even the thin watches in favor to-day were put upon the market as early as 1776, when this country was still fighting for its independence.

What, then, have we done in the watchmaking line that the people of other countries have not done? We have improved upon the inventions of the European, have made a watch so well that the people of the world demand and use it, have placed them on the market so cheap in price that the laborer may possess them, and, above all, have made them interchangeable so that a part may be taken from one watch and placed in another without changing it in any way and both watches give perfect results. Aside from this, we have invented new forms of springs, more perfect balances, safety pinions and devices too numerous to mention. While the makers of Europe were having their trains made by one man or family, their balances by another, their assembling done in one house and their adjusting done in another, we have been erecting modern factories in which the watch was manufactured complete and ready to be placed upon the market, a monument to American genius.

Lepine made watches as thin as any now in the market and various Swiss makers have turned out watches as small or smaller than any we now make, but, alas! their usefulness was in doubt, for as timekeepers they were failures, and not being made on the interchangeable plan, it cost about as much to repair one as it did to purchase a new movement.

When our watches have been entered in any of the European tests we have never failed to secure a creditable show-

ing, and all this has been brought about by intelligent effort and work done by automatic machinery—machinery which performs the work in an almost human manner and performs it so well that all the hand work of Europe has never surpassed it. This is a few, a very few, of the things that American watch factories have been doing. Europe invented, but it required the skill of the American to bring the watch to its present high standard of perfection and low price.

CHAPTER I.

The term watchmaker, in America, does not necessarily imply one who manufactures watches, but is more generally applied to those who make a business of repairing and cleaning timepieces. In days gone by a watchmaker was a mechanic of no mean order, capable of making and fitting any part of a watch, no matter what make the watch might have been or how complicated its construction, which, through negligence on the part of the owner, became deranged or broken. To-day a watchmaker need be possessed of only ordinary mechanical skill and intelligence in order to repair any watch of American manufacture, and all this change has come about by the manufacturers of the various movements working on the interchangeable system, first applied to watchmaking by Mr. Aaron L. Dennison in 1850.

Mr. Dennison is widely known as "the father of American watchmaking," a title which cannot justly be applied to him, as he was not the first manufacturer of watches in this country, neither was he the first person to make watches in this country by machinery, as we will demonstrate presently. The claim is made, and perhaps justly, that he was the originator of the idea of making watches on the *interchangeable system* and finishing the parts entirely by machinery. This claim the English and Swiss dispute and bring forward proofs to the contrary. However, it is not our intention to argue this matter either pro or con, but simply to record facts which are beyond dispute.

It would be a very hard thing to determine who the first

manufacturer of watches in America was, since in the beginning of the nineteenth century many of the trade manufactured movements in small quantities, either to order or for the purpose of carrying in stock until such time as a purchaser might turn up. These watches were of necessity hand-made, and the manufacturers depended considerably upon Europe for supplies, such as hands, springs, jewels, balances, etc., and therefore to that extent they cannot be regarded as *complete manufacturers,* although they may have delivered *completed watches.*

The Goddard Watch.

In 1809 Luther Goddard of Shrewsbury, Mass., commenced to manufacture watches of the verge pattern, in somewhat larger quantities than had been attempted before. Mr. Goddard could not compete with the cheap foreign watches, however, and retired from the business in 1817, having manufactured about 500 watches. This was the greatest number of watches ever made by one manufacturer in America up to this time.

Following closely in the wake of Mr. Goddard, in 1812 an establishment for the manufacture of watches was started in Worcester, Mass. The establishment was small, and was suspended shortly after for want of ready funds. In 1838 the first machine-made watch ever made in America was placed upon the market. It was known as the Pitkin watch and was manufactured by two brothers, James and Henry

Pitkin of Hartford, Conn. These movements were three-quarter plate, slow train and about the diameter of the modern 16-size. The machinery with which they were manufactured was very crude and was all made by the Pitkin Bros. The Pitkin watch, however, suffered the same fate as its predecessors. The cost of manufacture was too great to compete with those made by the Swiss, and shortly after mov-

The Pitkin Watch.

ing the factory to New York, which they did in 1841, the enterprise was abandoned. The total product of the Pitkins was about 800 movements.

Following Pitkin Bros. came several other small manufacturers, but nothing of importance in this line was attempted until the year 1849, when the nucleus of what is now known as the American Waltham Watch Company was formed.

CHAPTER II.

A person standing on Crescent street, Waltham, and gazing upon the mammoth structure occupied by the American Waltham Watch Company, as a factory, a building whose frontage occupies nearly 800 feet, and which, with its connecting wings, would equal a four-story building over half a mile in length, within whose walls 3,600 employes are daily employed, and from which 16,000 timekeepers are turned out weekly, can scarcely realize that the company has seen failure and disaster staring them in the face on more than one occasion, but such is the fact. The road to success is not always strewn with roses, and although the company is now a large and prosperous one, yet it has struggled with adversity, and has seen the time, when, it might be said, the toss of a penny would have decided whether they would continue, or give up in despair.

In the fall of the year 1849, Aaron L. Dennison commenced to study out machinery for the manufacture of watches on the interchangeable system. Mr. Dennison, who was a dealer in watches, jewelry, tools and materials, in Boston, and who had been educated as a practical watchmaker, undoubtedly got his ideas in regard to manufacturing on the interchangeable system from the Springfield Armory, having visited that institution on numerous occasions, and inquired into their mode of manufacture. He revealed his ideas to Mr. Edward Howard, a manufacturer of clocks at Roxbury, then a suburb of, but now a part of Boston. Mr. Howard agreed with him that the scheme was a plausible one, and a small room was divided off in Mr.

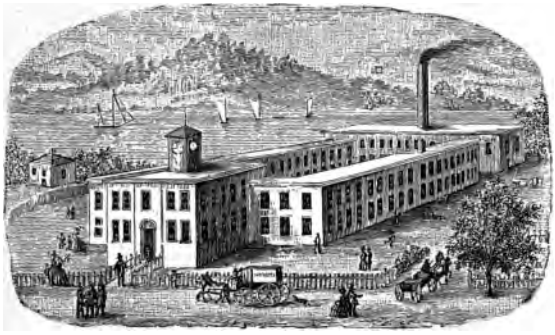
Howard's factory, and there Mr. Dennison commenced work on his machines. In 1850 a small factory was built opposite Mr. Howard's shop, and some English and Swiss watchmakers put to work. Mr. Dennison's machinery did not prove a success, however, and one of Mr. Howard's

Factory of The Boston Watch Co., 1853.

men was detailed to help Mr. Dennison, and after numerous attempts, they finally succeeded in getting together a few tools and machines of anything but perfect construction.

In the summer of 1850 Mr. Dennison completed the model of the first watch, which corresponded with the full plate 18 size of to-day. This watch was made to run eight days, but was pronounced to be impracticable, and its place was filled by a one-day watch. At this time the firm was known as "The American Horologe Company," and consisted of A. L. Dennison, E. Howard and Samuel Curtis. Mr. Curtis took no active part in the management of the

concern, but furnished most of the money with which the buildings and machinery were built. After a lapse of about one year the name of the company was changed to "The Warren Manufacturing Company," and the first hundred watches bore that name. The first watches were actually placed upon the market in 1853. The name "Samuel Curtis" was substituted for "Warren" on the next six or seven hundred watches; the reason being that the name "The Warren Manufacturing Company" was abandoned as being unfitting, and the name "Boston Watch Company" was used



The Waltham Factory in 1857.

instead. These watches were 18 size, full plate, slow train and were sold at $40. About this time Mr. Dennison became dissatisfied with the location of the factory, as it was very dusty in summer and was not fitted as a site for a watch factory. He accordingly started to look up a new location for the factory, and going to Waltham he visited a locality known as Stony Brook, which was then quite active through the work done at Sibley's machine shop. After viewing the piece of land he was not quite satisfied with it and came to Waltham to take a train to Boston. While waiting for this train he met an acquaintance, Samuel Payson Emerson, then foreman of the machine shop of the Boston Manufacturing Company. In the course of conversation Mr. Dennison explained what he was in search of, and

Mr. Emerson told him he could show him just the spot he wanted. They left the station and Mr. Emerson pointed out to him the plot of ground on which the factory is at present located. After examining it Mr. Dennison decided it was exactly the spot he was looking for, and steps were taken to secure the property. At the suggestion of Mr. Dennison a stock company was formed to purchase the property, and this company was known as "The Waltham Improvement Company."

This company was incorporated with a capital stock of $100,000, "The Boston Watch Company" owning thirty shares of $100 each. The building for the watch factory was started at once, and was ready for occupancy in the fall of 1854. At this time the company were making about five watches per day, and employed about ninety hands. After removing to Waltham, the movements were engraved "Dennison, Howard and Davis." The fall of 1856 found the watch company in desperate circumstances. All the ready money of the company had been expended, and the sales of the watches were very slow. Matters went from bad to worse until the spring of 1857, when the company made an assignment. The assignee offered the property for sale, and it was bid in by Mr. Royal E. Robbins, for $56,500, for himself, and the firm of Tracy & Baker of Philadelphia, who were creditors of the defunct company, having furnished them with cases. The property consisted of the real estate, factory, and numerous other buildings, the machinery, steam engine, shafting, etc., together with the material manufactured and in process of manufacture.

The new firm was known as Tracy, Baker & Co., but Messrs. Tracy & Baker having a case business of their own to look after, and having a good offer made them by Mr. Robbins, decided to sell out their interest. Mr. Robbins then associated himself with Mr. James Appleton, and the firm was known as Appleton, Tracy & Co., Mr. Tracy's name being retained, because he was well known to the

trade, although he had no moneyed interest in the concern. The winter of 1857 proved a rough one for the new company. Money was scarce and times hard, and in the spring following, Mr. Robbins made up his mind to remove the factory nearer to New York, which was then the market for his goods.

In the spring of 1858 trade revived somewhat, and Mr. Robbins proposed the consolidation of the watch company and the Waltham Improvement Company, which had been organized to assist the Boston Watch Co. Notwithstanding their previous unfortunate experience their faith in the watch-making enterprise had revived so that they believed that real success in the business was to be expected. They therefore wisely decided to accept the proposal of Mr. Robbins, who sold out to the improvement company, taking his payment largely in shares of the company, but reserving to himself the stock of manufactured watches which he had deposited in certain banks as collateral for borrowed money. Those watches he gradually redeemed and sold, with the result of a fair profit for his two years of anxiety and hard work. When the Waltham Improvement Company purchased the watch factory it paid $100,000.00, plus a bonus of $20,000.00. It also voted to increase its capital to $200,000, and Mr. Robbins subscribed the additional capital. Dr. Horatio Adams was president of the company, W. H. Keith was clerk, and Mr. R. E. Robbins was elected treasurer and general manager. He continued to hold the office of treasurer until three days before his death, which occurred on July 22, 1902.

When this consolidation occurred the *firm* of Appleton, Tracy & Co. disappeared, but the *name* has been a popular one on watch movements made by that company and its successors, and is still in use.

On February 8, 1859, the name of the company was changed, by act of the legislature, to The American Watch Company, and on March 31 of that year the officers of

the improvement company were formally chosen to like positions in the new company. On May 19, 1860, the capital stock was increased to $300,000, and in the same year a dividend of 5 per cent was declared, it being remarkable as being the *first dividend declared on American watch making.* Mr. Dennison remained with the new company until December, 1861, serving in the capacity of superintendent. During this year came the outbreak of the Civil War, which brought the business to a standstill, and threatened to again bankrupt the enterprise. There was little hope of finding a market for the factory product unless it should be so reduced in quantity as to be manufactured at a loss. It was therefore decided to reduce expenditures to the lowest point, but to keep the factory in operation to such an extent as to hold the leading operatives. The hours of labor were therefore reduced, and some of the machinists were employed in the manufacture of small lathes, for which a market was found. Some of the workmen enlisted in the volunteer army, others were discharged, and a very few were kept at work on watch movements and cases. But the calamity of war from which so much was feared became the occasion of great prosperity; for the soldiers in the army wanted watches, and the watch company exerted itself to meet the demand. In common with everything else the prices of watches at that time were high, perhaps relatively higher than at any time in the history of American watch making. As a result the profits were large, and a goodly surplus was gradually accumulated, and in 1865 the capital was increased to $750,000; the additional stock being distributed to the stockholders in the form of a special dividend.

In 1859 the outlook for American watch making was so promising that a number of men left the Waltham factory and organized another factory in Nashua, N. H., with a capital of $100,000, but after less than three years of effort they were compelled to abandon their undertaking for lack of money, and in 1862 Mr. Robbins purchased the entire

plant, save the real estate, and moved it and the unfinished watches (numbering about 1,000) to Waltham. To accommodate this additional machinery the Waltham factory was enlarged, and the prominent men of the Nashua factory were given good positions in the Waltham factory. Among those men were Mr. N. P. Stratton (who went from Waltham as one of the originators of the Nashua factory), Mr. C. H. Moseley and Mr. C. Vander Woerd. Of these Mr. Stratton acted for a time as assistant superintendent of the Waltham

The Factory in 1863 from a Photograph.

factory, and later was sent to London as agent for the purchase of supplies. Mr. Moseley remained in Waltham until 1864, when with several others he went to Illinois and established the Elgin National Watch Company. Mr. Vander Woerd was given the charge of the Nashua machinery, which constituted a separate department of the factory. He continued in this position till 1874, in the meantime having the opportunity to exercise his inventive faculty by the devising of several semi-automatic machines of much value. Recognizing his ability in this direction Mr. Robbins, in 1874, assigned to him the position of mechanical superintendent of the entire factory, and in 1876 he succeeded Mr. A. T. Bacon as general superintendent of the factory, which

position he held till 1883, when he severed his connection with the American Waltham Watch Company. Mr. G. H. Shirley acted as assistant superintendent from 1874 till 1893, when he retired.

The Factory in 1865 from a Photograph.

In 1865 quite extensive additions were made to the factory buildings, including a wing devoted to the manufacture of silver cases, which manufacture was gradually increased, and continued till 1890. A gold case factory also was established in New York City, and run under the supervision of the company's selling agents, Robbins & Appleton.

The success of the Waltham company naturally created or aroused a desire in the minds of others to engage in a line of manufacture which gave such promise of profitable returns, so that quite a number of new watch factories were organized, *and existed for a time.* Of these various factories mention is made elsewhere. They did, however,

produce watch movements, but not cases, so that naturally there was created a demand for watch cases, and case factories were created to an extent hardly justified by the demand. But the fact of their existence gave the Waltham company the opportunity to withdraw from that line of work, and devote their resources of capital, skill, and factory ca-

The Factory in 1870 from a Photograph.

pacity to the production of watch movements alone. With the increasing facilities of additional room and improved machinery the production of watch movements continued to increase until the summer of 1893, when the widespread commercial panic compelled the curtailment of production to but little more than one-half of its previous amount. But the liberal policy of the factory management kept the working force as large as possible and so continued to manufacture much in excess of the requirements of the market, and gradually increased the number of employes. But notwithstanding the almost constant increase it was several years

before the number of employes reached that of 1893. In the meantime, however, great advances were being made in the direction of machine construction, so that the daily product of the factory reached its previous high number long before the number of operatives did so. But both the number of operatives and the daily product of watch movements have steadily increased, and not only so, but the average grade of the movements produced has been gradually raised. Of course the last mentioned fact has resulted from the very favorable conditions of general business. The wonderful accuracy of the new automatic machinery has also been a potent factor in the increasing excellence of the product. The adoption of systematic time inspection by most of the leading railway systems of America has created a demand for watches of a degree of accuracy in performance which was previously uncalled for, and in meeting this demand the American Waltham Watch Company did its utmost. Aside from its mechanical equipment it has an independent astronomical outfit which, by more than twenty years of usefulness, has justified its creation and maintenance. This outfit consists of an observatory building equipped with a transit instrument for observing the passage of stars across the local meridian, a chronograph instrument for recording the movements of the pendulum of a sidereal clock, and also the telegraphic signals made by the observer at and during the passage of the star across the graduated field of vision in the transit instrument. In addition to the sidereal clock there are two "mean time clocks," one of which telegraphicly transmits signals to all parts of the factory which have to do with the adjustment and timing of watches. This astronomical equipment is soon to be reinstalled in apartments now being prepared, and when complete will be equal if not superior to anything of the kind in the world. It is in charge of Mr. H. E. Duncan, of whom personal mention is made in another place.

We have said that the prosperity of the watch company

enabled it to increase its capital in 1865 to $750,000. With a steady increase of business in the few succeeding years a still further increase was required, and in August, 1870, a half million in addition was made, bringing the amount to $1,250,000. But within three years thereafter still more working capital was needed, and $250,000 were added. Mr. Robbins provided the opportunity for employes to subscribe for a portion of this stock on more liberal terms than were allowed to outside parties. The amount of $1,500,000 capital was continued till 1885, when the Massachusetts legislature authorized an increase to $4,000,000, and also authorized the change of corporate name to the American Waltham Watch Company. In March of that year the stockholders voted to increase the capital to $2,000,000, and in March, 1889 they voted another increase of $1,000,000. In 1899 it was voted to still further increase to the limit authorized by the legislature. Of this money a portion was devoted to the enlargement of the factory and its equipment with new and improved machinery. Of course the continued increase in product involves an enormous increase in the number of watch movements in process in all departments of the factory. The production of the factory, however, has increased at a much greater ratio than the increase of its capital, for whereas up to 1884 the total product for the preceding thirty years amounted to 2,515,119, the succeeding ten years saw that number more than doubled (the total product reaching 5,897,035). The decade just passed more than doubled that product, the total being about 12,000,000.

Mention has been made of the enlargement of the factory plant. The successive changes and enlargements are shown by the accompanying views. Not only was the factory enlarged, but the style and construction of the buildings was modified to better adapt them to the improved methods and scale of manufacture. The original factory buildings were built with walls of concrete and the rooms were both low

The Factory of the American Waltham Watch Company in 1904.

and narrow. The second form of construction included wooden frames filled in with brick and plastered on the outside and inside. The last of the original buildings was demolished in 1879. Of the second type only a single wing, which was built in 1865, stood until 1905 and was then demolished. Beginning about 1873 brick construction was adopted, and a third story was built in the first of these wings; a few years later a fourth story was added, and by filling into the river in the rear of the factory sufficient land was obtained to lengthen some of the wings. Estates adjoining each end of the factory were also purchased and built upon. Besides enlarging at both ends and also in front and in the rear, there remained one other direction for enlargement, namely, *the top,* and within the past four years a fifth story has been added to most of the wings. In 1903 a five-story wing was built, somewhat different in style, and of improved construction, making use of steel beams for supporting the floors and roofs.

In the later buildings much attention has been given to fire protection, by adopting what is called the "slow burning construction." As additional stories were made there was needed corresponding provision for the safety of the employes by furnishing means for rapid exit from every room in case of emergency; so that each room has at least two exits.

With changes and enlargements almost constantly in progress, it is hardly possible to give a complete pictorial record, but the views already given will indicate *some* of the successive changes in the factory buildings. It will be readily realized that the great extent of the buildings makes it now impossible to obtain a complete photographic view, but the accompanying illustration shows substantially the present appearance of this great factory. A comparison of this view with that of the original factory will give some indication of the progress in fifty years. But the *actual* advance is much greater than can be shown pictorially.

Waltham Watch Co., 1905, looking across the

There is a peculiar appropriateness in the publication of this history just at this time, from the fact that fifty years ago this month work was begun on the erection of the original Waltham Watch factory.

Just at this writing (March 5th) comes the news of the death of Mr. Edward Howard, of whom mention has been made as having been associated with Mr. Dennison in the inaugurating of American watchmaking. (A more extended notice of Mr. Howard will be found in succeeding chapters.)

Having rehearsed some of the prominent facts concerning the Waltham factory, it is proper to make brief mention of some of the *men* who have been more or less prominently connected with its establishment, its growth and its development.

CHAPTER III.

Leaving our main subject, the watch factories, let us call your attention to the founder of the "Interchangeable System" of making watches in the United States—Aaron L. Dennison, the so-called "Father of American Watchmaking."

Born, March 6, 1812, in the small town of Freeport, Maine, the eldest of a shoemaker's eight children, the conditions of his childhood and youth were not calculated to develop genius, but the struggle of his parents to feed, clothe and shelter their large family, developed perforce in their eldest son, elements of character which were to serve him well in later years.

We find the little lad combining duties of gentle nurse to his younger brothers and sisters with those of efficient general aid to his overworked mother, and when only ten years of age, sawing and chopping the wood used by the family, and carrying the mason's hod for his father, who was building with his own hands, a much needed new chimney for their small house in the village of Topsham.

From this place, the family removed to the town of Brunswick, in the year 1824, where the boy's capable and willing services were so much in demand that, at the age of thirteen, he no longer depended upon his father for support. He worked also with his father at shoemaking. This combat with poverty, however, seriously interfered with his schooling. He was ambitious to know as much as the boys of his own age, who could attend school the year round, so,

Aaron L. Dennison.

with untiring energy, he made up the deficiency by study in the long winter evenings. He soon showed such a passionate love for all mechanical industries, and such a distaste for shoemaking, that his father, in 1830, decided to apprentice him to James Carey, a watchmaker in the town, with whom he remained three years. It was during this time that young Dennison first thought of making watches by machinery. With absolutely no practical knowledge of machines excepting that gained at his master's bench with a watchmaker's lathe, he saw possibilities which only the brain of a mechanical genius could conceive. There are still in existence I believe, some of the working models in wood, executed roughly by him at this time with penknife and a few tools, the first outcome of those conceptions which were destined to accomplish such wonders a few years later.

In 1833 he went to Boston, to perfect himself as journeyman watchmaker, entering the employ of Currier & Trot, and later, we find him with Jones, Low & Ball. While at work with the latter firm he had the benefit of the friendship and advice of Tubal Hone, one of the finest watchmakers then in the country. Here also, while repairing the best hand-made watches, he noticed their often faulty construction and workmanship.

In a letter written in 1835 he said: "Within a year I have examined watches made by a man whose reputation at this moment is far above that of any other watchmaker in London, and have found in them such workmanship as I should blush to have it supposed had passed from my hands in our lower grade of work. Of course I do not mean to say that there is not work in these watches of the highest grade possible to carry the finisher's art, but, errors will creep in and escape the scrutiny of competent examiners."

In 1839 he started in business in Boston for himself, doing repairing for the trade and carrying a line of tools and

materials. This shortly developed into a thriving business with a full line of watches and jewelry, and at about this time he invented and brought on the market the "Dennison Standard Gauge." His business being now on a firm footing, Mr. Dennison, with the unselfish zeal to benefit others, which was one of his chief characteristics, turned his thoughts toward bettering the condition of his parents by finding an easier and more lucrative occupation than shoemaking by hand for his father, who was getting on in years.

While importing a line of cards, small tags and jewelry boxes from France for the trade, it had often occurred to him that these supplies could be manufactured in the United States with simple machinery and be supplied to the trade at far less cost than the imported article. Why would not this be just the thing for his father, as the son could find a market for all he could make? The outlay for material would be slight—all that was required was a few labor saving devices to cheapen manufacture. His active brain soon invented a machine for cutting the cardboard and paper to standard sizes and contrived simple devices to facilitate finishing. With roll of material in hand, he started for Brunswick to propose and arrange the new business for his father, which proved such a success that in fifteen years' time the old gentleman retired, selling out to his son, E. W. Dennison, the able founder of the "Dennison Mfg. Co.," of which this was the modest beginning.

Mr. Dennison now began to turn his thoughts in earnest toward the dream of his youth, the manufacture of watches on what is now known as the "Interchangeable System," and here it may be as well to state that, among the objects which spurred Mr. Dennison on was the need of the masses, and especially of the American artisan, to be supplied with a reliable timekeeper at a price within his means. The foreign cheap grade watch which he could afford to buy being wholly unreliable; and, further, he desired to estab-

lish a fine mechanical industry in our country which would tend to raise the standard of skilled labor and give employment to talented mechanics. Pecuniary success was always a minor consideration with him, and, as is generally the case with inventors, he never became a rich man.

We will here use Mr. Dennison's own words: "The principal thinking up of the matter was done when I was in business at the corner of Bromfield and Washington streets in Boston. Many a night after I had done a good day's work at the store, and a good evening's work at home, repairing watches for personal friends, I used to stroll out upon the "Common" and give my mind full play upon this project, and, as far as I can recollect what my plans then were as to system and methods to be employed, they are identical with those in existence at the principal watch factories at the present time."

In 1846 Mr. Dennison predicted that within twenty years' time watches would be manufactured with the same expedition and with the same system and perfection with which firearms were then made in the Springfield armory. He often visited this armory and took great interest in examining the various processes of finishing firearms.

In 1849 his good friend, Edward Howard, had a long talk with him in regard to the manufacture of steam fire engines. He did not agree with Mr. Howard in his ideas about their manufacture, and soon convinced him that the manufacture of watches on the interchangeable plan would prove a far more profitable undertaking. Mr. Howard soon became as enthusiastic over the idea as Mr. Dennison and, together, they went in search of a capitalist who was willing to risk some money in the experiment. This gentleman was found in the person of Samuel Curtis of Boston, who furnished $20,000 for the purpose. Mr. Howard's partner in the clock and scale business, D. P. Davis, became also interested, and the three projectors met at an early date to

enabled it to increase its capital in 1865 to $750,000. With a steady increase of business in the few succeeding years a still further increase was required, and in August, 1870, a half million in addition was made, bringing the amount to $1,250,000. But within three years thereafter still more working capital was needed, and $250,000 were added. Mr. Robbins provided the opportunity for employes to subscribe for a portion of this stock on more liberal terms than were allowed to outside parties. The amount of $1,500,000 capital was continued till 1885, when the Massachusetts legislature authorized an increase to $4,000,000, and also authorized the change of corporate name to the American Waltham Watch Company. In March of that year the stockholders voted to increase the capital to $2,000,000, and in March, 1886, they voted another increase of $1,000,000. In 1899 it was voted to still further increase to the limit authorized by the legislature. Of this money a portion was devoted to the enlargement of the factory and its equipment with new and improved machinery. Of course the continued increase in product involves an enormous increase in the number of watch movements in process in all departments of the factory. The production of the factory, however, has increased at a much greater ratio than the increase of its capital, for whereas up to 1884 the total product for the preceding thirty years amounted to 2,515,-[illegible], the succeeding ten years saw that number more than doubled, the total product reaching 5,807,035. The decade just passed more than doubled that product, the total being about 12,000,000.

[illegible] has been made of the enlargement of the factory plant. The successive changes and enlargements are shown in the accompanying views. Not only was the factory enlarged, but the style and construction of the buildings was modified to keep abreast of the improved methods and tools of manufacture. The original factory buildings were built with walls of concrete and the rooms were but low

The Factory of the American Waltham Watch Company in 1904.

Birmingham, under the firm title of Dennison, Wigley & Co., and commenced their manufacture with such good results that the firm were soon able to compete successfully with manufacturers both in this country and Switzerland, with such ample means at its command with which to overcome all errors and obstacles.

Mr. Dennison was the active and efficient head of the firm until Nov. 30th, 1894, when he was taken ill and died on the 9th of January, 1895, in his 83d year. He retained full possession of his inventive faculties to the last. In fact, the drawing on which he was engaged a few weeks before his death proved to be a most important improvement to one of the machines then in use and was at once adopted.

Mr. Dennison left a wife, two sons and two daughters. The eldest son was for many years one of the principal men in the London office of the Waltham Company. The youngest son was in the case business with his father from the start, and now takes his place in the firm.

It may be interesting for his countrymen to know that Mr. Dennison is buried in the churchyard of the old church in Handsworth, where rest the remains of the celebrated James Watt. Having finished this brief sketch of his business career it only remains to enumerate some of the salient points of his character that you may form a picture for yourselves of the man. He possessed the refined instincts of a true gentleman. Modest and retiring in manner, frugal and temperate in all his habits of life, cheerful and resigned to the dispensations of Providence, with high moral courage and hatred of injustice, which caused him to take the part of the weak and oppressed. He had a keen sense of humor and a strong love of the beautiful in nature and art, an exceptionally sound judgment and clear insight into future conditions in business. His treatment of all who came in contact with him was marked with upright dealing and sympathetic consideration and care for

their welfare. In a word, the "Golden Rule" seemed to be the guiding principle of a long life of strenuous toil of brain and hands. The portrait at the head of this chapter is taken from a photograph made by his youngest son about ten years before Mr. Dennison's death, and is considered to be the best one ever taken of him. It gives but a hint of the fine head poised above the slightly stooping shoulders, the clear, grey eyes with often a humorous twinkle in them peering from under the bushy eyebrows, and the kindly smile so rarely absent, which those who knew him remember so well.

Royal Elisha Robbins.

CHAPTER IV.

Royal Elisha Robbins, who for forty-five years was treasurer of the American Waltham Watch Company and senior member of the firm of Robbins & Appleton, distributing agents for the company, died July 22, 1902, at his country home at Pride's Crossing, Beverly, Mass., aged 78 years.

He was a man of sterling worth and merit, who never forgot the interest of the humblest employe in the big factory. The needy never sought in vain his help. A vigorous specimen of manhood, he continued business until his final sickness overtook him. Many will recall his kindly acts to employes in distress, his advice to young men struggling into business life, and his general kindly and sympathetic character. His policy was unlike that of many men of the day, inasmuch as he never discharged an employe because he had outgrown his usefulness. He believed that an employe who had grown old in the harness was entitled to share with him the results of his labor. He gloried in the fact that the company had never had a strike.

He was essentially one of the fathers of American watchmaking, and the people of Waltham recognize that to him more than to any one man the success of the city is attributable. His portrait hangs in the city hall at Waltham, being presented to the city by the company and being paid for by contributions of the stockholders and employes of the company in twenty-five and fifty-cent pieces. The accompanying likeness of Mr. Robbins was made from this portrait. A park and a school in the city were named in his honor, and he was held in the greatest respect by every citizen of the busy manufacturing city.

Mr. Robbins was born in Kensington, a parish of Berlin, Conn., on March 10, 1824, and attended a private school until twelve years of age. His father, the Rev. Royal Robbins, was a graduate of Yale College and a minister of the orthodox Congregational Church.

At the age of twelve he went to the Worthington academy, where he remained three years, when he secured a situation as a clerk in a store at Hartford. In the fall of 1841 he received an invitation from his uncle, Chauncey Robbins (who was an American merchant and member of the firm of Robbins & Martin, Birmingham), to visit him. In November he set sail for Liverpool on the packet ship Patrick Henry. The firm of Robbins & Martin were engaged in the purchase of goods of English manufacture for the American market, and handled quite a quantity of English watches. The young man was offered a position by his uncle, which he accepted, and finally the full charge of the watch department was placed in his hands. For five years he continued with this house and upon its dissolution in 1846 he returned to New York and started in business for himself in Cedar street as an importer of English watches, having gained a thorough knowledge of the business while with his uncle's firm. After two years he took as a partner in the business his brother, Henry A. Robbins, and the business was removed to larger quarters in John street, the firm being known as Robbins & Bro. A year or two later Daniel F. Appleton became a partner in the business and the firm name was changed to Robbins Bros. & Co.

During the fall of 1856 Mr. Robbins' health was very poor, and on January 1, 1857, he retired as a general partner, but still retained his interest in the firm, the name being changed to Robbins & Appleton. These few years of experience in the watch trade had, however, served as a preparation for his life's career, which was then about to begin. In the following May he went to Waltham, Mass., in the interest of Tracy & Baker of Philadelphia, who were manufactur-

ers of watch cases, and who were creditors of the Boston Watch Company for cases which had been furnished them but for which they were unable to pay. The watch company's property being put into the hands of an assignee, he offered it for sale by auction. Tracy & Baker hoped to secure as much as possible out of the wreck and entertained the project of purchasing the factory, provided the price did not get too high. Mr. Robbins proposed to assist them in their project, to the extent of a loan of $35,000. By some misunderstanding he continued bidding on their behalf with the result that at last the property became theirs, to their immediate disgust and their subsequent loss, for after a few months' attempt at managing it they abandoned the enterprise entirely, with all they had invested in it.

Daniel Fuller Appleton.

CHAPTER V.

Daniel Fuller Appleton, merchant, was born in Marblehead, Mass., in 1826, son of General James and Sarah (Fuller) Appleton. His first American ancestor was Samuel Appleton, who came from England in 1635 and settled in Ipswich, Mass., on land still in possession of the family, being occupied by the subject of this sketch, at the time of his death, as a summer home. Samuel Appleton was the ancestor of all of the name in New England, among whom have been some that became distinguished in the State of Maine, notably, the Hon. John Appleton of Portland, member of Congress and United States minister to Russia; Rev. Jesse Appleton, D. D., second president of Bowdoin College, and Chief Justice Appleton of Bangor. General James Appleton, the father of our subject, removed from Marblehead to Portland in 1833. He became actively interested in politics, was several times the candidate for governor of the old Liberty party, the forerunner of the Republican organization, and was a conspicuous advocate of anti-slavery and of temperance. He was an especially determined advocate of prohibition as applied to the liquor traffic and was the first man anywhere to propose and propagate that principle—first by petition to the legislature of Massachusetts in 1831, and afterward, in 1837, by a report to the Maine legislature, of which he was then a member. Daniel F. Appleton was educated in the public schools of Portland and, best of all, in his own home. His is the old story of a young man leaving home at the age of twenty-one, with an ambition to do the best he could to rise in the world and make as much

of fortune as the opportunities of the great city of New York would afford. Although he was without money and had no friends there who could assist him, he had not much trouble nor many difficulties in getting a start. After employment for a few months with a concern that soon went out of business, he answered the advertisement for a clerk of Royal E. Robbins, an importer of watches, by whom his application was at once accepted. His connection with Mr. Robbins continued from that day to the time of Mr. Robbins' death, he having been admitted after a few years to a partnership in the business, forming the firm of Robbins & Appleton, which firm in 1857 became the owners of the then young and small watch works at Waltham, Mass. The firm soon after organized and established the American Waltham Watch Company, which business they have conducted continuously ever since. To the advancement and success of that business Mr. Appleton gave his constant and active attention. In the earlier years of the company's existence, his energies were mainly devoted to the selling of the product and it was through his activity and great ability that the American watch was successfully placed before the buying public all over the world. It is a remarkable incident that he, with Mr. Robbins and his younger brother, Henry A. Robbins, continued together in the same business actively for forty-nine years. It is to be noted that Mr. Appleton was content to begin and continue in the business of a watchmaker, in which he was brought up in the store of his elder brother, James, in Portland; and that he sought to enlarge and develop that business until his concern became the greatest watchmakers in the world. Mr. Appleton, though he never sought office, had been at times active in the councils of the Republican party, to which he came by evolution from the old Liberty party. He was a member of the first national convention of that party, held in Philadelphia in 1856, when General Fremont was nominated for the presidency, and has ever since given his active and earnest sup-

port to the party. Of all the many New England boys who have come to New York to seek their fortune, and have contributed so much to the welfare and glory in many professions of that great city of their adoption, not many have attained a more prominent social position or a higher commercial standing than the subject of this sketch. He was one of the founders of the Union League Club of New York, and at one time its vice-president; a member of the Century, Metropolitan, Grolier and various other club organizations, and served as president of the New England Society of the city of New York in 1878-9. Mr. Appleton died on Friday, February 10, 1904, at his residence, 28 E. Thirty-sixth street, New York, in his 78th year. Mr. Appleton was twice married, first in 1853 to Julia Randall, and second in 1889 to Susan Cowles. He has three sons and two daughters: Francis Randall, Randolph Morgan and James Waldingfield Appleton; Mrs. Gerald Livingston Hoyt of New York and Mrs. Charles S. Tuckerman of Boston.

CHAPTER VI.

Of course, in starting into the manufacture of watches, as did Edward Howard and Aaron L. Dennison in 1850, one of the essential matters then, as now, was to decide upon a model of the watch which the factory proposed to turn out. This, of course, it was necessary to do before any tools or machinery for the building of the watch could be commenced. While Mr. Dennison was a pretty fair watch repairer, he did not consider that he was equal to the task of making a model for the proposed watch, and this work was intrusted to two brothers, Oliver and David Marsh. They were soon joined by Mr. Chas. S. Moseley, whose name is familiar in many of the watch factories in this country, and to whom credit is due for designing much of the machinery which is now in use in watch factories. Among others who were engaged on the original watches and machines, it is proper to mention here James Baker, who afterwards became a foreman of one of the departments of the Waltham factory, which he left in 1874 and engaged in the mercantile business, returning, however, after a few years' absence.

David S. and Oliver Marsh went to work in a small room which was partitioned off in the Howard and Davis watch factory, and they produced two models, both of which were designed to run from seven to eight days with one winding. An illustration of this original model watch is shown herewith. After thoroughly looking over the field and talking to the jewelry trade in regard to this model, it was finally decided that it would be unwise to enter the market with a

watch of this character and a simple one-day watch was finally adopted as the model. Before the new factory was in operation, however, the Marsh brothers severed their connection with it, but after a few years' absence David Marsh returned to the company and for several years was engaged in adjusting the high-grade movements.

David S. Marsh was born in Calais, Vt., in 1826. In 1868 he abandoned the watch business and for a few years carried on a mercantile business in the city of Waltham. He retired from active business on his own account in 1882 and died on March 10, 1901. The original model watch,

Dial and Plate View of the Eight Day Watch.

which is herewith illustrated, is now owned by his son, a resident of Waltham.

Oliver B. Marsh was also born in Calais, Vt., and at an early age showed a natural inclination for mechanics and the solving of mechanical problems. After leaving the firm of Dennison, Howard and Davis, he went to Newark, N. J., and entered the employ of Jas. M. Durand, the watch case maker, and in 1857, with his brother David, he opened a jewelry store, and later continued the business alone for a number of years, and finally moved to Binghampton, N.

Y., where he opened a jewelry establishment. He died on March 18, 1894.

James Baker, of whom we have spoken, was born in Newport, N. H., in March, 1827, and was educated in the district schools of that town. He worked at farming until

David S. Marsh.

he was nineteen years of age, when he went to Nashua to learn the machinist's trade. Later on in life he went to Boston, when he entered the employ of Leo & Blodgett, manufacturers of the first practical sewing machine made in this country. In 1852 he commenced work for Dennison, Howard & Davis as a tool maker and machinist, but was *soon set at work on* the escapement, making the pallets,

forks and wheels, and he worked on the first watch which was turned out in that factory. As the business gradually developed, Mr. Baker was promoted to the position of foreman, and when the company moved to Waltham, he went with them and remained with the company nearly all the time during a period of thirty-seven years. He was a clever mechanic and painstaking man and was peculiarly fitted for this duty. He died on December 21, 1897.

N. P. Stratton had a varied experience in the early watch factories in this country. He was born in Northfield, Mass., in June, 1820, and was educated in the schools of that town. In 1836, he was indentured apprentice to Henry and J. F. Pitkin, who were at that time jewelry manufacturers at East Hartford, Conn., and who failed during the financial crisis in 1837. In the fall of that year Henry Pitkin conceived the idea of manufacturing watches, and Mr. Stratton commenced work on tools and machinery for this enterprise, continuing work during the remainder of his apprenticeship. Ambrose Webster, who was pretty well acquainted with all of the early watchmakers, stated that the Pitkins made a thousand watches in all and that they attempted to make uniform interchangeable watches, cutting the wheels in stacks and making all parts interchangeable as far as possible with the crude appliances of those days. Mr. Stratton also declared that they secured an interchangeability equal to that secured by the present methods. After the discontinuation of the Pitkin factory, Mr. Stratton worked at various mechanical pursuits until 1849, when he entered the employ of A. L. Dennison as watch repairer. In this position he stayed but a short time, as Mr. Dennison had arranged with Howard and Davis to engage in the making of watches by machinery. It has been suggested by those who were very conversant with the early history of watchmaking in this country that it is very possible that Mr. Dennison got his idea of interchangeable watch parts from N. P. Stratton. On March 1, 1852, Mr.

Dennison offered Mr. Stratton the position of assistant superintendent in the Roxbury factory, which he gladly accepted, manufacturing being more to his taste than repairing. When the new company undertook to gild their movements, they found that they were undertaking something of which they knew nothing, and so great were the obstacles that they finally sent Mr. Stratton abroad to learn the electroplating process, which was then coming into use in England. Mr. Stratton first introduced the hubbing of wheels, to save staking them on pinions, and also introduced the peep holes in order to study the action of the escapement. The first attempt to copy an English watch with ratchet tooth 'scape wheels caused so much difficulty in the manipulation of the wheel that the club tooth became necessary, and Mr. Stratton urged its adoption very strongly, and his views were finally acceded to. For many years, Mr. Stratton was assistant superintendent, and during Mr. Dennison's absence in England, acted as superintendent of the Waltham factory, and his mechanical skill and energy are quite an important factor in the development of that institution. He was sent to England as purchasing agent of the company, where he remained in all some seventeen years. He crossed the Atlantic thirty-two times in the interest of watch companies. When the American Watch Company decided to introduce their watches in England Mr. Stratton's acquaintance with the English market proved valuable, and he opened the London office for the company in 1874. A further reference to Mr. Stratton will be found in the history of the Nashua Watch Company to follow. He retired from business in 1880 and died Dec. 29, 1888.

Jas. T. Shepard was another of the early watchmakers. He was born in Springfield, Mass., in 1824, and was educated in a private school and afterward in a high school. He first took up architecture, but his natural taste soon led him into the working of metals, and he secured a situation in the Springfield Armory, where he remained a number of

years. Through the influence of his brother-in-law, Mr. Stratton, he secured a situation with Dennison, Howard and Davis in 1853, where he first worked on fitting trains and was afterwards given steel work, such as regulators, hair spring studs and what is termed flat steel work generally. In the making of regulators, great difficulty was experienced in securing flatness during the tempering, and Mr. Shepard introduced a system of straightening by pressure while the temper was being drawn. He also introduced the use of pulverized Arkansas oil stone for grinding purposes, which proved far better than any grinding powder that has ever been used. Mr. Shepard moved with the company in 1854 to Waltham and for a number of years had charge of the flat steel work. In fact, from the time when only one boy was employed on the job until 1893. All the stem winding and all the flat steel and regulators, clicks and click springs were made in this department, also the damaskeening on the steel work and the fitting of the stem winding of all grades of watches and the gold wheel finishing. Before the factory had adopted the better methods of machinery building, Mr. Shepard developed many crude devices, which were afterwards worked up in machinery of a better class, such as machines used for rounding regulators, etc., and being a man of good taste in the matters of finishing, he showed a great deal of skill in finishing and polishing steel work, raying and combinations of polish, etc. Mr. Shepard severed his connection with the Waltham factory in 1893, and is now living quietly in Waltham.

E. C. Fitch.
President of the American Waltham Watch Co.

CHAPTER VII.

Mr. Ezra Charles Fitch has been president of the American Waltham Watch Company since 1886. He comes from a somewhat noted ancestry, being a descendant of Thomas Fitch, governor of Connecticut, and Ebenezer Fitch, president of Williams College. Another relative was John Fitch, the real inventor of the steamboat.

His father was a sea captain in the mercantile service, and during one of his trips, accompanied by his wife, Ezra was born in Bremen in 1846. As a boy he attended the public schools in Worcester, Massachusetts. His business career began with his employment in Worcester, Massachusetts, to learn the trade of watch-making or repairing. Later he entered the employ of Bigelow, Kennard & Co. in Boston, as a clerk, but after a comparatively brief term of service with that firm he entered the employ of Robbins, Appleton & Co. of Boston, selling agents of the American Waltham Watch Company. After a few months of service in Boston he was transferred to the New York office of Robbins & Appleton, for whom he traveled over a good portion of the United States in the interest of Waltham watches.

But after a year or two of this experience he was retained in the New York office, of which he became the manager, and also became a member of the firm. His experience as a salesman, both on the road and in the home office, brought him in contact with all the important watch dealers in the United States, and gave him exceptional opportunities to learn the wants of the watch trade; and his dealings with men qualified him for a field of work and usefulness which

he had not anticipated, and which he was loth to enter. But the judgment of his associates led him to forego his personal desires, and accept the position of resident manager of the watch factory, which duties he assumed in 1883. His influence was soon manifest in improved conditions at the factory; and on the death of the president of the corporation in 1886, Mr. Fitch was chosen to that office, which he has continued to hold to the present time (1904). His extensive commercial experience, combined with his practical experience of more than thirty years in the manufacture of both watch cases and movements, have naturally given him a most prominent position among the watch manufacturers of America, so that his judgment on matters affecting the business carries great weight.

He also possesses inventive ability to an extent quite unusual among men whose training has been largely along commercial lines. Perhaps the most important, as well as one of the earliest of his inventions, was that of the dust-proof watch case, commonly known as the screw bezel case. In this line of case construction Mr. Fitch was the pioneer, the work of later inventors being in the nature of modifications of his original patent. The manufacture of these cases proved profitable, and subsequently the right to engage in their manufacture was obtained by other case makers.

The largely increasing product of the watch factory, with its multiplicity of detail, and his connection with the commercial branch of the business, impose a heavy burden of care, so that Mr. Fitch has within a year called to his assistance his oldest son, Conover, who had previously acquired some commercial experience in several of the distributing offices of the sales agents.

Royal Robbins.

CHAPTER XV.

Mr. Royal Robbins, the treasurer of the American Waltham Watch Company, was born in Boston, December 12, 1865. He is the eldest son of the late Royal E. Robbins. He was graduated from Harvard in 1887, "magna cum laude," and was married in 1888 to Theresa, daughter of the Reverend Doctor Huntington of New York, and has two children.

In 1887 he became a member of the firm of Robbins & Appleton, and in July, 1902, he succeeded his father as treasurer of the American Waltham Watch Company.

Many inducements have been held out to him to enter politics, but aside from 1892, when he represented the Back Bay district in the Boston city council, and in 1893 and 1894, when he served the same district in the Massachusetts house of representatives, he has steadily refused to accept the proffered support of important people for various offices. He evidently believes in the advantages that accrue from concentration of effort, and has devoted himself pretty exclusively to the watchmaking business, although, in 1903, he was appointed by Governor Bates to represent the employers of Massachusetts on the Special Commission on Relations of Employers and Employes, and served with efficiency and distinction on that committee. The *Boston Home Journal,* in speaking of him, in August, 1902, said: "He is a man of earnest and thoughtful character, and Waltham feels great confidence in his ability to continue the industry in the lines that have made for success in the past, and built up an important town to be a prosperous and flourishing city."

He is a member of the University, Essex County and Eastern Yacht Clubs, and is a director of the American Loan & Trust Company and the Home Market Club.

CHAPTER VIII.

Duane H. Church was born in Madison County, New York State, in 1849, and at the age of sixteen began his apprenticeship as a watchmaker under the instruction of J. E. Gridley of St. Paul, Minnesota, whose constant admonition to the young mechanic was "Never leave a piece of work until you have done the best you can do"; Mr. Church said that he believed his own success was largely due to having this injunction so often repeated to him by Gridley, who was most conscientious and highly successful in his vocation. The words may have furnished a formula expressive of the dominating motive of his work, but even a slight familiarity with what he has done is quite sufficient to convince the observer that Mr. Church could not possibly construct a new tool which was not very much superior, both in general conception and in details, to all that had gone before. After completing his work under Gridley's instruction, Mr. Church worked for seventeen years as a watchmaker at the bench, principally for Matson & Co. of Chicago, and for St. Paul establishments, all of this time giving no hint of his latent powers as a tool-maker, though he was accounted one of the best of watch repairers; finally he attracted the attention of the officers of the Waltham company, which at that time needed the best watchmakers obtainable, and entered its service, first traveling one month on the road in "missionary" effort, asserting machine-made watches to be superior to all others—a proposition much more nearly true now than it was then. Next he was for another month in the Boston office of the company on ex-

Duane H. Church.

perimental work, and finally, in 1882, reached the factory and at once took the position of master watchmaker, which he held for eight years, during which he greatly improved the general design of the watch movements and devised the highly important form of pendant setting watch which enables stemwinding movements to be placed in cases not specially fitted to them—the most valuable feature, commercially, ever applied to watch construction.

Finally, after twenty-five years of intimate association with watchmaking in all of its forms, Mr. Church began his great work of advancing the use of Maudsley's slide rest and Stone's turret to what is now by far the most exalted plane of development known, and giving those elements powers which appear impossible of farther advancement, these tools being fully automatic, and in all instances completing the piece produced before letting it go, no matter how many or how complicated the operations to be performed.

Mr. Church added to the slide rest and turret two new elements—first, that of compressed-air-driven piston-and-cylinder actuation of his automatic-machine members, and, second, a perfectly exact series of transfer elements, having the power to take a piece of work from one machine and place it accurately in another machine, with a beauty of action and precision of effect which seem to the experienced observer, when he sees these automatic machines in operation for the first time, to fall very little short of the miraculous.

In addition to the pneumatic and transfer elements, Mr. Church originated an automatic grinding machine, which produces cylinders and cones with absolutely no measurable variation in dimensions, wholly without human intervention, and at a saving of at least three-quarters of the cost of producing ground work under manual attendance. The production of cylinders of uniform diameter is an indispensable necessity of the highest development of tool-making, and this automatic grinding machine was one of the most

wonderful advances in the whole history of tool-making. The possibilities of the machine are as yet almost wholly unknown to the world of mechanics, and apparently equally unappreciated, the tools not being in use anywhere outside of the Waltham shops, although the inventor is perfectly willing they should go into authorized general use. Space does not permit a full description of the machine. It may be said that the use of the grinding-wheel periphery as the effective abrading surface is wholly abandoned, grinding rings being used in place of grinding wheels, and that the grinding ring is advanced toward the axis of the work in process of grinding until its working surface touches a diamond, when the machine draws the ring back, removes the ground piece of work from the machine, places another piece in position, and starts the ring to grinding it. This machine is adapted to be used on work of any ordinary size, and can produce true cylinders and cones at far less cost than anything else known.

When Mr. Church took the position of superintendent of toolmakers at the Waltham factory, the theory of step-by-step production was in force. There were roughing cuts and finishing cuts on the same piece, made in different machines and involving separate handlings. Mr. Church had become fully convinced that the cheapest and best method of machine-part finishing was formulated in Gridley's admonition, "Never leave a piece of work until the best possible effect has been gained"—that is to say, once a piece is in the grasp of an automatic machine it should not be released until fully completed. In the ten years during which he has been in charge of the Waltham tool-making he has succeeded in carrying out this conception of complete production with only one handling in the making of many of the watch parts, the plate-drilling machines being the most impressive of all of his creations, because they are the largest, and the superlative accuracy of their transfer movements is plainly observable. When he took the plate-drilling in hand it was

done through jigs handled by girls, each girl having a drilling machine with three vertical spindles carried in one head, each spindle rotating a different tool, and having an independent feed motion. Each girl drilled in a watch plate all the holes of the sizes produced by the three drill spindles of her machine; then the plate was taken out of the jig and passed on to the next operator, who placed it in another jig and went on to drill the holes of the sizes produced on the machine under her charge. In spite of the utmost care possible this step-by-step production produced imperfect plate drilling and made trouble without end.

Mr. Church had a clear conviction that there should be no jig work, which means that all holes must be located by the axis of rotation of the drill spindle, the drill itself having no surrounding exterior guiding surface, and hence that, for each hole, the plate must be brought to exact position in relation to the drill-spindle axis; if the plate could be held, say, horizontally over a rising drill spindle or cutter spindle, then the desired operation could be properly located in the plate. There are about one hundred and sixty different operations to be performed on a full plate; each vertical spindle head could conveniently carry as many as six spindles and it was clearly possible to place as many heads, each carrying six tool spindles, as were needful, on one long frame, and provide each of the six-spindle vertical heads with overhead plate holders, and to transfer the watch plates from one plate holder to another, successively, each plate holder correctly locating the plate over some spindle carried in one of the revolving spindle heads. It was also clearly possible to begin operations on the watch plates by supplying them in filled delivery magazines to the drilling machines, so that the transfer arm and hand could take a plate from the magazine and place it in the first horizontal plate holder, and from this first plate holder another transfer arm and hand could take the partly completed plate and deliver it to the next plate holder in sequence, until, at last, the

final delivery arm and hand should place the completely drilled plate in a receiving magazine, located at the end of the machine farthest from the delivery magazine through which the plates are given to the machine.

Here, then, was a clear, clean-cut, general scheme of plate drilling—which was, however, wholly impossible of construction with any details then known in tool-making. The horizontal plate holder could be mounted on two of Maudsley's slides, one carried by the other, and these slides could be so moved as to bring any point in the plate over the axis of the tool carrying spindle below—but how?

The answer Mr. Church made to this apparently unanswerable question was wonderfully simple and wonderfully suitable.

It was wholly impossible to produce the double motion of the plate carriers by means of cams and levers, for two reasons: first, want of possible accuracy, and, second, want of room. It was impossible to place the required number of cams and levers in their proper relation to the plate holders and spindles, and cams and levers being the only means known for operating automatic tool members, it was clearly impossible to construct this ideally perfect plate-drilling machine. The requirement was some device which would move two comparatively heavy slides, quickly and certainly, to positions absolutely certain with relation to a fixed point, which employed no mechanism, and was not subject to wear of any description. Could absurdity of mechanical demand go farther?

Yet these impossible conditions were met in the easiest manner possible by the use of compressed-air pistons and cylinders, applied directly to the moving parts, so that, whenever air pressure was admitted to a cylinder, the piston instantly drove the connected member to a flat contact stop of hardened steel, the rapidity of traverse and intensity of the contact blow being perfectly controlled by the air-admission cocks, which are cam-operated. With this

beautifully simple and perfect machinery Mr. Church moves his plate-holding slides with positive accuracy, revolving heads of hard-steel stop pins giving each hole location in the plate an adjustable definition which can be individually regulated to any degree of precision desirable, with the practical result of producing watch plates with no measurable or discoverable variation in the location of the holes.

Here, then, we have the highest known development of the possibilities of the tool-maker's art, due to the addition, by Mr. Church, of compressed-air actuating devices to Maudsley's slides and Stone's turret.

The compressed-air movement makes accuracy possible, as it never before was. Compressed air gives movements with any degree of force, within any space limitations imposed by the exigencies of tool construction, and—impossibility of impossibilities—without wear.

The largest plate-drilling machines have a delivering and receiving magazine, six plate holders, six spindle heads carrying six spindles each, making thirty-six live spindles in all, and seven transfer arms and hands.

Within certain size limits, this compressed-air actuation in combination with these transfer elements, which are capable of taking a piece of work of any form and accurately locating it in the work-holder of any description, show the road to completely finishing any metal piece without direct manual intervention. That is to say, the methods and means now in operation at Waltham can be so modified as to produce any machine part without direct labor.

As to diameter-limit of work produced by this system, Mr. Church said that he thought his devices might be successfully and economically applied to pieces up to 10-in. or 12-in. diameter, and, in many forms of pieces, the length would be no bar to automatic finishing.

E. A. Marsh.

CHAPTER IX.

E. A. Marsh, the present general superintendent of the American Waltham watch factory, is a native of Massachusetts, having been born in 1837 in the modest little town of Sunderland on the Connecticut river. Being left an orphan before he was six years of age, he was deprived of the educational advantages which he might otherwise have received, but when thirteen years of age he went to live with a relative in Springfield, Mass., where he attended school for two years, then spent three years as clerk in a store. Then after a season of waiting he found an opportunity to enter a machine shop as an apprentice, but in less than two years a financial crisis closed the shop. Later he obtained a situation in the machine department of Colts Armory in Hartford, Conn. From there he went to Chicopee, Mass., and worked on gun-making machinery, which was being built for the English government. From Chicopee he was called to the Cheney Brothers silk mills of Manchester, Conn. While there he became associated with Mr. C. M. Spencer, the inventor of the Spencer repeating rifle, which became prominent in the Civil War. When a factory for the production of those rifles was established in Boston, Mr. Marsh became connected with it and moved to Boston in 1862.

When Mr. Marsh commenced his apprenticeship in Springfield his first job of work was given him by Mr. Ambrose Webster, at that time employed as a journeyman. Shortly thereafter Mr. Webster went to Waltham and entered the watch factory as a machinist and tool

maker. Later, on learning that Mr. Marsh was in Boston, he repeatedly endeavored to induce him to come to Waltham. But not until the spring of 1865 did he decide to do so. He had been at the watch factory but a few weeks when he was called away, but returned after an absence of a year, commencing work in the machine shop tool room. After about two years he was transferred to the draughting room, and in connection with the drawings and designs for new machinery he had the direction of their construction. When Mr. Webster, whose duties had been enlarged with the growth of the factory, became master mechanic, Mr. Marsh succeeded him as foreman of the machine department, which position he continued to hold during the administration of Mr. Van der Woerd as mechanical and general superintendent. On the retirement of Mr. Woerd in 1883 Mr. Marsh was appointed to the position of master mechanic, and served in that capacity until 1893, when he succeeded Mr. G. H. Shirley as assistant superintendent of the factory. The continued enlargement of the factory and the increasing cares of Mr. Fitch, the president, who had for eighteen years been superintendent, also subsequently led to the appointment of Mr. Marsh as general superintendent, with Mr. J. W. Burckes as assistant superintendent. When connected with the mechanical department, Mr. Marsh designed and built quite a number of new machines, but when he became assistant superintendent, Mr. D. H. Church was made mechanical superintendent, and since then has produced new machines in various lines and of marvelous performance.

Mr. Marsh's lengthy connection with the Waltham factory has rendered him quite familiar with its history and growth, and that fact doubtless led the late treasurer, Mr. R. E. Robbins to assign to him the work of making an historical sketch of the American Waltham Watch Co., which was embodied with other matter relating to the city of Waltham in the "History of Middlesex County."

Although not a practical watch maker Mr. Marsh has had occasion to write a number of articles on watches and watch manufacturing for publication in several encyclopedias as well as in trade journals.

N. B. Sherwood.

CHAPTER X.

NAPOLEON BONAPARTE SHERWOOD.

Mr. Sherwood was born in 1823, was educated in Albany Academy, under Prof. Peck, and graduated with high honors. From a boy he was passionately fond of mathematics, astronomy and chemistry and was a born mechanical genius. After graduating from Albany Academy he decided to practice medicine, but so great was his love of mechanics that the medical profession had but little charms for him, and he gradually drifted into a knowledge of horology. In 1852, he was engaged in watchmaking in Jefferson, Ohio, and from there he moved to New York city and engaged in jeweling watches and chronometers for the trade.

He became acquainted with Mr. E. Howard, at that time connected with the Waltham factory, and was employed by the company shortly after. Mr. G. B. Miller, in speaking of Mr. Sherwood recently, said: "He was a wonderful man; a thorough mechanic, gifted with a highly retentive memory and perceptive powers that seemed almost intuitive. He had the happy faculty of being able to grasp any subject of mechanics which was brought to his notice, and his fertile brain and faculty for imparting information, made him an interesting companion and valuable writer and instructor. Unlike other mechanics and inventors, he seemed to grasp the whole idea and work out his problem almost instantaneously."

His connection with the Waltham factory gave him abundant opportunity to bring his inventive genius into play *in originating* new tools to do work hitherto done by hand.

He was placed in charge of the jeweling department. He not only conceived new ideas, but being an excellent draughtsman, he placed them on paper, and then entering the machine shop, he, with his own hands, made and put them together.

Under his charge the jeweling department soon made a complete revolution. New systems and methods of doing work were introduced, automatic machines made and the amount of work turned out was doubled. Many of the tools used to-day in our watch factories were invented and first built by Mr. Sherwood. A list and description of the various tools invented by this remarkable man would fill a good-sized volume, and we will confine our remarks to but a few of them. He invented what is known as the "Counter-sinker or screw head tool," for jewel screws; "the end-shake tools," "the opener" and "the truing-up tools."

In speaking of "the end-shake tools," Mr. Miller says: "They were truly wonderful tools, being self-measuring and so constructed that no matter to what depth the shoulder was cut in the upper plates, by putting the plate against one end of one of the tools, and the jewel with its setting in a spring chuck, the tool would cut a shoulder on the setting that would bring the face of each and every jewel exactly flush with the under side of the plate when setting was put in. The jewels were then reversed and put into another chuck and the top of the setting cut down by this magic tool until it would come exactly flush with the top of the plate, or rather leave just enough projecting above to allow for polishing. After the jewel settings were 'stripped' and polished, they were put into the plates where they belonged never to be removed again. As the plate was already gilded, next the holes for the screws were tapped out and the holes bored for each screw-head on the screw-head tool, that would leave the head of the screw exactly flush with the top of the plate and not raise any burr. The end-shake tool was *certainly the perfection* of self-measuring tools. By it the

shoulder was cut on the setting of the lower holes (the holes in the plate being first bored out with a shoulder), so as to give each pinion and staff the exact amount of end-shake required. With these tools one man could do nicer work and more of it than any five men could do in the ordinary way."

The so-called "opener" was another ingenious tool. Mr. Sherwood found that it was impossible to open a jewel hole by hand so that the hole would be absolutely round, and accordingly he produced a tool which would do the work not only perfectly but rapidly. He never patented any of his inventions, and many of them can be found in daily use in the watch factories of the United States to-day. Some of the minor details of these machines have been improved on, but in many cases no improvements have been made in the machines, as originally built by him, as far back as 1860.

Mr. Sherwood died of consumption at his residence in New York city, in October, 1872, in his 49th year. In his death the horological firmament lost one of its brightest stars.

Patten Sargeant Bartlett.

CHAPTER XI.

Patten Sargent Bartlett, whose name is familiar to every watchmaker and jeweler in America, and we might say the world, was born in Amesbury, Mass., Dec. 3, 1834, of one of the oldest and most famous puritan families, his great uncle, Josiah Bartlett, being one of the signers of the Declaration of Independence. He had a common school education and learned the machinist trade in Lowell. His first connection with watchmaking was in December, 1855, when he went to work at 21 years of age for the Boston Watch Co. just after its removal to Waltham and before the organization of the Waltham company. In 1858 he became foreman of the plate and screw department of that factory and continued with them in that capacity until 1864. In 1859 the American Watch Company put upon the market a new 18-size movement, which they engraved P. S. Bartlett, and in 1861 they manufactured their first lady's watch (10 size), which they also designated as the P. S. Bartlett.

He brought J. K. Bigelow from Lowell to assist him, but Mr. Bigelow was not long afterwards given a department to manage and Leonard Green became Mr. Bartlett's assistant until he went to Elgin.

In 1864, Mr. Bartlett and Ira G. Blake came west from Waltham on a visit, and becoming acquainted with John C. Adams, whose brother George B. Adams was a jeweler in Elgin, he was induced to assist in organizing the National Watch Company of Elgin, and undertook to provide it with skilled labor. He was one of the half-dozen who was paid

a bonus of $5,000 and $5,000 a year for five years to go to Elgin and start a factory, his position being foreman of the plate department for five years, the same position which he had held in Waltham. He worked in the machine shop at Elgin until the factory had begun to produce watches.

In 1869 Mr. Bartlett commenced traveling for the Elgin company, and was the first watch missionary in the trade, although not then designated as a missionary. He was general traveling agent for the company for the next seven years, and in that time he introduced the Elgin watch in Europe, selling them in Moscow, St. Petersburg and other cities. Returning to this country he was assistant superintendent at the factory in Elgin until 1878, leaving to take a position traveling for the Waltham company, with whom he remained for three years.

At the conclusion of his connection with the Waltham company, he established himself in the wholesale and retail jewelry business in Elgin, which he continued until he died, Dec. 14, 1902, at the home of his daughter in Chicago.

CHAPTER XII.

There are probably few men in this or any other country who have had a more intimate connection with the machine watchmaking than had Ambrose Webster of Waltham, Mass. For over thirty years his sole time and attention was devoted to this industry. From one of the most lowly positions he rose, through diligent work and study, to one of the highest which the largest watch factory in the world had bestowed upon a faithful and efficient employe.

Mr. Webster was born in Southbridge, Mass., July 16, 1832, and he attended the common schools of his native town until his fifteenth year, when he went to Springfield, Mass., attending the school there until 1849. In this year he commenced a four years' apprenticeship in the Springfield Armory, being the first apprentice taken after the Armory was under military rule, i. e., under the superintendency of the ordinance department. This armory was, even in those days, famous for labor-saving machinery and its method of manufacturing fire-arms with interchangeable parts. It was in this same factory that Mr. Dennison conceived his ideas about interchangeable watches, and in which he spent many hours in examining the various tools and processes, and the writer has but little doubt that here also Mr. Webster acquired the foundation of what he afterwards carried out so successfully in watch machinery. In those days, however, Messrs. Webster and Dennison were not acquainted, although in after years they became fast friends. After finishing his apprenticeship in this factory he went to work for Messrs. Blanchard & Kimball, loco-

Ambrose Webster.

motive manufacturers. During the years 1853 and 1854 he was in the employ of the Richmond & Danville railroad as machinist and engineer.

In 1855 he went to work for the Ames Manufacturing Company of Chicopee, and was engaged in manufacturing the gun-stocking machinery, built by that company for the Enfield, Eng., arsenal, and later he worked for the Springfield Tool Co. in the manufacture of engine lathes. In 1857 he was engaged by Appleton, Tracy & Co., being the first machinist hired by them. He was appointed foreman of the machine shop of the American Watch Co. in December, 1859, and master mechanic in 1862. In the spring of 1857 he was the only machinist regularly employed ten hours per day at his trade, as machinist and tool-maker, in any watch or watch-case factory in existence. In 1872 he was promoted to the position of assistant superintendent of the Waltham factory, which position he held until his resignation in the spring of 1876, when he left the employment of the company and spent the following six months in visiting the various watch and clock companies of the country and making a thorough study of their methods.

When Mr. Webster took charge of the machine shop of the Waltham factory it was as crude as could well be imagined. There was absolutely no system, no appreciation of the fact that the machine shop was the foundation of the manufactory. The proprietors had not learned that to successfully run a factory *they must* build up a machine shop large enough, and under a competent head, to build and repair all the tools and machines needed in the business. Anything approaching an automatic machine was frowned upon. In spite of this fact, Mr. Webster may be credited with forcing automatic machinery to the front, as he constructed a machine to run half-automatically against the positive orders of the management. He also reduced the unsystematic method of measurement, then in the factory, to a system, having found that there were no less

than nine classes of measuring units or gauges, which he changed to one. He designed, and Mr. George Hunter (consulting superintendent of the Elgin Co.) built the first watch factory lathe with hard spindles and bearings, of the two-taper variety. He also made the first interchangeable standard for parts of lathes. Under his management the machine shop developed into a force of seventy men, and the daily product of the company was increased from five watches per day to three hundred and fifty.

He invented many machines now in use in the Waltham factory, conspicuous among them being an automatic pinion cutter, invented in 1865. Shortly after leaving the American Watch Company, which he did in the Spring of 1876, Mr. Webster received a very flattering letter of commendation from Mr. R. E. Robbins.

In the Fall of 1876 Mr. Webster entered into partnership with H. N. Fisher and John E. Whitcomb, under the title of the American Watch Tool Company, taking its general management. At that time they were making about fifty lathes per year. They immediately commenced the erection of a factory building, and when completed, increased their force from six men to eighty, taking a large contract to equip an English watch factory, and in 1878 they made a contract to equip the Waterbury watch factory. This establishment was planned, erected and equipped to make one thousand watches per day, by Mr. Webster and the American Watch Tool Co. The company put into this factory machinery to the value of $56,609.91.

While in Waterbury, Mr. Webster formed the acquaintance of Mr. Woodruff, of the Seth Thomas Clock Company, and used his influence in inducing that company to commence the manufacture of watches, and subsequently built a large amount of machinery for them.

When Mr. Doolittle organized the New Haven Watch Company, he used Mr. Webster's experience in building of machinery, and subsequently assisted in the planning of the

Trenton factory and the equipment of the same. The Cheshire Watch Co. also called upon him for assistance in the same line, as did also the Columbus and Aurora Watch Companies, and the same is true of the Hampden Co. in the erection of their last building in Springfield.

In the Spring of 1894, Mr. Webster made a trip to the watch factory towns of France and Switzerland in the interest of his company. He took with him Paul Simon, an employe of the company, who acted as interpreter. While in France he contracted a heavy cold, which turned to pneumonia, and on May 16 a cablegram was received by his relatives, from Beaucourt, France, stating that Mr. Webster was seriously ill and shortly after another was received announcing his death. He left a widow, four daughters and one son and his father, who was ninety years of age, was living in Southbridge at the time of his son's death.

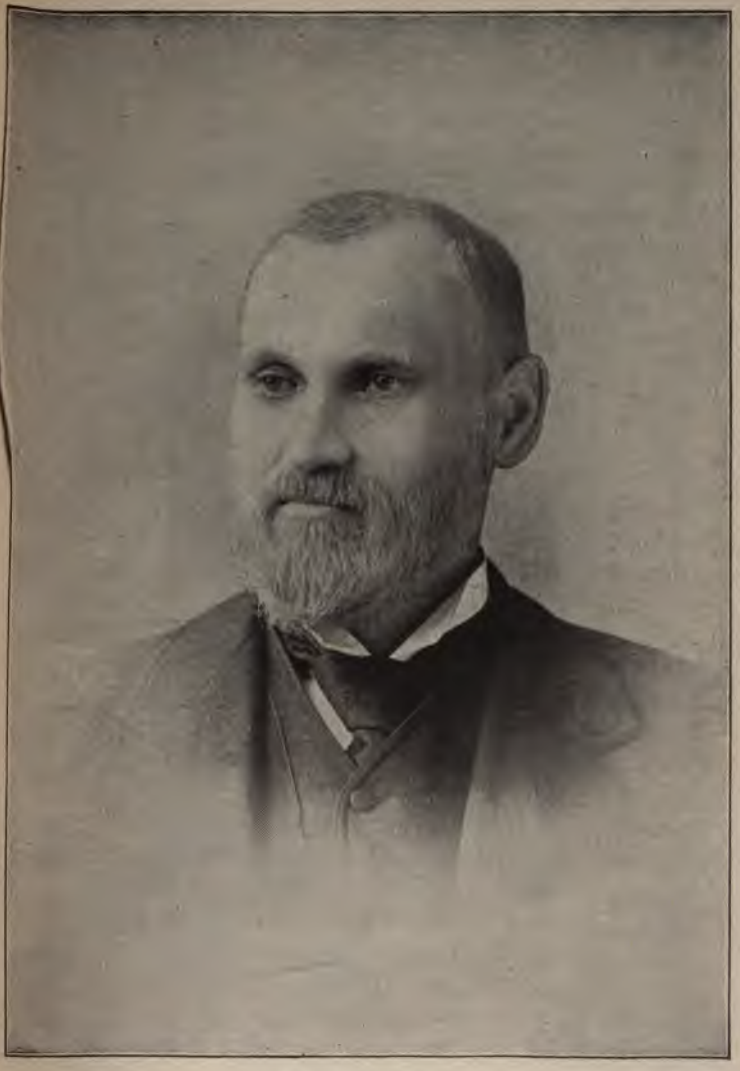
CHAPTER XIII.

Charles S. Moseley, whose name has been intimately connected with the history of nearly every watch factory in this country, was born in Westfield, Mass., Feb. 28, 1828. In 1836 he accompanied his father to Princeton, Ill., but soon returned to Massachusetts. At the age of eighteen he entered a machine shop in Westfield and some time afterwards went to Boston where he worked for George H. Fox, as a machinist, and remained there for some years. His first connection with a watch factory was in 1852, when he entered the employ of Dennison, Howard & Davis, who were then beginning the manufacture of watches in Roxbury, Mass. Mr. Moseley went with them when the factory was removed to Waltham and remained with the company, serving in the capacity of foreman of the machine shop and later as master mechanic

About the year 1859, the Nashua Watch Company was started and Mr. Moseley cast his lot with it, acting as master mechanic. He designed and built the machinery with which that movement was manufactured; and it is worthy of remark that it was certainly a splendid watch.

In the fall of 1864 Mr. Moseley identified himself with the Elgin National Watch Company, then just starting, and was made general superintendent, in which capacity he remained with the company until 1877.

Mr. Moseley has assisted, when they were in need of engineering help, a number of other factories. As a mechanical engineer and a designer of watchmaking machinery es-



Charles S. Moseley.

pecially, he has had but few equals. Many well-known inventions are due to his genius. Among those that have acquired a world-wide reputation we may mention first the split chuck which he invented in 1857 or 1858 while in the employ of the Waltham Watch Company, an accessory now become universal and indispensable to every watchmaker in the land. Following this came his invention of the hollow live spindle lathe, with a taper mouth and draw-in spindle, practically as used by all watchmakers and machinists to-day. In 1859, he designed for use in the factory of the American Watch Company, a small lathe, which he conceived would be a useful tool to the watch repairer and is the type of all the American-made watchmakers lathes.

The original chucks made by Mr. Moseley were intended for use with the old two-bearing watch factory lathe. It was found, however, that the chucks would not go back into the same place every time if some pieces were larger than others and he therefore modified his lathe so that the chuck was held in a fixed position and the lathe spindle advanced upon and receded from the jaws of the chuck to open and close it. This device is one of the most important features of all automatic machinery to-day and has spread from watch factories to all metal working lines and is the only known means of practically holding a piece of work true and gripping and releasing it instantly.

Mr. Moseley invented the interchangeable stem winding mechanism of the Elgin National Watch Company, patented in 1876. The dust band, or dust excluder, used by the same company, a patent regulator and many other improvements were invented by him. Mr. Moseley is still actively engaged in business with his brother in Elgin.

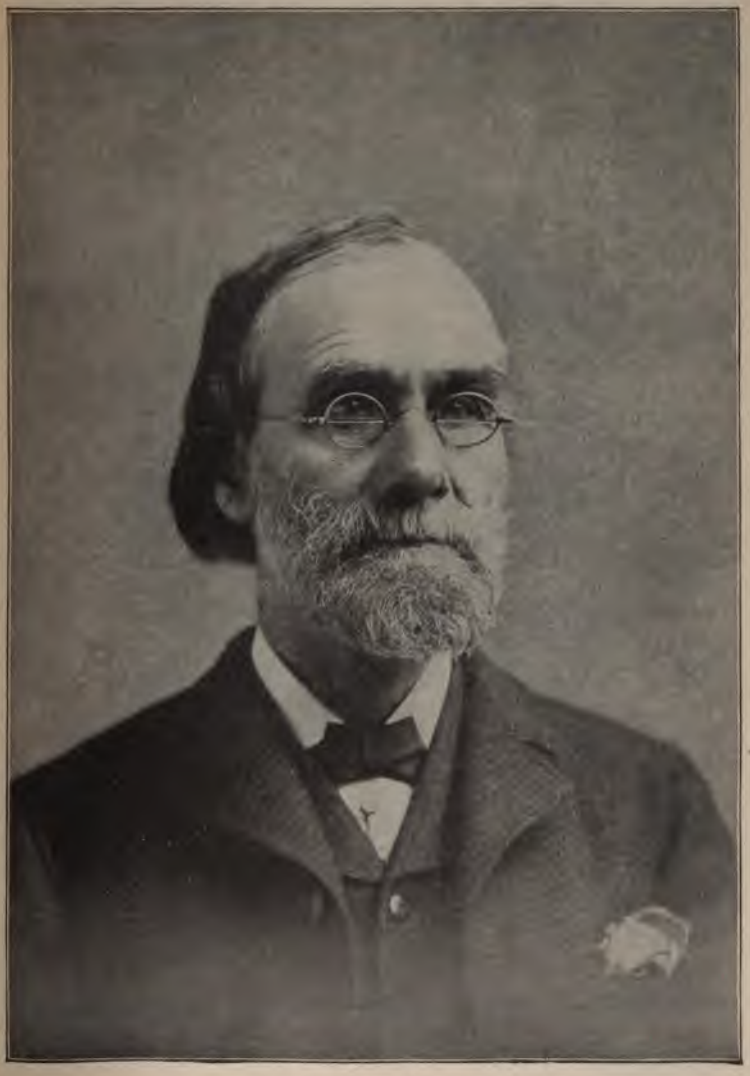
Charles W. Fogg was another clever mechanic who spent a large portion of his life in watch factory work. He was *born in Meredith*, N. H., on January 25, 1817, and was *twenty-five years* of age when he located in Waltham. A

first he carried on business as a watchmaker and jeweler, but when the Nashua Watch Company was purchased and removed to Waltham he became the superintendent of that department of the factory. He was one of the directors of the American Waltham Watch Company and was widely known in the trade as the inventor of the safety pinion which bears his name. During the last ten or twelve years of his life, Mr. Fogg was not in active business, although he retained a place in the directory of the company. He died on Wednesday, Sept. 6, 1893, at his residence in Waltham. He had been a director in the Waltham National Bank and the Waltham Savings Bank and was prominent in the Masonic fraternity.

CHAPTER XIV.

Chas. Vander Woerd was another example of the skillful mechanic and inventor who was associated with the Waltham factory in the building of its first semi-automatic machinery. He was born in Leyden, Holland, and early in life came to America; was at one time employed at the Seth Adams Sugar Refinery in South Boston; later he worked for Alvin Clark of Cambridge, on telescopes; from there he was induced by Mr. Moseley to enter the employ of the then "Boston Watch Company" at Waltham. He possessed a power of ready perception, as well as a good knowledge of mathematics, and was able to acquire a fair knowledge of astronomy, which in after years he utilized in the establishment of an observatory for the securing of exact time rate for the accurate timing of the watch movements made by the Waltham company. The transit instrument was made by Clark & Sons in conjunction with the machine shop of the watch company, and while not a large one, is of high grade and fine accuracy, and has been in constant use for about twenty-five years, and is believed to be the only instrument of the kind in the world forming a part of the equipment of a watch factory.

In 1864 Mr. Woerd invented an automatic pinion cutter, which, having been modified and improved, is still in use. In 1869 he modeled the Waltham company's first "Crescent Street" movement. In 1874 he invented an automatic screw machine, which attracted much attention at the Centennial Exposition in Philadelphia, and the Inventions Exhibition in London in 1885. In 1873 he designed and pat-



Chas. Vander Woerd.

ented a modified form of "slide spindle lathe," which was nominally a two-bearing lathe, but it was never a satisfactory form of construction and was abandoned. He became superintendent of the Waltham factory in 1876, which position he retained until his resignation in 1883.

After severing his connection with the American Waltham Watch Company he engaged in the manufacture of watch tools, and later the business was changed to the manufacture of watch movements, and developed into what is now the United States Watch Company, whose history forms another chapter in our series.

This new company had a severe struggle for existence, partly from lack of capital, and after a few years of vain effort for success, Mr. Vander Woerd withdrew from the company, and in 1888 became interested in a California mining enterprise, and while traveling in December of that year, he died suddenly in a railroad train.

Edgar L. Hull was born in Sudbury, Mass., in 1848. He began work for the American Watch Company as a boy, in June, 1862, and remained with them for about four years, when he went to Marion, N. J., and spent a year in the employ of the United States Watch Company of that place. From there he went to the Howard Watch Company and remained about nine years. He then returned to the Waltham company, where he has been employed continuously up to this time. He was appointed foreman of the dial painting department in 1883. He was probably the first person to learn the art of dial painting in America, all other dial painters in the employ of the Waltham company previous to him being English workmen. Mr. Hull's department is a very important one and he has developed many new methods and ideas in order to turn out large quantities of plain and ornamental dials in a speedy and economical manner.

John Logan was born in Lowell, Mass., in 1844, and *worked for the* American Watch Company many years ago

Edgar L. Hull.

in the springing department, afterwards going to the Howard Watch Company in Roxbury. There he began to manufacture hair springs and invented a new method of tempering springs. He was offered a position with the United States Watch Company, Marion, N. J., and left the Howard company to take charge of the spring department there. He left Marion to return to Waltham, and soon after arriving he began to manufacture hairsprings for the trade, having a small shop located between Adams and Crescent street, between Chestnut and Walnut streets. Later he moved to Vernon street, where he manufactured hair and main springs and small bench tools on an extensive scale. The good quality of his springs became famous, and for years he supplied several watch factories with them. Several years ago the American Waltham Watch Company secured his services to make their springs. He moved his Vernon street factory over to the watch factory and there he began to manufacture main and hair springs on an extensive scale, he being foreman of both departments, with Mr. E. R. Lyle as his assistant foreman in the hair spring department and M. Stevens as his assistant of the main spring department. During his connection with the Waltham company he invented many labor saving machines for the making of springs and also turned his attention to other inventions relating to watch manufacture. He committed suicide on Jan. 1, 1893, during a temporary aberration caused by illness, having been greatly troubled with nervous prostration.

H. E. Duncan was born in Worcester, Mass., in 1850, and after the usual common school education had two years of academy life, in which he was especially instructed in natural philosophy and chemistry. During these two years he had not only to earn his own living but pay for his tuition. Coming from a family of mechanics, he decided that he would like to learn the watchmaking trade, and in 1866 he was apprenticed to that trade. He met and worked with a number of fine workmen of American and foreign birth

H. E. Duncan.

and was a bench mate of D. A. A. Buck, the inventor of the Waterbury watch. At the end of his apprenticeship he went to Manchester, N. H., and later worked for L. S. Stowe in Springfield, Mass. He later went with D. A. A. Buck, then superintendent of the Cheshire Watch Company, from there to the Hampden Watch Company, and in 1885 entered the employ of the American Waltham Watch Company, his headquarters being with Robbins, Appleton & Company, Boston. For ten years he traveled on the road as missionary for the company, but in 1895 was called to the factory and has been there ever since. At the present time he has charge of the adjustment of the highest grade of watch movements. He is the astronomical observer and has charge of the determination and distribution of time signals throughout the factory. He has been given carte blanche in the designing and erection of a clock room for the time service, and it is believed that he has equipped one of the finest time stations in this country. In addition to his factory duties he has the direct charge of the missionary force, and as he personally traveled so many years he is well known to the watch trade. He is an amateur photographer, and has produced a large number of excellent pictures. He is well known to watchmakers through his finely illustrated lectures on watchmaking, which he has given in various parts of the United States and Canada.

CHAPTER XVI.

The factory of the American Waltham Watch Company is divided into twenty departments, of which the following are foremen: Machine, Francis H. Eaton; punch, Nathan P. Mulloy; plate, Eugene L. Folsom; train making, Charles R. Hill; flat steel, George T. Carter; pinion polishing, George C. Moor; escapement, Charles C. Byam; balance, Gleason Wood; hair spring, W. H. P. Smith; jeweling, Robert Speir; jewel making, J. W. Rushton; gilding and nickel finishing, A. P. Williams; dial Dept. "B," Frank Wetherbee; dial Dept. "A," Edgar L. Hull; main spring making, Milton R. Stevens; finishing, Charles L. Tuthill; adjusting, A, Charles A. Berry; adjusting, B, and packing, George Adams; engineering, Henry C. Eaton; carpenter, C. W. H. Boulton.

In addition to the above department heads, there is a general or executive staff, as follows: General superintendent, E. A. Marsh; assistant superintendent, J. W. Burckes; mechanical superintendent, D. H. Church; assistant mechanical superintendent, C. A. Whitney; forwarding superintendent, C. F. Smith; astronomical observer and time superintendent, H. E. Duncan; paymaster, Murray D. Clement; cashier, Fred H. Graves; purchasing agent, Chas. J. Olney, Jr.

The officers of the company are: President, Ezra C. Fitch, assisted by his son, Conover Fitch; vice-president, Francis R. Appleton; treasurer, Royal Robbins.

The directors are: Ezra C. Fitch, Royal Robbins, Francis R. Appleton, Benj. F. Brown, A. Lawrence Edmands, Augustus K. Sloan, H. P. Robbins, R. C. Robbins, J. W. Appleton.

The selling agents of the company are: Robbins & Appleton (whose principal office is in New York City, with a branch office in Chicago in charge of R. A. Kettle, and one in London, Eng., in charge of A. R. Harmon), and Robbins, Appleton & Co. (whose office is in Boston, with a branch in Montreal, Canada, in charge of J. C. Barlow).

The output of the Waltham factory has been a gradually increasing one for many years, save for an occasional interval, when the general business of the country was suffering extreme depression, as in 1893, and the factory capacity is now practicallly 3,500 movements per day.

The increasing adoption of automatic machinery, specially designed and adapted for the production of individual parts of the various movements, has not only lessened the manufacturing cost, but also made possible a degree of accuracy and uniformity not previously attained; and the great productiveness, together with the extreme costliness of such high-class machinery, give this company with its large capital and business standing of many years, a great advantage over younger and smaller companies, while the excellence of its product, resulting from its half century of experience, and its command of the highest grade of inventive talent and mechanical skill has given it a high reputation with exacting watch wearers, the excellent time keeping qualities of even its cheaper grade of movements have made the name Waltham familiar to the people of the whole civilized world.

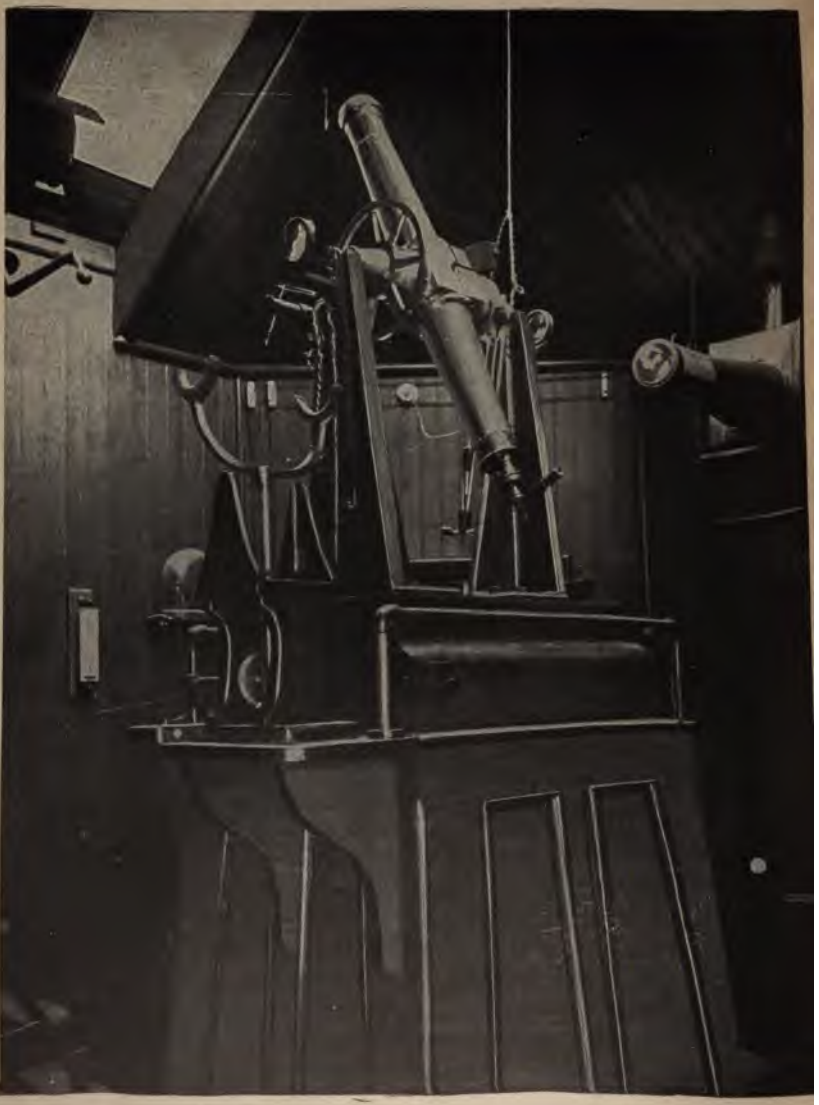
CHAPTER XVII.

On page 87 brief mention was made of the establishment of an astronomical observatory. It may be appropriate in closing this historical sketch to copy entire an article from the *Scientific American* of April 15, 1905, in which this observatory and its connected clocks and instruments are described and illustrated:

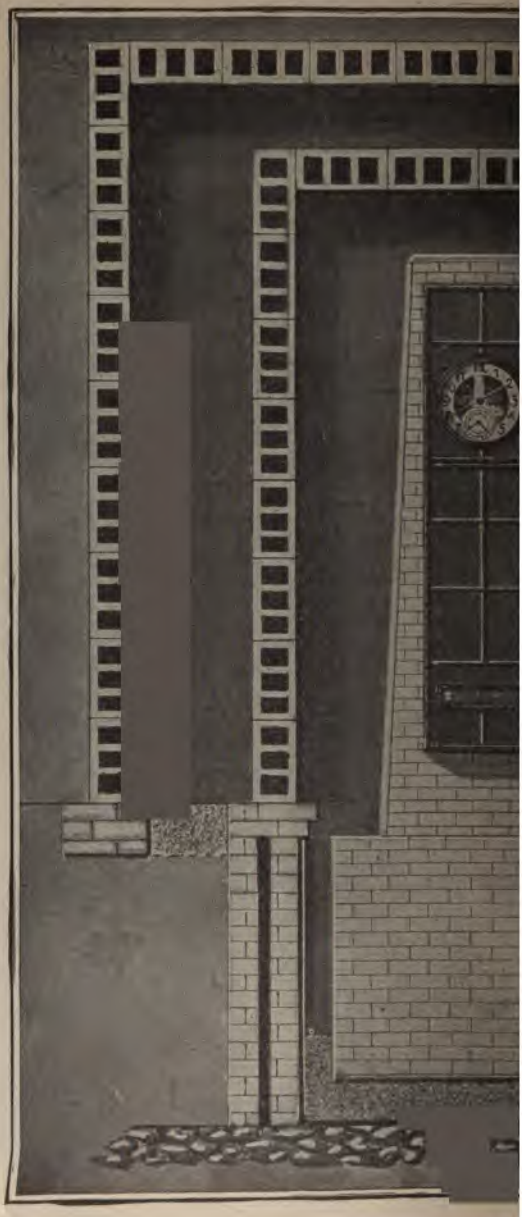
Among the many fields of industry in which hand labor has been superseded by automatic machinery, there is none in which the change has been so strikingly complete and successful as in that of the manufacture of watches. That the machine-made American watch of the higher grades can attain as high marks for time-keeping as the finest products of the skilled watchmakers of some of the older countries of Europe has been proved by tests at the National Laboratory, London. This fact is the more remarkable when we remember that the Waltham works, from which the test watches referred to were selected, is turning out watches at the rate of nearly three thousand per day.

It is not our intention to describe just now, the wonderfully complex and ingenious machinery by which the American watch is made; that is a long and deeply interesting story in itself. The present article will show how one great, modern watch works maintains its own private standard of time, for the guidance of the workmen in the various rooms of its vast establishment, in regulating the watches that are turned out at the rate of so many thousand a day.

The possession of some standard of time must be



Interior of the Observatory showing the Transit.



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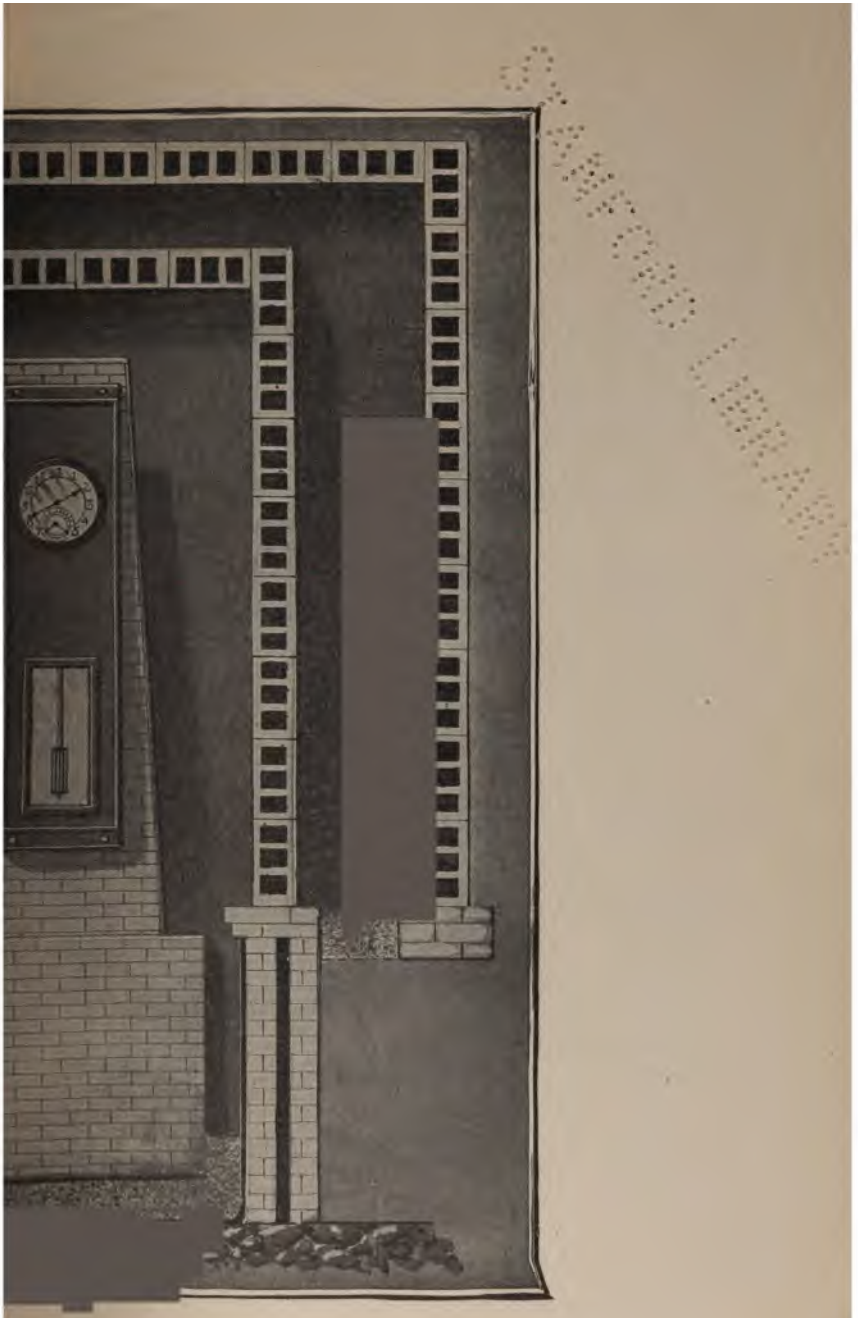


kroom.

reckoned as one of the absolute necessities of the highly-developed life of to-day. Every man's watch is his own particular standard. In case of doubt as to its accuracy he refers to some other higher standard, such, for instance, as a public clock or the chronometer in some watchmaker's window. In case these higher standards should disagree, it is necessary to go to some ultimate standard, superior to all of them. The ultimate standard in the United States is the time determined at the Naval Observatory, Washington; and this is referred to the transit of fixed stars across the meridian, which is a time which never varies, and therefore is the absolute standard.

Many years ago the Waltham Watch Company realized that it would be to their interest to get as closely in touch as possible with the prime source of time, which, for them, would be the transit of any celestial body, preferably a fixed star, across their meridian; and acting under the advice of the late Prof. Rogers (at that time connected with Harvard Observatory, Cambridge), they built in the works an observatory, and put in a transit of the size and form that is standard in the Geodetic and Hydrographic Surveys. In connection with the observatory they also constructed a clockroom, in which they placed two master clocks, which were designed specially for the purpose by the superintendent of the works. As far back as the forties the longitude of Harvard Observatory from Greenwich had been established by taking the mean time of forty box chronometers. At a later date this longitude was verified by means of cable connections between a chronograph at Greenwich and a chronograph at Harvard University, connected by the transatlantic cable. In 1880 the longitude of the Waltham Observatory from Harvard was similarly established, by means of two electrically-connected chronographs.

As the plant of the company increased in size, the vibration of the heavier moving machinery, that was transmit-

View in outer passage of Clockroom showing barometer and level tester.

ted through the earth to the clockroom, caused perceptible variations in the time of the two master clocks. It was decided, therefore, to build the new clockroom, of which we present several illustrations, install within it the two master clocks, and add a sidereal clock. The room was completed early in 1904 and is now running, as we shall show later in this article, with exceptional results as to accuracy.

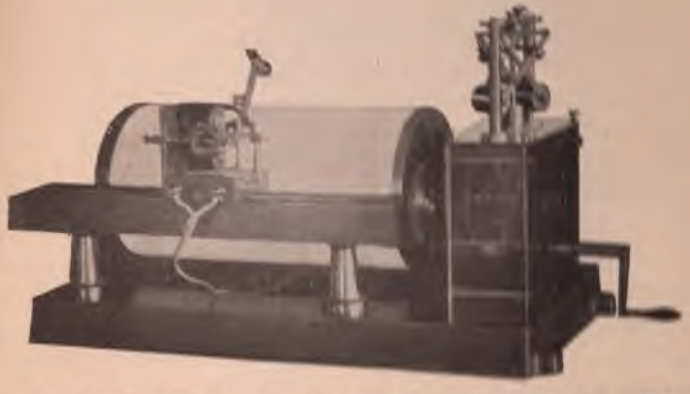
The clockroom, which is located in the basement of one of the buildings, is built with a double shell of hollow tile brick. The outer shell rests upon the floor of the basement, and its ceiling is within two or three inches of the basement ceiling. The inner shell is 10 feet square and 8 feet in height, measured from the level of the cellar floor. There is an 18-inch space between the walls of the inner and outer shell and a 9-inch space between the two ceilings. On the front of the building the walls are 3 feet apart to accommodate the various scientific instruments, such as the chronograph, barometer, thermostat, level-tester, etc. The inner house is carried down 4 feet below the floor of the basement, and rests upon a foundation of gravel. The walls of the inner house below the floor level consist of two thicknesses of brick with an air space between, and the whole of the excavated portion is lined, sides and bottom, with sheet lead, carefully soldered to render it watertight. At the bottom of the excavation is a layer of 12 inches of sand, and upon this are built up three solid brick piers, measuring 3 feet 6 inches square in plan by 3 feet in height, which form the foundation for the three pyramidal piers that carry the three clocks. The interior walls and ceilings and the piers for the clocks are finished in white glazed tiling. The object of the lead lining, of course, is to thoroughly exclude moisture, while the bed of sand serves to absorb all waves of vibration that are communicated through the ground from the various *moving* machinery throughout the works. At the level of

the basement floor a light grating provides a platform for the use of the clock attendants.

Although the placing of the clockroom in the cellar and the provision of a complete air space around the inner room would, in itself, afford excellent insulation against external changes of temperature, the inner room is further safeguarded by placing in the outer 18-inch space between the two walls a lamp which is electrically connected to, and controlled by, the thermostat, of which we give an illustration. The thermostat consists of a composite strip of rubber and metal, which is held by a clamp at its upper end and curves to right or left under temperature changes, opening or closing, by contact points at the lower end of the thermostat, the electrical circuit which regulates the flame of the lamp. The thermostat is set so as to maintain the space between the two shells at a temperature which shall insure a constant temperature of 71 deg. in the inner clock house. This it does with such success that there is less than half a degree of daily variation.

The two clocks that stand side by side in the clockroom serve to keep civil time, that is to say, the local time at the works. The clock to the right carries a twelve-hour dial and is known as the mean-time clock. By means of electrical connections it sends time signals throughout the whole works, so that each operative at his bench may time his watch to seconds. The other clock, known as the astronomical clock, carries a twenty-four-hour dial, and may be connected to the works, if desired. These two clocks serve as a check one upon the other. They were made at the works and they have run in periods of over two months with a variation of less than 0.3 of a second, or 1-259,000 part of a day. The third clock, which stands to the rear of the other two, is the sidereal clock. It is used in connection with the observatory work, and serves to keep sidereal or star time.

Portion of Chronograph Record with passage of star indicated on line marked 45 minutes.



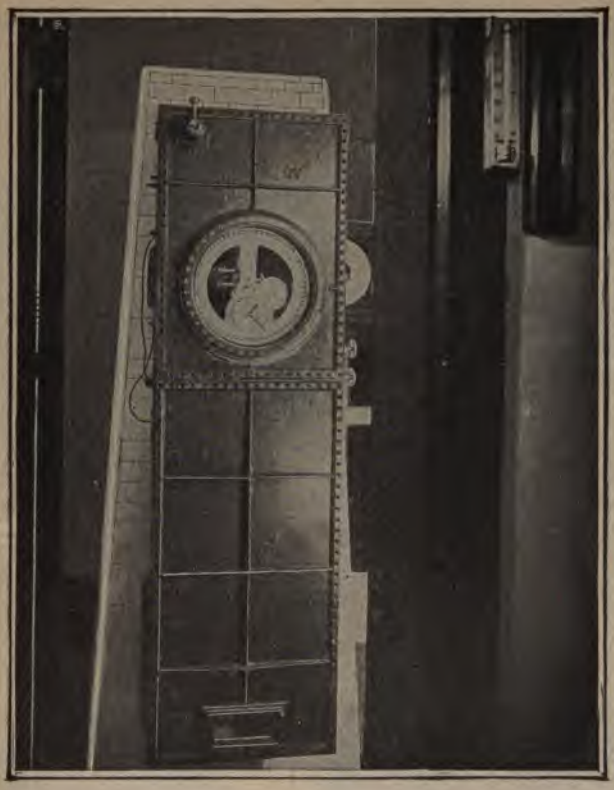
Enlarged view of Chronograph with pen lifted off paper. When the Chronograph is running, the pen rests on the paper on the cylinder and is moved by the lead screw in the carriage to trace the lines shown above.

Sidereal time is determined by the transit of the fixed stars across the meridian. The stars are at such enormous distances from the earth that their transit is not appreciably affected by the revolution of the earth in its orbit. It is the change of position of the earth with regard to the sun that accounts for the daily difference between sidereal and solar time of 3 minutes 56.55 seconds, the sidereal day being shorter than the solar day by this amount. The passage of a particular star across the meridian at Waltham is noted in the works' observatory on two nights of every week, and an exact record of this time is obtained by means of a chronograph. The chronograph, which is carried on a shelf in the space between the inner and outer shells of the clockroom, consists of a horizontal metal drum, rotated at such a rate of speed by means of a weight as to give exactly one revolution per minute. Upon the drum is fastened a sheet of paper. In front of the drum is a small carriage, which is moved laterally, by means of a revolving feed screw. This carriage carries a pen that normally traces a continuous straight line on the sheet. The pen is electrically-connected to the sidereal clock, and at every full oscillation of the pendulum, or at every alternate second, the electrical circuit is broken and the pen makes a slight jog in the line. The speed of the cylinder is so arranged that the distance between the jogs corresponds to a certain scale, say of one inch to the second. The pen carriage of the chronograph is also electrically-connected to the observatory, where a button is placed conveniently to the hand of the observer. When an observation of a transit is to be made, the chronograph is started and the observer, with his eye at the telescope, presses the button at the instant that the star passes each vertical hair line (there are five in all) in the eye-piece of the transit. Each time the button is pressed, an extra jog is made on the paper; and by using a scale graduated, *say, to 0.01 inch, it* is possible to determine to one-hun-

View in outer passage of Clockroom showing chronograph and switch board.

dredths of a second the time of the transit of the star across each hair line. By taking the mean of these five observations, it will be seen that the time of the transit of the star is obtained with remarkable accuracy. The next step is to compare the time of transit as recorded by the sidereal clock at Waltham with the time of transit of the same star as given in the tables of the "Ephemeris." The "Ephemeris" is an official publication, issued annually, which gives the exact position of the heavenly bodies for every day of the year; and from this the exact time of the transit of the particular star observed may be known. Whatever the sidereal clock differs from this time is the error of the clock. The amount of this error is then compared with the amount of error observed at the last observation, and the difference between the two observations, divided by the number of days, gives the daily rate of variation. This rate, as observed at the Waltham works, rarely exceeds one-tenth of a second per day. That is to say, the sidereal clock will vary only one second in ten days, or three seconds in a month. The variation, as found, is corrected by adding or subtracting weights to or from the pendulum, the weights used being small disks, generally of aluminium.

Summing up, then, we find that the great accuracy obtained in this clockroom is due to the careful elimination of the various elements that would exercise a disturbing influence. Changes of temperature are reduced to a minimum by insulation of the clockhouse within an air space, in which the temperature is automatically maintained at an even rate. Changes of humidity are controlled by the specially designed walls, by the lead sheathing of the foundation pit, by the preservation of an even temperature, and by placing boxes of hydroscopic material within the inner chamber. Errors due to vibration are eliminated by placing the clocks on massive masonry piers which stand upon a bed of sand as a shock-absorbing medium.



Astronomical Clock in Inner Building.

The astronomical clock is inclosed in a barometric case, fitted with an air pump, by which the air may be exhausted and the pendulum and other moving parts relieved from barometric disturbances. For it must be understood that variation in barometric pressure means a variation in the density of the air, and that the speed of the pendulum must necessarily be affected by such changes of density.

This equipment is the only one in the world forming part of the equipment of a watch factory, and is believed to be the equal of anything of the kind yet installed.

In conclusion, it may be mentioned that of late years it has been the custom of the company to submit a percentage of its watches to the National Physical Laboratory at the Kew Observatory, London, an institution which accepts instruments of precision from applicants all over the world, tests them, and makes a report. Eighty-six per cent of the watches submitted by the Waltham Watch Company have been accepted and passed in Class A. A mark for accuracy of as high as 80 to 85 per cent is a common figure. This result is extremely interesting as showing that American automatic machinery has been brought to such a pitch of perfection that the machine-made watch is able to hold its own at this laboratory with the finest products of European hand labor.

WALTHAM WATCHES

have received the highest awards wherever exhibited.

PARIS, 1878.
First Prize Gold Medal.

LIVERPOOL, 1886.
First Prize Gold Medal.

American Institute,
1857. First Prize Gold Medal.

CHICAGO, 1893.
Seven Medals and Diploma.

SYDNEY, 1879.
First Prize Gold Medal.

CINCINNATY, 1880.
First Prize Gold Medal.

Mass. Charitable Mechan. Assn.
BOSTON.
First Prize Gold Medal.

PHILADELPHIA, 1876.
Four First Prize Medals.

LONDON, 1885.
First Prize Gold Medal.

MELBOURNE, 1880.
First Prize Gold Medal.

ATLANTA, 1881.
First Prize Gold Medal.

NEW ORLEANS, 1885.
Five First Prize Medals.