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FEBRUARY 1949

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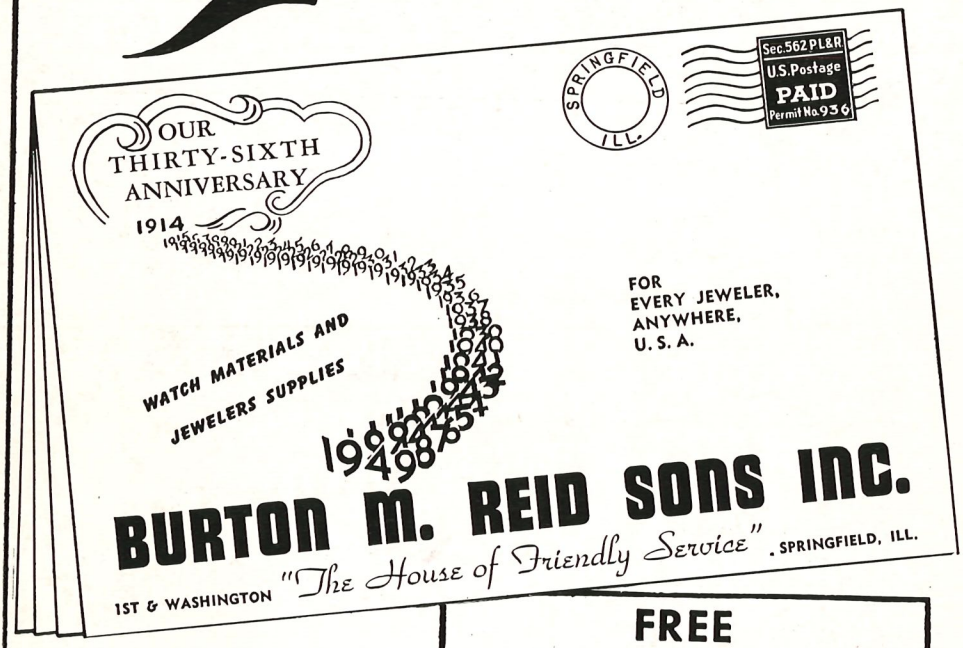

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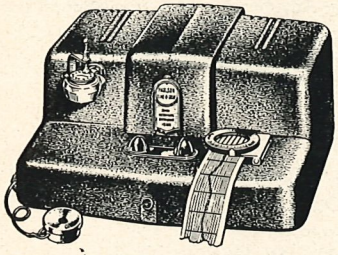

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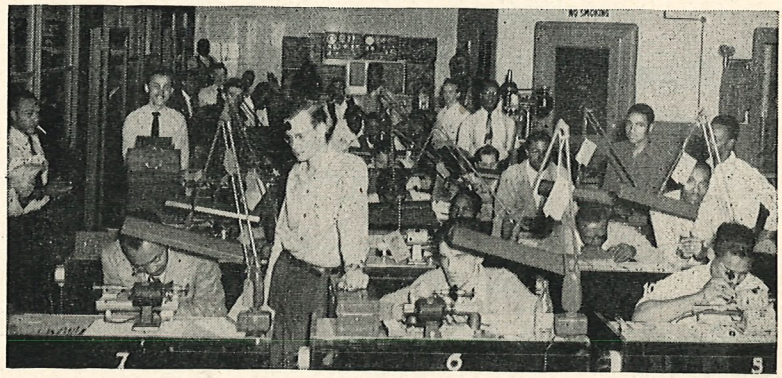

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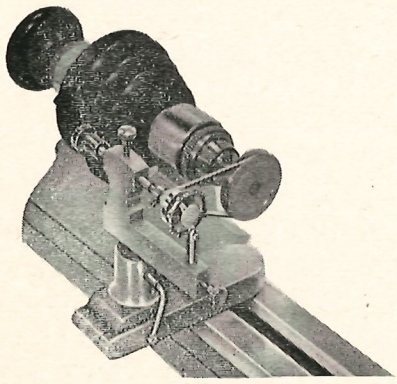

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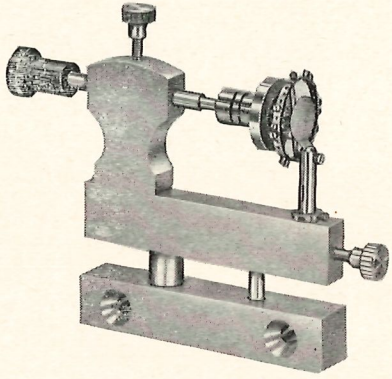

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Subscription Price of H. I. A. Journal

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The Atomic Clock

Illustrated On the Cover Page

An Atomic Standard of Frequency and Time

A basically new, primary standard of frequency and time, invariant with age, has been developed at the National Bureau of Standards; an atomic clock based on a constant natural frequency associated with the vibration of the atoms in the ammonia molecule. Based on a principle developed by Dr. Harold Lyons of the Bureau's microwave research laboratory, the new clock promises to surpass by one or two orders of magnitude the accuracy of the present primary standard, the rotating earth. Dr. Lyons was assisted in the design and construction of the clock by B. F. Husten, E. D. Heberling, and other members of his staff.

This is the first atomic clock ever built and is controlled by a constant frequency derived from a microwave absorption line of ammonia gas, providing a time constancy of one part in ten million. Theoretical considerations indicate a potential accuracy of one part in a billion or even ten billion, depending on the type of atomic system and spectrum line used.

The present crowding of the radio frequency spectrum has imposed severe limitations, both nationally and internationally, on the expanding use of radio for industry and communications. The atomic clock may be expected to benefit greatly the communications industries and the military services, for it will, in effect, provide additional room in the radio frequency range for more communication stations of all types. The present "radio space" allows for a drifting of each station's frequency, so that a broad "radio space" is required if interference with other stations is to be avoided. The maximum utilization of available space in the radio spectrum depends on the accuracy

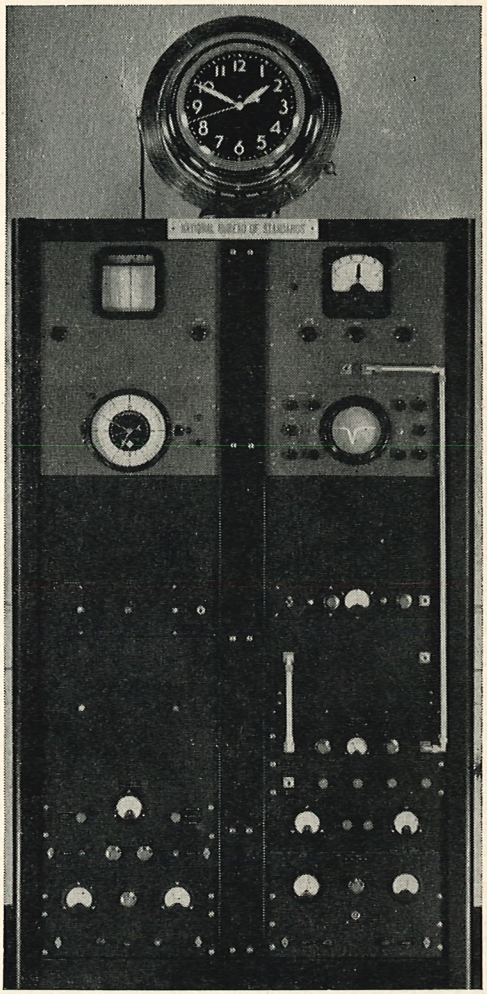

Figure 1.

The new atomic clock at the National Bureau of Standards is completely contained in this unit with the electronic equipment housed in a standard rack cabinet and the waveguide absorption cell wound in a spiral around a 50-cycle synchronous clock on top of the cabinet. From top to bottom, on the left panels: frequency deviation re-

corder: 1000-cycle synchronous motor clock (24-hour dial); electronic frequency meter (drives deviation recorder); 100-kilocycle quartz-crystal oscillator; frequency dividers (divide 100 kc down to 50 and 1,000 cycles); regulated power supply for klystron tubes; regulated plate and filament power supply. On the right panels: frequency comparator and deviation indicator; monitoring oscilloscope; pulse amplifiers and shapers, and pulse discriminator; d-c control voltage indicator; sweep generator, FM modulator, and klystron frequency multiplier (270 mc to 2984 mc); frequency multiplier (100 kc to 270 mc); electronic vacuum gage; regulated plate and filament power supply.

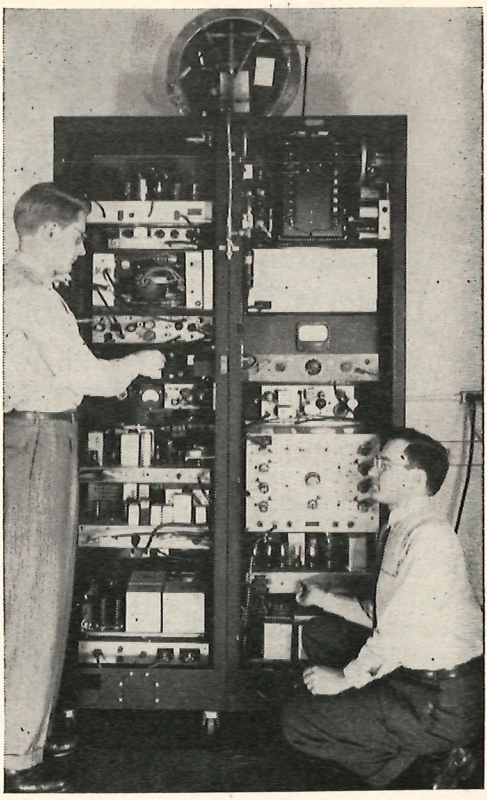

Figure 2.

Details on size and construction of the atomic clock, developed at the National Bureau of Standards, appear in this general view of the back of the equipment. E. F. Husten (left) and E. D. Heberling (right), members of the staff at the NBS Microwave Standards Laboratory, are shown making adjustments on the clock's amplifier and power supply circuits. The amount of equipment shown is larger than needed for the clock alone since some of the instruments are for measurements and tests of performance. Actually, the circuits essential to the operation of the atomic clock could be condensed into one of the two cabinet racks.

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with which the frequency of an individual station can be controlled, especially at the higher frequencies where quartz crystals cannot be used as frequency controlling elements. These frequencies, used by radar, television relays, and microwave equipment in general, could be controlled by atomic elements. Such control would also make possible the permanent establishment of radio channels on such an exact basis that tuning could be made as automatic as the dialing of a telephone number.

The improvements in frequency and time measurement offered by the atomic clock are also of fundamental importance in many fields of science. An absolute time standard will be of special importance in astronomy, where present time standards leave much to be desired. The atomic clock and the method represent important tools of research and development in every technical field where precise measurements of time and frequency are crucial—for example, in long-range radio navigation systems, in the upper range of the microwave region where atomic systems can serve as electronic components, and in basic research in microwave spectroscopy and molecular structure.

The present time and frequency standards are based on astronomical determina-

tions of the period of rotation of the earth. However, the earth is very gradually slowing down in response to the forces of tidal friction in shallow seas. In addition, there are irregular variations—some of them rather sudden—in the period of rotation, the reasons for which are unknown. These two causes are responsible for changes in mean solar time and therefore in the frequency of any periodic or vibrating systems measured in terms of such time standards.

In recent years, vibrations of atoms in molecules—or what are more specifically termed spectrum lines originating in transitions between energy levels of these atomic systems—have been found in the microwave region of the radio spectrum. It has been possible to make very precise measurements of these lines by radio methods using all-electronic equipment of unprecedented sensitivity and resolution. When it became evident that such spectrum lines might eventually provide new primary frequency standards, scientists at the National Bureau of Standards began seeking a means of utilizing one of these lines to control an oscillator which in turn could be used to drive a clock. Because the resulting equipment, the atomic clock, is controlled by the invariable molecular system of ammonia gas, it is independent of astronomical determinations of time.

The National Bureau of Standards atomic clock consists essentially of a crystal oscillator, a frequency multiplier, a frequency discriminator, and a frequency divider, all housed in two vertical-type cabinet racks, on the top of which are mounted a special 50-cycle clock and a waveguide absorption cell. Ammonia gas under a pressure of 10 or 15 microns is maintained in this cell, a rectangular one-half by one-four-inch copper tube wound in a compact 30-foot spiral about the clock.

The new development uses an absorption frequency of ammonia to hold a microwave signal fixed. If the microwave signal output of a generator differs in frequency from the ammonia absorption line, then the control circuits generate an "error signal" which brings the microwave signal back to the frequency of the spectrum line. The oscillator generating the microwave signal is thus controlled, and the setting of the clock which it drives can be compared with an astronomical clock.

The microwave signal is initiated by a 100-kilocycle quartz-crystal oscillator or any other oscillator which, for purposes of convenience and accuracy, is designed for a high degree of stability. By means of vacuum-tube circuits and silicon-crystal diodes, this frequency is multiplied to provide output signals throughout the microwave range. These signals are compared with the frequency of a microwave spectrum line, in this case of ammonia gas, by suitable control circuits, often called frequency discriminator or "servo" circuits. If the quartz-crystal oscillator drifts after the microwave signal at the upper end of the multiplier chain has been exactly turned to the frequency of the spectrum line, the discriminator circuit generates an output signal which, through the proper control circuits, can be applied to the oscillator at the bottom of the multiplier chain to bring it back to the proper frequency. By means of a frequency divider, the 100 kilocycles may be reduced to any desired frequency for driving a clock; e. g., one thousand cycles or 50 cycles.

Principles and Operation[1]

Frequency-discriminator or servo-mechanism control circuits for atomic clocks might be developed in many different forms. The electronic control circuit in the present atomic clock is one successful form of several being developed by the National Bureau of Standards. It is now being refined to give even greater time-keeping accuracy.

The fundamental frequency signal generated by the 100-kilocycle oscillator is first multiplied up to 270 megacycles per second (abbreviated Mc) by a frequency-multiply-

ing chain using standard low-frequency tubes. In the next step, the multiplying chain is continued up to 2970 Mc by means of a frequency-multiplying klystron, which is also modulated by an FM oscillator generating a signal at 13.8 -|- 0.12 MC. This makes the frequency-modulated output of the klystron 2983.8 -|- 0.12 Mc. After further amplification, the frequency-modulated signal is multiplied in a silicon crystal rectifier to 23,870.4 -|- 0.96 MC, and fed to the ammonia absorption cell. As the frequency of this modulated control signal sweeps across the absorption line frequency of the ammonia vapor, the signal reaching the silicon crystal detector at the end of the absorption cell dips because of the absorption, thus giving a negative output pulse.[2]

A second pulse is generated when the output of the frequency-modulated oscillator at 13.8 -|- 0.12 Mc is fed to a mixed (or radio receiver) into which is also fed a 12.5-Mc signal from the quartz-crystal multiplying chain. When the signal sweeps across the proper frequency to be tuned in (12.5 Mc plus the 1.39 Mc intermediate frequency of the receiver, or 13.89 Mc), an output pulse is generated. The time interval between the two pulses—that from the absorption cell, caused by the absorption line, and that from the receiver or mixer—is a measure of the degree to which the frequency-multiplying chain is turned to the absorption line. The two pulses can therefore be made to control a discriminator circuit which will give zero output when the time interval is right (that is, when the circuit is tuned to the absorption line) and will generate a control signal when the time interval is wrong. If the quartz-crystal oscillator drifts in frequency to higher values, the time interval between the two pulses increases; for frequencies which are too low, the interval decreases. The control signals thus generated are fed to a reactance tube, which then forces the quartz-crystal circuit to oscillate at the correct frequency to tune to the absorption line. The quartz-crystal oscillator is thus locked to the ammonia line. Frequency dividers then divide the precise 100-kilocycle signal down to 50 cycles to drive an ordinary synchronous motor clock, and also down to 1,000 cycles to drive a special synchronous-motor clock, which is designed for exact adjustment and comparison with astronomical time to within 5/1,000 of a second.

Control of the quartz-crystal circuit depends on the relative duration of the positive and negative portions of a square-wave signal generated by the discriminator. In the discriminator, the two pulses between which the time interval is to be measured turn a trigger circuit or square-wave generator on and off. When the time interval is correct, the on-off cycle generates no output signal from the positive and negative peak detectors driven by the square-wave signal. The detectors or rectifiers draw current on the positive and negative peaks of the square-wave, but when the positive and negative portions of the square wave are of equal duration, they balance and give no direct current output. However, if the time interval between the two input driving pulses gets longer or shorter, the relative duration of the positive and negative parts of the square-wave changes so that a resultant direct-current output is generated. This output is positive or negative, depending on the change in the time interval. Thus, no control voltage is generated when the quartz-crystal oscillator is on the proper frequency to agree, through the frequency-multiplying chain, with the ammonia line, but a positive or negative control voltage is produced for correcting the oscillator circuit when it drifts one way or the other from its proper value.

One great advantage of this particular clock circuit lies in the inherent short-time stability of the quartz-crystal oscillator, which makes it unnecessary for the discriminator circuits to apply correcting control signals to the oscillator at a very rapid rate. The crystal and multiplier circuits

bridge the gap between the frequency of the clock and that of the absorption line.

Recording equipment and a frequency meter are used in checking the accuracy of the clock. For this purpose, the frequency of the clock's crystal oscillator is compared to the frequency of the Bureau's primary frequency standards, a group of precision, 100-kilocycle quartz-crystal oscillators calibrated in terms of the U. S. Naval Observatory time signals. These oscillators maintain constant frequency with respect to each other to an accuracy of one part in a billion for intervals up to 10 hours and better than one part in 100 million per day. They can therefore be used to measure the constancy of the atomic clock to this accuracy. This is done by beating the signals from the two sources together at a frequency of 12.5 Mc to obtain greater measurement sensitivity. A change of one cycle per second in the frequency of the beat note, as recorded on the frequency meter or on an automatic recorder, indicates a frequency variation of one part in 12.5 million. In recent tests the clock maintained a constancy of one part in ten million for several hours. These tests show that the clock will lock accurately to the ammonia line even when a perturbing signal is applied to the reactance tube in the attempt to force the clock to change its rate.

Ultimate Accuracy

The ultimate accuracy of an atomic clock depends on many factors, of which the most important are those governing the width of the spectrum line. Spectrum lines are not infinitely narrow but have a finite width covering a considerable frequency range, since atoms or molecules do not emit or absorb radiation at only one frequency but rather over a narrow band of frequencies. The ratio of a line frequency to its width at the half-power points is called the Q of the line, in analogy to the Q (quality) factor of resonant circuits used in standard radio technique. The Q is a measure of the sharpness of the line and therefore determines its usefulness as an accurate frequency and time standard.

In the case of ammonia, the natural line width determined by the uncertainty principle of a quantum mechanics gives a Q of about 10^{18} (a billion billion). If a line width were determined only by the natural life time of an excited state in the ammonia molecule, giving a Q of 10^{18}, frequency and time could be determined to better than one part in a billion billion (1,000,000,000,000,000,000). However, the line is broadened by other factors which lower the Q to a value of from 50,000 to 500,000, depending on the temperature and pressure of the gas. This may be compared to Q values of roughly 50,000 for a good cavity resonator in a microwave circuit and values of 1,000,000 or so for the best quartz crystals. The ammonia spectrum line thus has a Q approximating that of the best quartz crystals, though much more constant and stable.

The ammonia molecules in the absorption cell are moving rapidly in random thermal motion at an average speed of almost 2,000 feet per second at room temperature. When a gas molecule in an absorption cell is approaching or receding from the source of an electromagnetic wave because of its heat motion, its absorption frequency is different from that which it would have if it were standing still. This gives rise to a "Doppler broadening" of the absorption line, analogous to the change in pitch of sound as its source approaches, passes, and leaves an observer. Thus, the line width can be reduced slightly by lowering the temperature of the gas (or by using a heavier molecule). Doppler broadening lowers the Q of the ammonia line to about 330,000 at room temperatures.

Molecular collisions also broaden the absorption line. This broadening occurs because the collisions abruptly terminate the absorption process, causing the molecules to absorb wave trains whose lengths vary in a random way determined by the distri-

bution of time intervals between collisions. A frequency analysis of these wave trains shows a corresponding random distribution of absorbed frequencies, all centering about a mean value determined by the number of collisions per second. In ammonia gas at a pressure of 10 microns there are about 120,000 collisions per second, giving an experimentally measured Q of 45,000 for the absorption line used. (This is the line known to spectroscopists as the 3,3 line, for which the quantum numbers J and K are each equal to 3.)

Actually, there are more collisions effectively interrupting the absorption process in ammonia than the kinetic theory of gases would indicate. Further broadening of the line results from collisions of the molecules with the walls, and even near misses between molecules cause interaction strong enough to interrupt absorption. The number of collisions per second, and thus the collision broadening, can be reduced by lowering the gas pressure. This process, if not carried too far, does not reduce absorption in the gas, because the decrease in number of molecules absorbing energy is offset by the increase in absorption per molecule resulting from the increase in Q. However, when the pressure is reduced too much, a phenomenon known as saturation of the line sets in, caused by an excess of radiation. Too few molecules are then left in the proper energy states to absorb the microwave radiation coming into the cell. Many molecules, which normally would be in the proper energy state to absorb the incoming radiation, are in an excited state as a result of previous absorption. Eventually these molecules will emit the quanta which they have absorbed, returning to the normal level where absorption is again possible. However, as this process is slow, the molecule usually returns to the ground level in a collision with another molecule, converting the absorbed radiation into heat. As the gas pressure is lowered, the number of collisions is greatly reduced, and not enough molecules return to ground levels. The excessive incoming radiation then weakens and broadens the absorption line through saturation. The broadening results because saturation occurs earlier at the peak of the line than out at its wings.

Saturation can be eliminated by reducing the strength of the incoming radiation. However, as the gas pressure and radiation intensity are both lowered, a condition will finally be met for which the signal strength will be down in the natural electrical noise level of the circuits used to detect the signal. Circuit noise then sets the ultimate limitation on the reduction of collision and saturation broadening. It is estimated that a Q of 300,000 to 400,000 can be attained at pressures of about one micron—still a long way from the Q of the natural line width. Assuming that effective Q values of 400,000 can be obtained with ammonia, an accuracy of one part in 100 million or better should be possible since a measurement of the center of the absorption line to within 1/250 of the width of the line could be made.

Applications and Significance

Improvement of the accuracy of the atomic clock will make it useful in several fields of pure and applied science. The lengths of the mean solar day, used in astronomical measurements, fluctuate as much as one part in 20 to 30 million, because of variations in the rate of rotation of the earth on its axis. The variation in present time standards, due to these fluctuations, causes errors in the location of heavenly bodies and in studies of their orbits and motions. The atomic clock offers the possibility of an invariant master clock against which the variation in the earth's time-keeping could be measured. An absorption cell on an atomic clock could, for some purposes, take the place of an astronomical observatory.

Broadcasts of standard frequency are of importance in keeping all kinds of radio, radar, and electronic equipment properly tuned throughout the world. This service

is required in international transportation and communications so that, for example, an airplane with radio navigational equipment will be using the right frequency whenever it is in the world and whatever airport it is using. At present, the National Bureau of Standards Station, WWV, broadcasts standard frequency and time signals on several transmitter frequencies to all the World. The Navy Department also uses quartz-crystal clocks to broadcast time signals for navigational purposes. These quartz-crystal clocks drift slightly in frequency and have to be adjusted to keep them in agreement with the basic astronomical time signals. Clocks of this type could be kept constant automatically by means of absorption lines.

Maintenance of transmitter frequency to within close limits is also necessary to utilize the available radio spectrum efficiently. The use of long-distance standard frequency broadcasts is complicated by a large reduction in accuracy due to ionospheric effects. A long distance, short-wave signal travels around the earth by reflection from the upper ionized regions of the atmosphere, known as the ionosphere. Every morning at sunrise the ionosphere moves downward, and every evening at sunset it rises. This daily variation in height causes a Doppler shift of the frequency of the reflected wave and, together with other as yet unknown causes, is responsible for a reduction by a factor of 25 or more in the accuracy of the frequency of the received signal. Thus, the Bureau's standard frequency broadcast agrees with astronomical time signals to one part in one hundred million at the transmitter but may be known to only one part in four million after transmission over long distances. This difficulty can be partly overcome in several ways. One is the provision of a local, precise frequency standard calibrated by means of received standard time signals also transmitted by radio. However, this process, which requires a day or more, complicates the equipment problem and introduces additional errors, making impractical the use of standard frequency broadcast for instantaneous or continuous frequency calibrations of the highest precision.

At the last International Radio Conference held in Atlantic City in 1947, plans were formulated to provide standard frequency and time broadcasts from many stations located to render good service throughout the world. These services may be improved or simplified by means of atomic clocks and frequency standards. Such clocks could control the standard frequency emissions of the various stations without checking and monitoring by astronomical time signals. The Doppler frequency shifts could then be eliminated by limiting transmission distances to short ranges. Also, equipment anywhere in the world could be checked against an absorption line with the certainty of obtaining a precision calibration against an absolute standard and without depending on a standard frequency broadcast.

On advantage of the rotating earth as the basic time-keeper is that it never stops rotating or breaks down. Likewise, any man-made clock must not break down but must be kept running forever if it is to keep track of time from some arbitrary instant chosen as a starting point. With the present quartz-crystal clocks, this difficulty is met by using a large number of similar clocks constantly inter-compared so that breakdown of one does not mean a loss of time-keeping records. While this procedure could also be used with atomic clocks, it would not be necessary for use of the clock as a frequency standard or for defining a standard of time-intervals since the applications do not require continuous operation of the atomic clock.

The atomic clock should permit improvement in astronomical time standards in a way impossible with electric-pendulum or quartz-crystal clocks. It thus opens the possibility of improving the precision of knowledge of the length of the year, that is, the time it takes the earth to revolve once

in its orbit around the sun. This is independent of the time it takes the earth to rotate once on its axis—the mean solar day. Measurements could then determine whether the mean sideral year is more constant than the mean solar day, as some astronomers believe may be the case.

Although the use of atomic time presents advantages in many fields of science, it will always be necessary for some purposes to have astronomical time standards. This is because the pointing of a telescope depends on the orientation of the earth at the instant of observation, in other words, on astronomical time measurements which derive from the motion of the earth.

The NBS Program and Microwave Spectroscopy

The atomic clock program is being carried on at the National Bureau of Standards along several different lines. Among these is a project being developed with the cooperation of the atomic beam laboratory of Columbia University which may result in greatly improved accuracy. In this method, quantum transitions in beams of atoms such as cesium will be used to establish frequency and time standards. The broadening of the lines by collisions and Doppler effect is largely eliminated in this method so that the potential accuracy is increased by a factor of 10 to 100 or more. Calculations show that an ultimate accuracy of one part in ten billion may be reached. The atomic beam is again used in conjunction with a quartz-crystal oscillator and frequency multiplier system, just as in the present method of using an absorption cell.

The chemical analysis of many heavy molecules by means of a microwave spectroscope has been carried out by many investigators. This makes it highly desirable to place frequency standards on an atomic basis at an early date in order that better precision can be obtained in the measurement of molecular constants. More and more chemicals will be analyzed as the technique is pushed to higher and higher frequencies in the microwave region. Spectroscopic analysis has hitherto been dependent on infrared, optical, and ultraviolet methods, which for the most part are limited to work on atoms and the simpler molecules. However, a large part of medical and industrial chemistry requires analysis of large, complicated molecules. The heavy molecules, rotating at slower rates, usually have spectrum lines in the microwave region so that the recent advances in microwave measurement technique now provide highly accurate methods for the study of molecular constitution. Such large molecules are principally involved in the fields of high polymers, plastics, rubber, textiles, oil, foods, drugs, and biological chemicals such as vitamins.

Stable isotopes which are now available from the Atomic Energy Commission, are being widely applied in industry and medicine, and it is becoming important to have quick, accurate instruments for measurements of the kind and quantity of isotopes present in a sample. Isotopic identification is not possible by ordinary chemical methods, which deal only with the outer parts of an atom or molecule and not with the nucleus. The microwave spectrometer, having a resolution up to 100,000 times greater than an infrared spectroscope, will be able to make measurements on time isotopic samples, and it can be built to do this quickly and accurately with automatic, all-electronic components.

One of the most important applications of quartz crystals is to the frequency-control of transmitters and filters used in radio equipment—both military and civilian. If these transmitters varied in frequency, radio and television sets would constantly have to be retuned, and much interference between adjacent channel transmitters would also result. Telephone companies operate carrier telephone circuits in which large numbers of simultaneous messages are transmitted over the same cable and are separated by means of crystal filters. Similar

needs are met in microwave relay networks used for simultaneous communications, television, and FM broadcasting. At the higher frequencies, which are inaccessible to crystal oscillators or filters, the need for frequency-control equipment is urgent. Here atomic oscillators and spectrum lines used as filters would give the necessary frequency control and stability. A filter would consist of a cell filled with a gas that would absorb many different frequencies. A band-pass rather than a band-stop filter can also be made by means of additional microwave components called magic tees. Such filters could be electrically tuned by making use of the Stark effect, in which an applied electric field can force a molecule to change its frequency.

Stable oscillators for controlling high-frequency transmitters can be made by using a method similar to that in the present atomic clock. Here a discriminator or servo circuit locks the transmitter to a spectrum line through a control signal generated by the servo whenever the frequency drifts. However, it would be advantageous to eliminate the servo or discriminator and develop an atomic oscillator in which the absorption line would directly determine the frequency of the oscillator or transmitter. This would be analogous to a low-frequency quartz-crystal oscillator and make possible many new applications to microwave radio systems.

Dr. Harold Lyons, in recent work at the National Bureau of Standards, has designed circuits of this type for use in transmitter control and for making an atomic clock and frequency standard without using discriminator circuits. In this method, the atomic-oscillator frequency is reduced by means of frequency dividers, but no quartz crystal-driven frequency-multiplying chain is used, as in the present clock, nor is any servo circuit required. The circuit is that of a feedback oscillator in which feedback is obtained for the amplifier through a magic tee only at the absorption line frequency. The tee is balanced at other frequencies, but the absorption occurring at the resonance frequency of the line unbalances it and allows the signal to be passed through so that the amplifier oscillates. This circuit requires a microwave amplifier at the frequency of the absorption line. Such amplifiers have been built, but are not yet commercially available, at 24,000 Mc where the ammonia lines are found.

Meanwhile, an exact equivalent of this circuit has been set up at 3,000 Mc, where amplifiers are now available. This circuit uses a resonant cavity in an equivalent circut of the absorption line. As the oscillator has functioned satisfactory, an attempt is being made to find suitable absorption lines in the 3,000-Mc region. This involves a search for the lines of deuterated ammonia, in which some of the hydrogen atoms in the ammonia molecules have been replaced by heavy hydrogen (deuterium) atoms. The heavier deuterated ammonia will give lines at lower frequencies than ordinary ammonia. For example, when all three hydrogen atoms have deuterium atoms substituted for them, the frequency will go down to approximately 1,200 Mc. The National Bureau of Standards plans to construct a magic-tee atomic oscillator using the lower-frequency ammonia lines. Another atomic oscillator to be constructed at the Bureau will be similar to the magic-tee type but will use a six-arm waveguide bridge to control the feedback of the amplifier. This circuit should largely eliminate possible effects of the external circuits on the frequency of the oscillator. Thus the oscillator controlled by the absorption line alone should be especially suitable for primary atomic clocks and frequency standards. Analogous circuits at low frequencies, using quartz crystals in ordinary bridges, have become the most precise quartz crystal oscillators so far constructed. The relative merits of the magic-tee and bridge circuits are being investigated.

The atomic clock may eventually be used to improve the standard frequency and time broadcasts of the National Bureau of

Standards, both from Station WWV and the Bureau's new station in Hawaii, WWVH. This could be done by monitoring the present quartz-crystal clocks with an atomic clock and would be especially useful at the Hawaiian transmitter. A precise atomic clock would give the Bureau a time standard analogous to the Bureau's new atomic standard of length provided by the invariant wavelength of the light from a single mercury isotope (Hg^{198}).

The goal of using spectrum lines of individual, isolated atoms in a field-free space to establish time and frequency standards is most nearly attained in the method using quantum transitions in atomic beams. Both this method and the method using absorption cells stem from the application of atomic physics to practical problems. In fact, quantum mechanics must be used to calculate and design the necessary apparatus, and the absorption by ammonia gas is a typical quantum mechanical effect incapable of explanation by classical physics. The ammonia molecule, structurally like a pyramid with three hydrogen atoms forming the triangular base and the nitrogen atom at the apex, continually turns itself inside-out, giving rise to a quantum-mechanical resonance absorption. The atomic clock is thus another example of the importance of atomic physics to engineering. The overlapping of the fields of electronics and microwave physics may well provide a new technique for opening up the millimeter-wavelength bands above the region where ordinary microwave methods are applicable and below the region of optical methods.

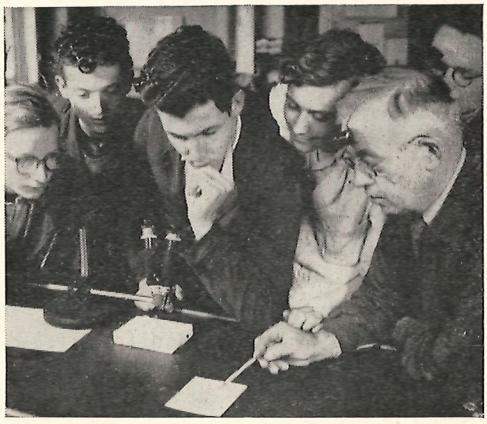
(EDITOR'S NOTE: *In our March issue of the H.I.A. JOURNAL, we shall publish a second installment of this foregoing article, which will be profusely illustrated with diagrams and charts, making clearer the text matter which has been published in this issue. Be sure to save your February issue and then check over the plates and read the type matter in the second installment of this illuminating technical article.*)

HIGH REQUIREMENTS MAINTAINED BY SWISS WATCHMAKING SCHOOLS

LE LOCLE, Switzerland — Famed Swiss cantonal watchmaking schools today continue to cooperate closely with Swiss watch industry employers so that the training of students will meet the professional work standards of the factories and assure a constant demand for graduates.

This standing demand for graduates, however, has not shortened the long period of study required by the Swiss horological schools. It still is necessary to complete four years' study to qualify as a repairman, which is the shortest course given. The technician's course is five years and the watch engineering course runs seven years.

The schools take a genuine interest in the students to help them secure employment after graduation through special offices that place graduates with watchmaking



The second year of the Swiss horological school curriculum is composed of watchmaking theory and its practical application. The turning of a balance wheel staff is explained to four students at the Le Locle school by a master craftsman.

factories. However, most of the students receive offers of jobs even before they have completed their final year. It is always a strong temptation for students planning to spend one or three more years to become watch technicians or engineers to go directly into plants after receiving their certificate as watch repairmen.

Third-year students in the public-sponsored watchmaking school at Le Locle, Switzerland, learn how to grind and polish the parts for the watches they must complete for graduation. They are pictured turning countersinks and adjusting fittings. In the background is a Neuchatel clock which the Swiss made famous between 1760 and 1820.

Seven public-sponsored horological schools provide Swiss watch plants with a pool of skilled craftsmen. These schools, run by the cantons (or states) are located at Geneva, Bienne, La Chaux-de-Fonds, Le Locle, St. Imier, Solothurn and Le Sentier. Supplementing them are numerous private schools sponsored by the watch companies themselves.

The final tests for graduating from the Swiss schools are as severe as those demanded by the best American medical or engineering colleges. Before a Swiss can receive the primary title of "watch repairman," he must have designed his own watch, built his own tools and made the finished movement so accurately that it will not vary more than four seconds in twenty-four hours.

"Pivoting" is a delicate job for the second year students in Swiss horological schools. These eighteen-year-old boys, whose fathers and grandfathers were watchmakers, are learning the skill of polishing and adjusting pivots to the finest tolerances.

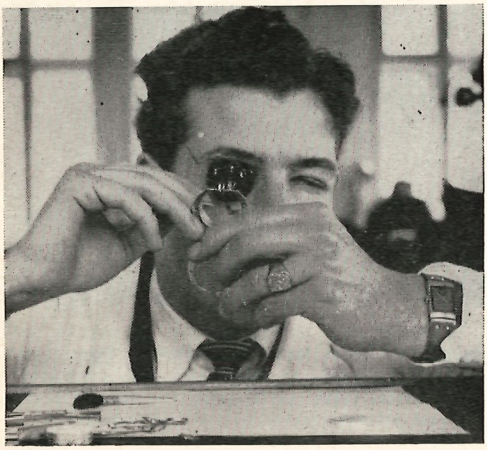
This insistence on high standards for graduates is carried over by manufacturers of Swiss watches into their own production requirements. To insure constant standards of the highest skill, the industry accepts the authority of the world-famous observatories maintained at Geneva and Neuchatel. These observatories are engaged in continuous testing of watches; those that pass can be certified as having undergone the most rigorous conditions of accuracy.

Even the watch which the student makes must pass the temperature and position tests demanded of wrist chronometers.

The curriculum of the Swiss horological schools is built around this final achievement. Every step in designing movements and watchmaking tools, in shaping parts, assembling them and timing the movement, is followed by the students in their own piece of work.

During the first year, the students receive the rough metal from which they will

make their movement. They are introduced to the basic tools they will use the rest of the course and during this year and the second they are given intensive instruction in making tools, drawing and watchmaking theory. The third year they learn to turn and polish watch parts, how to set jewels and the fundamentals of repairing watches and clocks.

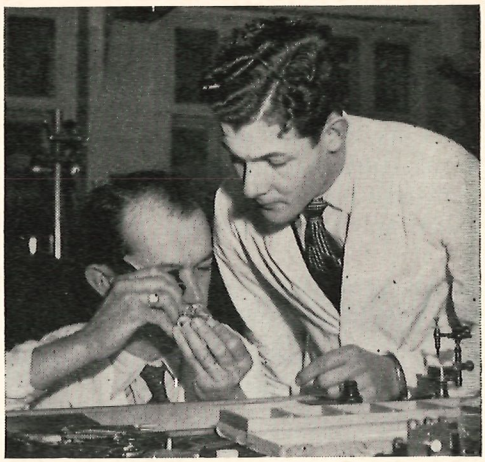


After three and a half years of closely supervised training, the student watchmaker has well-disciplined hands capable of undertaking the delicate job of adjusting springs for balance wheels. This Swiss student is following a family tradition and is in fact wearing a watch made in his father's factory.

By the fourth year, the students' watches take final form as they learn the more intricate and delicate processes of assembly, regulation and timing. Toward the end of this year, the watches are sent off to the cantonal observatory for rigid testing.

A large proportion of the students attending these schools are carrying on the watchmaking skill of three or more generations of their families. In Switzerland, watchmaking skill is regarded not only as an art, but as a "national resource" in providing a product that can be sold around the world.

Graduation day is a big event, not only for the students but also for the whole town where the school is located. The celebration looks something like a victory parade in an American college town after a football game. Crowds, arm-in-arm, sing and dance their way down the streets, through the stations, the hotels and restaurants. Being graduated as a watchmaker is a great achievement in Switzerland. And the townspeople know that on the watchmaker's ability depends in large part their prosperity.



An instructor at the Le Locle watchmaking school explains the adjustment of a watch after its first regulating to a fourth-year student. Most students who have passed this stage of their training successfully have already received offers for goods jobs in Swiss watch factories.

HOROLOGICAL SOCIETY OF NEW YORK ELECTS OFFICERS

Mr. Andrew Park was relected as president of the Horological Society of New York at the January meeting. Mr. Park defeated two other candidates, each by close margins.

Mr. Otto Ross was elected to the office of vice-president. Mr. Henry Morris, former holder of this office, was elected

to the office of trustee after he declined to run for the vice-presidency.

Returned to office with Mr. Park were Henry B. Fried, executive secretary, Paul G. Roth, recording secretary and Frank Knoll, treasurer. Mr. James J. O'Shaughnessy, former president was continued in his present position as trustee.

Mr. Arthur Lindig was reelected to the office of Librarian and newly elected to the position of co-librarian was William F. Burns.

The race for positions on the executive committee was an interesting part of the proceedings. Elected to this office were Dr. Arthur L. Rawlings, W. Hoffsemmer, F. Klein, C. K. Johns and M. Epstein.

At the business part of the meeting it was voted to lend financial and other aid to the New York State Watchmakers Association in their efforts to secure watchmakers legislation in this state. Others who donated as individuals were Andrew Park, James J. O'Shaugnessy, Teddy Taus and Jean L. Roehrich.

During the counting of the election ballots Henry B. Fried, executive secretary, answered questions pertaining to the legislative program. Other speakers were Mr. O'Shaughnessy, Mr. Goldstein, Mr. Roth, Mr. Liemer and Mr. Klein.

Watchmakers and Jewelers Use Swiss Bureau

Since the opening of the Swiss Watch Repair Parts Information last fall, over 60,000 letters have been received from watchmakers and jewelers in connection with the introduction of the new repair program and the repair and service of watches with Swiss movements in general.

A large percentage of the mail received by the Bureau covered the requests for the Official Catalogue of Swiss Watch Repair Parts (Part 1), the 150-page loose-leaf book being distributed to the trade. The use of the catalogue sets into operation a single standard system of ordering parts by the watch repair department and the filling of the orders placed in that system by the materials distributor.

Another feature in the program is the publication of the Official Dictionary of Watch Parts, illustrating 700 parts and nomenclature of each part in four languages. The Dictionary, which can be ordered through this magazine, is the definite reference book and was compiled after years of research by Swiss Horologists.

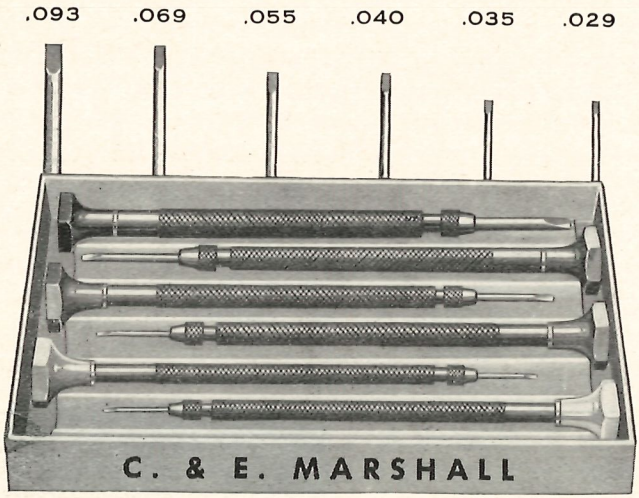
Based on a national survey of consumers and trade, and the results obtained from the advertising run last year, The Watchmakers of Switzerland advertising in 1949 will continue to promote the buying of watches in jewelry stores for gift occasions.

All-American Cotton Bowl stars Norm VanBrocklin of Oregon U (left) and Doak Walker of SMU (right) compare their Hamilton award watches that they received after competing in the annual New Year's day classic. Hamiltons were presented to all the members of both teams by the Cotton Bowl Association.

WATCH-CRAFT

REG. U.S. PATENT OFFICE . No. 348436

DOUBLE END



SET

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EXAC

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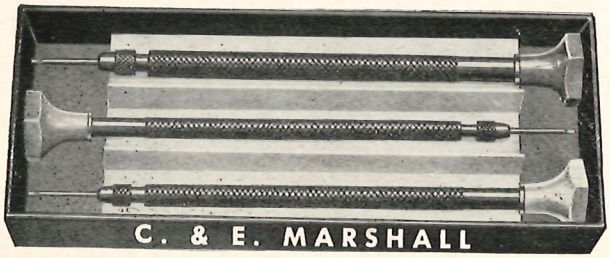
Set of 6 Light Weight Screw Drivers with reversible blades and 3 different diameter sizes in the handles . . . 2 of each size handle. Handles are in proportion to the blades, so you get the right "feel" when you use them. Has sleeve style blade holders. Every part is of high grade steel except plastic tops. Tops are of 6 different colors for quick, easy identification of sizes. WATCH-CRAFT screw drivers are an amazing improvement over the heavier, clumsy types. Comes complete with blade dimensions printed on box. Price is pre-war . . . quality is WATCH-CRAFT. No. 42183.

Set of 3 WATCH-CRAFT Jewel Screw Drivers illustrated below. Has the same quality, design and "feel" as the larger set. Three different colored plastic tops . . . body and reversible blades of high grade steel. Comes complete with blade dimensions printed on the box. Two body sizes with the length and diameter of handles in proportion to the blades for better balance. Both sets DESIGNED . . . MANUFACTURED . . . GUARANTEED BY C. & E. MARSHALL CO.



SET OF 3

Different Colored Tops

No. 42185

$1.35

C

SCREW DRIVERS

OF 6

75

SIZE
2183

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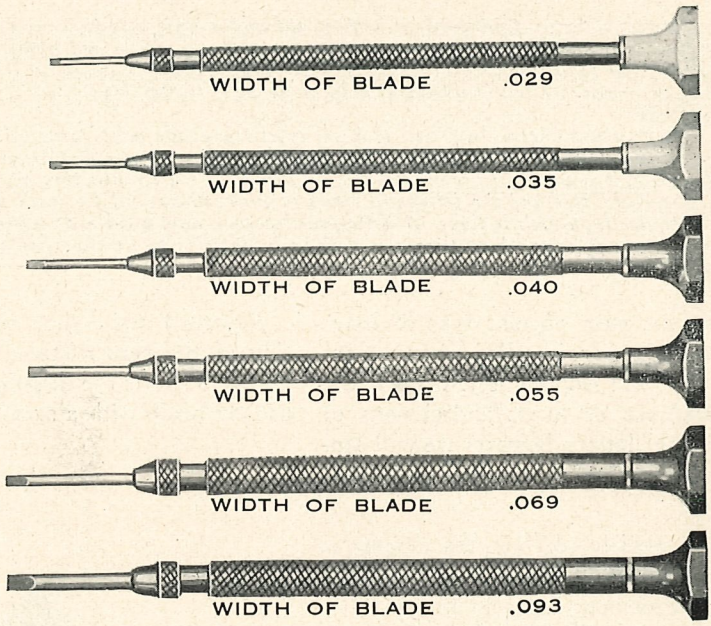

EXTRA BLADES FOR BOTH SETS OF SCREW DRIVERS

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	¼ Doz. or More of a Size	Less than ¼ Doz. of a Size
1 Doz.	$ .90	$1.20
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1 Dozen EXTRA BLADES Assorted Sizes

(Mostly Small)

All Sizes.....$1.00

. & E. MARSHALL CO.

Box 7737, Chicago 80 and Principal Cities

A Practical Training Program for The Engraver-Beginner

EDITOR'S NOTE: *Engraving is both an art and a craft, and it is not the intention of this added training feature to create artists but to develop and apply the watchmakers and their apprentices' craftsmanship ability along mechanical lines to produce in a more or less mechanical way, a passable artistic effort or "a reasonable facsimile."*

It does not always hold true that an artist makes the most successful engraver, or is always true that a beautiful hand-writer makes a successful letter engraver. However, it is true that the outstanding engravers are a combination of both.

Therefore, this and the following series of instructions will be based on mechanical rather than artistic lines. A little practice each day, a little determination, and in a reasonable length of time you will be in position to do the simpler forms of engraving.

Perhaps the most popular type of letter which the engraver is called upon to engrave is the "Old English" style. There are many variations of forms and designs of "Old English" letters, however we will confine our instructions to the two most popular styles.

You can readily see that the cutting is similar to the Block letter which we have described in previous issues of The H. I. A. JOURNAL, and it should be unnecessary to go into a lengthy description of designing and cutting of simplified Old English at this time.

NOTE: The angular lines are usually a little wider than the perpendicular lines, by at least one to two numbers wider, i.e., if the perpendicular lines are cut with a number 37 flat graver, the angular lines should be cut with a number 38 or 39 flat graver.

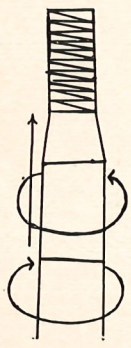

Fig. 1

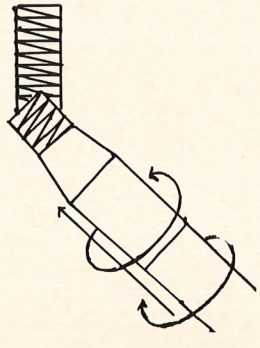

Fig. 2

Figures 1 and 2 show the "wriggle" cutting of the perpendicular and angle lines. Figure 3 shows the finishing cuts which are usually made with a square graver.

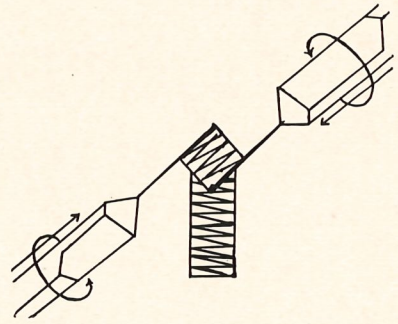

Fig. 3

Starting at the point shown at the right, (Fig. 3 top) in a fine line, cut downward, gradually increase the width of the cut by "rolling" the graver away, until the cut is slightly beyond the edge of the perpendicular cut. To make the finish cut shown on the left (top) the same method is followed except that the cut is continued to conclusion of the angle line (top). However, the reverse is true when cutting the finish cuts at the bottom, as you can see in Fig. 4.

The curve cut shown in Fig. 5 is perhaps the most difficult of all "wriggle" cuts to make. It is a "trick" cut and requires considerable practice to perfect. This cut is started with the full width of the graver

Fig. 4

and the position angle of the cutting face of the graver is maintained to the end of the cut. (See Fig. 5 left.) The principal involved in making this "trick" cut is comparable to the shading-pen method used by sign card writers. By holding the shading pen in one position and pulling slightly to the right or left, the width of the curve line decreases. This also holds true with the flat graver; however, there are two separate and distinct motions required in cutting this curve. The engraving tool should be held a little higher than in cutting perpendicular and angle cuts (approximately 45°). At the instant you start your "wriggle" cut, pull the graver slightly towards you, retaining this side "pull" throughout the entire cut, as shown by the straight arrow. CAUTION — DO NOT CHANGE THE DIRECTION OF THE CUTTING angle face of the graver, or turn the work to meet the graver. This curve "wriggle" cut when mastered makes a most attractive cut, which, when finished with the square graver, makes a graceful appearing cut.

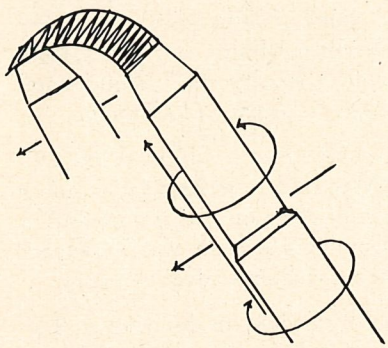

Fig. 5

A little practice in making the receding curve "wriggle" cut will be time well spent for it produces an attractive symmetrical finish to the Old English letter.

This same "trick" cut can be used on either short or long curve cuts, which appear in all upper case Old English letters, and also in a few lower-case.

In the March issue of the H. I. A. JOURNAL we will begin the formation and cutting of simplified Old English text, later taking up the more artistic forms of this popular style letter.

IMPROVED POISING TOOL OFFERED BY SWARTCHILD

Advertised on page 10 of this issue, SWARTCHILD'S New Triumph Poising Tool, now featured with ruby jaws, two adjustable legs and spirit level. It is machined from solid brass and is guaranteed accurated. The amazing thing about this tool is that with all the added features, and the price remains at $10.50. Swartchild and Co. state that this is in line with their policy of featuring very low prices in order to maintain the company's leadership in offering values to the trade.

Pictured here, left to right, are W. James, F. Coates, and L. D. Weaver of the Tool and Supply Department. Following is Mr. M. Crawford, School Electrician; Mrs. M. E. Peters, secretary and treasurer; F. E. Peters, Technical Director; C. M. Bowen, Registrar; J. W. Scott, Assistant Registrar, and A. Holmes, Janitor.

Elgin Executive Dies

T. Albert Potter

T. ALBERT POTTER, 65, chairman of the board of directors of Elgin National Watch Company, died Monday evening, January 24, at the University of Pennsylvania Hospital, Philadelphia, Pa., after a short illness.

Mr. Potter was born June 16, 1883, in Dresden, Germany, of American parents who brought him to this country as an infant. In Philadelphia, where he grew up, he attended the Forsythe School and the Episcopal Academy. After studying in Switzerland he entered Princeton University and was graduated in 1906.

Following his graduation, Mr. Potter became associated with the Quaker Oats Company. Experiencing consistent and steady advancement, he was transferred to the company's general offices in 1918, and in 1929 was named vice-president, a position he retained until January, 1932, when he was elected president of Elgin National Watch Company.

In March, 1948, he was named chairman of the board of directors of Elgin.

Mr. Potter was a trustee of the Illinois Institute of Technology, Elgin Academy, and the Chicago Zoological Society. He was a director of Bell and Howell Company, Chicago National Bank, Public Service Company of Northern Illinois, and of the Continental Casualty and Continental Assurance Company of Chicago.

He was a past president of the Illinois Manufacturers Association and a former director of that group, and at the time of his death was a member of the association's advisory group.

He is survived by his widow, Eleanor Horn Potter; two sons, Thomas A., Jr., and Gordon; and a daughter, Joan.

Watchmaker Invents New Tool

The tool catalogs are filled with "gadgets" for making the work easier for the watchmaker. Some of these are real time-savers and meet the exacting requirements of the expert watchmakers; the "SETSIT" Roller Jewel Setting Tool is such a tool.

The "SETSIT" Roller Jewel "setter" is the development of more than 36 years of practical experience of Mr. P. A. Harmon, a watchmaker of unusual mechanical ability, a certified H. I. A. Master Watchmaker, and son of an outstanding watchmaker, as Mr. Harmon jokingly remarked, "I cut my teeth on a pair of tweezers."

Mr. Harmon enjoys the enviable reputation of consistently turning out satisfactory timekeeping watch work, and appreciates the time saving advantages of practical precision tools and equipment.

The "SETSIT" Roller Jewel "setter" should be a part of every watchmaker's equipment because it does a difficult job on

Well Known Watchmaker Dies

The entire American watchmaking industry will mourn the passing of William H. Manby, long an outstanding figure in the watch manufacturing field, who passed away January 5 in a West Chester, Pa., hospital after a prolonged illness. He was 78 years old.

Mr. Manby, the son of the late William H. and Anne Howe Manby, was born in Hagerstown, Maryland, in 1870.

"Bill" Manby, as he was affectionately known to his host of friends and colleagues, at an early age showed unusual mechanical aptitude and, at the age of 14, began his watchmaking career with the old Keystone Watch Company, whose factory was then located on what is now a part of the present site of the Hamilton Watch factory.

Like many watch factory workers of that period, "Bill" Manby made the circuit of watch factories, working in the Deuber Hampden factory at Canton, Ohio, the Elgin Watch factory and Waltham factory, returning to Lancaster in 1896, where he joined the staff of the Hamilton Watch Company.

W. H. Manby

In 1924 he was made technical superintendent of the Hamilton Watch Company, and in 1930 was elevated to General Superintendent, which position he held until his retirement in 1940.

Mr. Manby was sincerely interested in the advancement of the science of horology in America and was one of the original organizers of the Horological Institute of America, in Washington, D. C., October 21, 1921.

all types and sizes of roller tables accurately and speedily without removing the roller table, as illustrated on page 35. For the past three years, Mr. Harmon has been experimenting on an ideal roller jewel cement that is hard, yet with superior adhesive qualities which would not "flash" over the work. He has perfected such a roller jewel cement, and which is included with the "SETSIT" Roller Jewel Setting Tool.

You can secure the "SETSIT" Roller Jewel Setting Tool from your jobber.

H. I. A. Executive Committee Held Meeting In Indianapolis

The mid-winter meeting of the Horological Institute of America, Inc., was held January 17 in the Severin Hotel in Indianapolis.

Attending this meeting were A. S. Rowe, president, Indianapolis; George J. Wild, vice-president, dean of Horology, Bradley University, Peoria, Ill.; George T. Gruen, treasurer, director of Gruen Watchmaking Institute, Cincinnati, Ohio; Ralph E. Gould, Washington, D. C., executive secretary; Harry D. Henshel, vice-president, Bulova Watch Company; Paul E. Morrison, regional vice-president, A.N.R.J.A., Kalamazoo, Mich.; John J. Bowman, director Bowman Technical School, Lancaster, Pa.; S. Geo. Cochron, dean Cochron Watchmaking School, Nashville, Tenn.; Howard L. Beehler, dean, Beehler School of Watchmaking, Chebeague Island, Maine, and technical consultant of Joseph Bulova School of Watchmaking, Woodside, New York; Howard S. Schrantz, chief technician, Ball Watch Company, Cleveland, Ohio; Howard Isenthal, H. W. Schaefer and Thos. E. Cook, Indianapolis, members of the examining board, and L. R. Douglas, Indianapolis, member of Advisory Committee and Editor of the H.I.A. JOURNAL.

Arrangements were completed for the 28th Annual Convention of the Horological Institute of America, Inc., which will be held May 9 and 10 in the National Academy of Science Building, Washington, D. C.

An outstanding program of interest to horologists, watchmakers, their apprentices and student watchmakers will be presented by recognized national authorities on theoretical and practical Horology.

Detail information will be published in the April issue of the H.I.A. JOURNAL. Make your arrangements now to attend.

Seated (left to right): John J. Bowman, Howard L. Beehler, George J. Wild, Ralph E. Gould, A. S. Rowe, Harry D. Henshel, George T. Gruen, Howard R. Isenthal, Thomas E. Cook. Standing (left to right): Paul E. Morrison, S. George Cochron, L. R. Douglas, H. W. Schaefer, Howard S. Schrantz.

Tennessee Watchmakers and Jewelers Joint Convention Plans Completed

Plans have been completed for the joint convention of the Tennessee Watchmakers and Jewelers Association and the Tennessee Retail Jewelers Association (A.N.R.-J.A.) to be held in the famous Andrew Jackson Hotel, Nashville, May 1, 2, 3.

This will mark the first joint convention of these two organizations for a number of years and undoubtedly will be the most successful from points of program interest and attendance ever held by these organizations. It is expected that the meetings of these organizations in a friendly spirit of cooperation and good fellowship will result in more ethical and profitable business relationships.

The program committee is to be complimented on the unusual interesting and entertaining program which it has arranged. Speakers of national reputation in the industry will address the joint session on various subjects of vital importance to both groups.

A jewelry and gift show, as well as a display of the latest watchmakers tools and equipment of a magnitude seldom seen in the South has been arranged, and it will also be open to the general public.

Reservation of exhibit space has been made by the following leaders of the industry: Hamilton, Elgin, Bulova, Gruen Watch Companies; Parker & Schaeffer Pen Companies; International Silver Company; Ewing Bros.; Young-Neal Company; S. Fargotstein and Son; C. & E. Marshall; Henry Paulson and Co.; S. LaRose, and Cas-Ker Company. Display space will be greatly enlarged before the opening of the Convention.

An innovation in convention entertainment will have its premier at this meeting. A section of the hotel has been set aside as a moving-picture theatre, where continuous moving pictures of the industry will be shown to the visitors and the public.

There will not be a dull moment for the ladies who attend the joint convention as special arrangements have been made for their entertainment, including a style show of the latest spring fashions; a "give-away" radio program, "Breakfast at the Maxwell House," with valuable prizes; tours of historical interest in and around Nashville, including a visit to The Hermitage, the colonial home of Andrew Jackson; Fort Nashboro; The Parthenon with its art treasures, and several colleges, which have caused Nashville to be known as "The Athens of the South."

A banquet and elaborate floor show will highlight the social activities of the joint convention.

Those desiring reservations should make application early to the committee chairmen listed below, all of Nashville, Tennessee.

Hotel and Banquet—Howard S. Stone, 220 Fifth Ave., N.

Advertising—Sam L. Cordell, No. 3, Arcade.

Display Space—L. D. Stallcup, 1813 Beechwood Avenue.

Convention Publicity and Coordination—Ed. F. Cochron, 50 Arcade, Robert F. DuBose, 2205 Fifth Ave., N.

The National Bureau of Standards, Washington, D. C., have advanced the fees for their tests, effective January 1, 1949. This makes it necessary to advance the H. I. A. Certified Grade Examination Fee from $10 to $12.50 and the Certified Master Watchmakers' Grade examination fee from $15 to $17.50, effective January 1, 1949.

H. I. A. CERTIFYING COMMITTEE.

Your Questions Answered Here!

By "The Professor"

EDITOR'S NOTE: *A nationally renowned professor—who prefers to remain anonymous—has consented to answer questions from our readers pertaining to the science of horology and its various practical applications in the field of watch repair. Simply address your questions to the editor, H. I. A. Journal, 921 State Life Building, Indianapolis 4, Indiana. It will be our pleasant duty to forward all questions received to "The Professor" for a prompt reply and publishing in these columns every month.*

Dear Professor:

For some time I have been seeking the answers to several questions. Although they sound simple, I have asked several watchmakers and their opinions all differ.

1. Why are most new Swiss watches fitted with dial washers that to me are placed on wrong? I always thought the curve should be upward, but they all seem to be down. Right or wrong, I always turn them around unless there are two of them.

2. What would be the effect on the daily rate, as well as the isocronal rate, when one allows a pocket watch to swing on the hook? Most times it cannot be stopped unless it is against the wall.

3. Recently I purchased an Elgin sapphire burnisher and pivot polisher. I am not pleased with it and would like to know if it is recommended as a finished job or should rouge be used afterwards?

4. A fellow watchmaker loses the cap jewels on the watch when he cleans them. Is it possible to get results—this way he has few comebacks and I always take them off and don't seem to get any fewer than he.

5. Try as I may, I cannot cover any more than four watches a day. What is considered a good day's work and what figures have you on the percentage of comebacks in the average store?

Thanking you in advance, I am

A. H. C., Manchester, N. H.

Dec. 6, 1948.

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(1) If dial-washers are used, they should be put on with the convex side downward, and the concave side upward, against the dial, to lessen any chance that the outer edges of the washer might catch in the gearing of hour-wheel and intermediate pinion. It should be said, however, that the use of

dial-washers, either in manufacturing or repairing watches, is an admission of inferior workmanship in fitting of the pipe of the hour-wheel on the cannon-pinion. The side-play and the end-play of the pipe should not be allowed so great as to require dial washers to keep the gearing in correct action.

(2) Watches should always be hung on a rack for timing them, with the watch resting against the backboard of the rack, so that the movements of the balance cannot cause the watch to "swing" on its hook. If allowed to swing, the watch will produce a false rate, on which it would be impossible to regulate or adjust it. Your question: "What would be the effect, on daily and isochronal rates, if a watch is allowed to swing on the hook?" is answered by saying that this would not be alike in all cases; you would have to find it out for each watch separately, by simply hanging the watch so it will swing, and noting the rates in comparison with your standard of timekeeping.

(3) For directions for the proper use of your sapphire burnisher, and about any complaints concerning it, as well as concerning claims made for it, we suggest writing to the manufacturer of the tool; the advantage of direct communication between buyer and seller of a special product, in a matter like this, is obvious.

(4) Certainly the cap-jewels should always be removed, in cleaning watches. It is impossible to remove old oil and dirt from pivot-bearings, unless this is done, in every case. Judging the difference in this, by comparing "the number of comebacks" of watches cleaned both ways, is manifestly absurd. Many other things, besides methods of cleaning, could be causes of comebacks, in either way.

(5) We do not consider it a good way to judge the output of a watchmaker by how many watches per day he repairs. Conditions differ too much for this, even to strike an average that would standardize such a criterion. One shop may have many more watches that require much work to complete the jobs; another shop, more short-order jobs; standards of quality in work differ, and so on. To judge a fair personal output, in comparing between workmen, we should know more about the conditions suggested above, than your question states. We believe, however, that if the shop has good standards of workmanship, and does a rather high percentage of complete good-order jobs, four watches a day for a watchmaker would be a very good output. Concerning your question: "What figures do you have on percentage of comebacks in the average store?" will say we know of no such statistics that are available covering enough shops to be used as a standard for judging this matter. One large highly departmentalized jewelry business we know of, that kept figures on this, found that of all complete-order watch repair jobs their shop turned out in one year, only 1 per cent were returned with complaints, not counting those in which the customer was at fault instead of the watchmaker. This, of course, applies to only one shop, and shouldn't be taken as applicable to the trade in general. We think is the percentage stated is highly exceptional; it certainly indicates a high order of management, and of competency in the watchmakers in that shop.

QUESTION: We traded in an old American 18 size watch of three-quarter plate design with movement engraved "Stratton's Patent, No. 125420, American Watch Co., Waltham." It is finely finished and has a stopwork at barrel that looks more like Swiss than American work. Can you give us some idea of the age of the watch?

ANSWER: In 1859, a business depression resulted in the lay-off of some of the foremen at the then recently organized watch factory at Waltham, Mass. Several of these interested investors at Nashua, New Hampshire, and organized a watch factory there. In 1862, business having revived at Waltham, the latter company bought out the Nashua plant and moved the machinery

to Waltham, re-employing the foremen, and taking the unfinished watches to be completed at Waltham. Your watch is one of those designed by N. P. Stratton at Nashua and finished at Waltham. It was made perhaps between 1865 and 1870 and is thus between 78 and 83 years old.

QUESTION: I wonder why I have so much trouble with my tweezers in straightening out hairsprings when I find them bent in putting watches in complete order? When pressed together with a good deal of force, the spring is apt to slip out from between the tweezer points, which makes it hard to bend the coil. I use Boley AA and BB tweezers for this work.

ANSWER: If you examine the points of your tweezers, you will probably find that they are not perfectly flat on the inside surfaces. These should be occasionally dressed flat with an oilstone slip; their surfaces should not be only flat, but should be exactly parallel to each other when the tweezers are closed. One other thing necessary is that the rivets at the top end of the tweezers be tight. The best tweezers for hairspring bending are the kind originally made under the brand, "Dumont". These are now made under other brand names also; the characteristics of the type are: exceptionally firm-closing at the points; finish, plain steel, not nickel plated; extra well tempered steel throughout; heavy enough for firm grasp on work, but no excess weight. Any dealer would know what to furnish if you specify tweezers of Dumont type. The Boley BB tweezer is good for holding hairsprings for vibration-timing, but not for bending springs. It is intended for timing only.

QUESTION: Wouldn't it be a good thing to lacquer the plates of a French clock which are highly polished after cleaning them to keep them from tarnishing?

ANSWER: No. On the other hand, it would be dangerous since most kinds of lacquer contain elements that have a chemical effect on oil, hastening its thickening.

QUESTION: What is it best to do with a watch that the owner has gotten full of sea water? This happened about a week ago and most of the steel parts are rusted.

ANSWER: Clean the watch in the usual way. Immerse the steel part in kerosene for about 24 hours. This will loosen the rust, which should then be brushed off. What will be left will no doubt be more or less of pits where rust has eaten into the steel. If the hairspring is of steel, this will probably be found so much pitted that it will need to be replaced with a new spring. Unless a hairspring is very superficially rusted, that is, if rust has eaten out noticeable pits in it, it will have lost its capacity to control the motions of the balance so as to keep accurate time. As to the other steel parts, such as pinions, winding wheels, etc., these can be repolished by using the ordinary abrasives—oilstone powder, diamantine or rouge. A dentists' circular brush in your lathe may be used with abrasive powder and oil on all parts of such shape so that the bristles of the brush will reach the rusted place. Where this will not do, the abrasive can be applied with pegwood, cut so that it will reach the rusted surfaces. On flat surfaces, these may be refinished by rubbing them by

hand on ground glass or metal bench laps, first with oilstone powder and oil, and finishing with diamantine or rouge if a high polish is desired. ———

BIT: The *seconds-bit* in an enamel watch dial is the circle of enamel soldered or cemented in the main dial and forming the second dial. The *center-bit* in a "double-sunk" dial is the piece cemented or soldered inside the hour-circle and forming the center of the dial.

BOB: The weight on the lower end of a rod, both together forming a pendulum for a clock.

Basic Points for Operating a Successful Watch Sales and Service Dept.

By BENJAMIN MELLENHOFF

EDITOR'S NOTE: *Volumes have been written on the theoretical and practical servicing and repairing of timepieces, but little has been written about the need for or the value of customer goodwill as it concerns the selling of new watches and their maintenance in a satisfactory timekeeping condition, after they are sold.*

This is the first of a series of articles by Benjamin Mellenhoff, a well-known watchmaker, of New York City.

Mr. Mellenhoff is well qualified by experience and training to write intelligently on this important, but neglected subject. He spent three years in the St. Petersburg (Russia) Watchmaking School, under the auspices of Prince Ollenburg; has been employed in the E. Howard and Hamilton Watch factories; service department manager of several famous New York retail jewelry establishments, and has operated his own retail store.

He is a Past President and Honorary Member of the Horological Society of New York; a certified H. I. A. Master Watchmaker and an Honorary Member of the Horological Institute of America, and the H. I. A. Journal Half-Century Club.

ARTICLE ONE

The foundation of every jewelry store is the watch business, including watch and clock repairs. Now that the foundation has been laid, we commence building the rest of the structure, consisting of jewelry, diamonds, silverware, etc.

To have a good strong foundation, we must live up to fine business ethics, including merchandise of good quality. Every article that is sold should carry the indisputable motto: *We service our merchandise.* On this basis will be built the balance of the structure, specifically, your *NAME.* First of all, use your own name in your business instead of a fictitious title which is meaningless. Your name will instill confidence, and add a personal touch.

Now, let us analyze the purchasing of watches for your stock. You cannot put down rules as to what kind of stock to purchase—that all depends on the type of clientele you draw to your store and what type of watches you will sell most: high, medium or lower priced. It does not matter what the price of the watch is, but you must see to it that if you sell a watch for $25.00 or $100 or more, it must be in good running order. In particular, higher priced watches should be tested and checked carefully for timing in three or more positions, according to the grade and quality of the movement. As for the lower grade watches, I will leave the timing to you. But be sure when you sell a watch that it is in good running order, although in some instances trouble may develop later on. After all, a watch is a small complicated machine. The main point I am driving at is to make sure *your watches are in order when sold.* Adopt this method of carefully checking your new stock before placing in showcases. It is not necessary to set each watch on time, as you have already tested them for time, but wind each watch fully once a week so as to prevent the oil from becoming gummed up.

Don't use the word "guarantee" but use the word "service." Every watch we sell is serviced for six months or one year, provided it was not damaged by dropping or submerged in water. Another point I wish to make clear is, when showing a prospective customer a number of watches of different makes, to be careful in making inconsistent statements. You will only confuse the customer, and he will walk out on you. For example, if you display be-

fore the customer four, five or more different makes of watches ranging in price from $40.00 to $50.00, don't praise the $50.00 watch more than the $40.00 one, because there is a possibility that the style of the case and the appearance of the $40.00 watch will have greater appeal to the customer. Then you will have to reverse your praise from the $50.00 watch to the $40.00. Thus, the customer will lose his confidence right at the start. You may forfeit a customer and a future patron of your store.

Tell the customer the true facts and here they are: all watches are basically built under one principle, but each maker incorporates slight changes; however, these changes do not affect the basic principle which we call the lever escapement. In the higher priced watches, the basic principle is the same, except that the materials used and the finishing of parts are of the highest precision.

In the near future, I shall write and explain "what makes a fine watch fine."

QUESTION: Can you tell me the manufacturer's name of a 12-size pocket watch with "Helvetia" on the dial? It is modern; not an old watch.

ANSWER: The watch described was made by The General Watch Company, of Bienne, Switzerland.

FAMOUS "STUBS" GRAVERS AGAIN ON THE MARKET

Watchmakers and engravers will welcome the return of this famous English product after being off the American market for a number of years. Recently, Henry Paulson & Co. completed arrangements to again import these famous gravers, which have been received and ready for delivery.

Write Henry Paulson, 131 S. Wabash Ave., Chicago 3, Ill. for illustrated bulletin showing the various sizes and shapes of STUBS gravers available for immediate delivery.

BIG BEN: The famous London bell which sounds the hours. It is the largest of the five bells that make up the carillon of the Westminster clock on the Victoria Tower of the Houses of Parliament.

Why Some Applicants Fail to Pass the H. I. A. Examination

The purpose of the H. I. A. certification is to assure the public and employers of watchmakers that the rightful possessors of H. I. A. Certificates have demonstrated their ability to meet the minimum standards of workmanship and efficiency essential to satisfactorily servicing and repairing, established by the H. I. A. Examining Board and the Certifying Committee.

It has been evident from the general overall appearance of some watches submitted to the Examining Committee that some applicants for H. I. A. certification are not sufficiently advanced in practical servicing and repairing of watches to meet the minimum required tests.

There have been a few complaints from applicants who failed to make a passing grade, that the examining board is too critical. This, however, is a wrong impression.

The examining committee is composed of five recognized outstanding expert watchmakers of highest character and all H. I. A. Certified Master Watchmakers. Their combined practical watchmaking experience total more than 100 years of successful servicing and repairing of timepieces. They are not "hard-boiled" but they "call 'em as they see 'em," which is as it should be for the good of the profession, the employers, the public and the applicants themselves. Neither do the members of the examining board intend to lower the present fair and reasonable standards established by the H. I. A. technical committee for the sake of expediency.

The examining committee clearly recognizes and appreciates the fact that applicants for H. I. A. Certified grade are not, in the majority of cases, experienced watchmakers, and, therefore, they do not expect nor require, the same high quality of workmanship required and demanded of applicants for H. I. A. Certified Master Watchmaker tests. However, the examining committee does expect applicants for Certified grade to possess a basic knowledge of the principles involved in watch repairing, and to be sufficiently experienced in the practical use of the tools and equipment of the profession to do the simple repair jobs required, in a workmanlike manner.

Watches Submitted by Applicants for Grading

The examining board has the right to expect that the watches, submitted by the applicant for grading, are the best example of their skill and ability.

Some dissatisfaction has come to the attention of the Examining Committee from some WHO HAVE FAILED TO RECEIVE A PASSING GRADE in workmanship, particularly among applicants in the Certified Watchmaker division, whose watches have shown passable 3-position (P. U.—D. U.—D. D.) timing rates. However, after careful detailed study of the various factors which entered into these particular cases, it was found that one group of errors were counteracting another group of errors, thus producing a condition which resulted in a high position-rate grade.

It was also found that some watches showed excellent workmanship; movement well cleaned and free from fingermarks; jewel settings polished; steel parts free from rust; yet, these watches showed a BELOW PASSING, POSITION RATING. Investigation into the causes showed that the balances had unequal motion; low or poor motion; over motion; regulator pins improperly adjusted; hair-

spring out on collet; flat and round; overcoil not "circled" to the same degree of arc radius as the regulator index "sweep"; pivots rough; unequal size; balance out of true in round and flat; out of poise; bankings improperly adjusted; roller jewels loose; "corner freedom" unequal; balance side and end shakes improperly fitted; lock unsafe; excessive. While the cleaning jobs were well done, it proved that these applicants knew little of the basic principles of successful watch repairing.

(c) Trueness and poise of balance wheel.

(d) Perpendicular and position of roller jewel "face."

(e) Condition of hairspring and regulator pins.
(1) True on collet (2) round (3) centered (4) circle of overcoil (4-a) Overcoil located in center of regulator pins (5) Regulator pins parallel and perpendicular (6) Regular pins properly closed.

HOROLOGICAL INSTITUTE OF AMERICA

EXAMINERS' GRADING SHEET

CERTIFIED WATCHMAKER EXAMINATION

POCKET WATCH

No.....

	Points *Maximum*	*Obtained*	Remarks
Repair work:			
1. Function of winding	4		Performance
2. Function of setting	2		— = fast; + = slow
3. Clearance and fit of hands	5		PD
4. Condition of jewel settings and screws	5		DD
5. Motion - dial up	4		DU
6. Motion - dial down	4		
7. Motion - pendant down	4		Max.
8. Freedom of train	3		Diff.
9. Condition of lock, drop and slide	10		
10. Jewel pin shake	4		
11. Guard pin shake	4		
12. Endshake of balance staff	4		
13. Sideshake of balance staff	4		
14. Trueness of balance wheel	7		
15. Condition of balance pivots	5		
16. Condition of hairsprings	5		
17. Flatness and trueness at collet	5		
18. Condition of overcoil	5		
19. Condition of regulator pins	2		
20. Condition of cleaning	4		
21. Condition of oil	4		
22. Condition of all steel work	4		
23. General appearance	2		
Total for Workmanship	100		

Examiners' recommendation:

Date.....

In order to assist the applicants to understand the points which enter into the grading of their work, the examining committee has made a list of imporant points to CHECK BEFORE SUBMITTING THEIR WATCHES FOR GRADING:

(a) Shape, size and polish of pivots.

(b) End, side, "shake" of balance staff.

(f) Escapement action.
(1) Lock (2) Drop (3) Corner Freedom (4) Jewel Pin "shake" (fork slot) (5) guard pin roller "shake" (6) slide.

(g) Cleaning and oiling (removing rust, etc.)

(h) Winding and setting mechanism.

(i) Proper fitting of canon pinion.

(j) Hand spacing and clearance.

(k) "Anchor" all screws in proper places.

(l) "Anchor" movement in case. (2 case screws).

(m) "Anchor" dial in place. (Usually 3 dial screws).

(n) Before placing the back on the watch case, lightly wipe off the upper plate, and steel parts, with a chamois buff-stick which has been very lightly (just a "trace") moistened with alcohol, using a circular motion.

BUTTING: A fault in the action of gearing in a train, in which the two wheels are too far apart or the teeth poorly formed, so that the transmission of power takes place too near the points of the teeth.

BRIDGE: A part of the framework of a watch movement, fastened to its base by a screw at each end of the bridge, and containing one or more pivot bearings.

BULLETIN WATCH: A watch that has won a prize in a timekeeping competition, in an accredited observatory; a certificate or "bulletin" is given by the observatory to the maker stating the performance of the watch, to go with the watch when sold.

BOWMAN STUDENTS VISIT U. S. NAVAL OBSERVATORY

BOWMAN TECHNICAL SCHOOL has completed installation of its own independent time-standard system, comprising a master-clock with mercurial compensation pendulum and auxiliary thermostatic temperature control. The beats of the pendulum are transmitted through an electronic system and wiring. to sounders in all departments of the school, to provide accurate signals for timing watches in teaching students operations such as balanc-springing and adjusting. The designing and making of special parts in the clock and of the wired transmitting circuits were done by Mr. Walter Haeseler, instructor in the school's finishing department.

The annual visit of the students in the finishing department of Bowman Technical School to the U. S. Naval Observatory took place Wednesday, December 1. Thirty-two students went to Washington in a char-

tered bus. The program at the Observatory included a lecture on astro-physics, a demonstration of sidereal photography of position of stars for checking the clock; inspection of the quartz-crystal clocks and time-transmitting equipment; the new zenith-tube and camera; and visits to the chronometer repair-shop and other related departments. The party waited until after sunset to view planets and stars through two of the equatorial telescopes. Dr. J. O. Sollenberger, head of the time-distribution services, generously cared for the visitors in seeing a great deal of the work of the Observatory that is concerned with time. Graduates of the Bowman School have for many years been employed in the Naval Observatory Shops where chronometers and other timepieces are repaired and built.

"Cotton Bowl" Players Receive Hamiltons

Doak Walker, All-American from Southern Methodist University, and Norm VanBrocklin, All-American from the University of Oregon, led their respective teams in a sensational New Year's Day Cotton Bowl game in Dallas that saw SMU come out on top by a 21-13 score. But no matter what the score was, the two teams were awarded American-made Hamilton watches to help heal the wounds of battle. A total of 91 Hamiltons, Hayes and CLD Brandon models were awarded to the entire squads of both colleges.

The watches which were presented to the football players contained special dials. Forming a square around the bowl trademark, a tuft of cotton, were the words "Cotton Bowl Classic 1949". The players were given their choice of a pocket or wrist model. Doak Walker chose the Hayes pocket model while VanBrocklin made his choice a CLD Brandon.

Arthur A. Everts Co., jewelers, Dallas, Texas, secured the watches for the bowl association and tied-in with the event by devoting an entire window to a display made up solely of the Cotton Bowl Hamiltons.

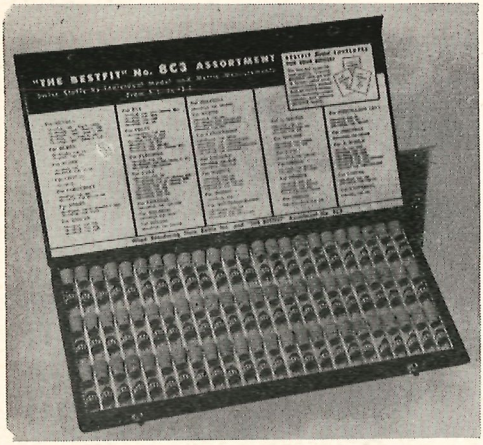
Down in Jacksonville, Florida, the Clemson College team dumped a strong University of Missouri team by a 24-23 score to cop the fourth annual Gator Bowl classic and win Hamilton watches for their efforts.

Each member of the Missouri and Clemson squads received a Myron strap watch. Over 100 Hamilton watches were obtained through the following jewelers in Jacksonville: Jacobs Jewelers, Charles L. Wells, Jeweler, and Underwood Jewelers.

Taking advantage of a local event with national prominence, Arthur A. Everts Co., Dallas, Texas, featured 44 of the 91 Hamilton Cotton Bowl watches in this special tie-in window display. The window was a colorful one with the SMU pennant and ribbons in red and blue and the Oregon pennant and ribbons in bright green and cold. One "mum" on the goal post was white, the other yellow. The two football players were in the colors of the competing schools. The display card read, "These Cotton Bowl watches to be presented to the members of the SMU and Oregon teams. Everts is proud to have been selected by the Cotton Bowl Association to furnish these fine Hamilton Watches."

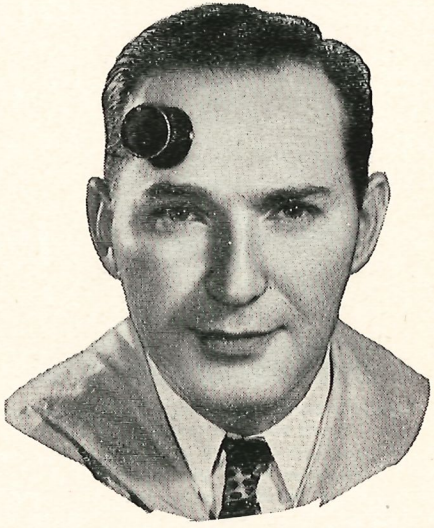
The Fourth Annual Banquet of the Peters School of Horology, Washington, D. C., held recently brought together the members of the entire staff whose responsibility is the operation of the school facilities.

NEW BESTFIT 8C3 STAFF, 9C3 STEM ASSORTMENTS SUPPLEMENT 8C2 AND 9C2



To answer the growing demand for staffs and stems for new and currently popular makes and models of Swiss watches, B. Jadow, Inc., New York, announce two additions to the famous family of Bestfit Assortments. Supplementing the widely popular Bestfit 8C2 Assortment of Staffs, and the 9C2 Assortment of Stems, the two new assortments of one gross each of staffs and stems, contain all new numbers for such makes as Civitas, Cortebert, Derby, Enica, General, Helbros, Helios, Buser, Pierce, Leon Levy, Precimax, Unitas, Universal, Helvetia, Jurth, Langendorf, Liengne, Marvin, Moeris, MST and others. To be known as the 8C3 and 9C3 Assortments, the two new members each contain in their attractive and convenient cabinets 72 bottles numbered from 73 to 144. Thus watchmakers may use the 8C2 and 8C3 Assortment of Staffs and the Bestfit 9C2 and 9C3 Stems and have a complete assortment embracing every essential staff and stem to answer virtually any repair need he may have. The new assortments contain all new numbers, and do not duplicate any of those included in the 8C2 or 9C2 cabinets. Included in each cabinet is the useful Interchangeability Chart which shows, in easy-to-read fashion, the yoke bridges and metric measurements for all models. Refills of the staffs and stems contained in this assortment will be available through wholesalers in factory-sealed envelopes. The popular Bestfit Assortments are handled by jobbers throughout the country, and are sold through wholesalers only.

New York Horologist Completes Text Book



Henry B. Fried

Henry B. Fried, lecturer and instructor in applied science of practical horology, in the Geo. Westinghouse Vocational High School, Brooklyn, has completed an interesting text book on practical servicing and repairing of modern timepieces. D. Van Nostrand Company, publishers, expect to have Mr. Fried's text book ready for distribution February 1.

Mr. Fried is qualified, both as an educator and as a practical watchmaker, to present a text book on the theory and practice of a successful servicing and repairing of modern timepieces. He was graduated from the Brooklyn (N. Y.) Evening High School, with scholastic honors; attended the Oswego (N. Y.) State Normal School,

and later was graduated from the University of the State of New York Industrial Teachers College.

His practical experience in repairing and servicing timepieces includes apprenticeship under S. J. Heiman and I. N. Locker Co., of New York City; nine years as foreman of special services, with the K. K. Importing Company, New York City, and later in the same capacity for B. JADOW, INC., well-known importer of watch materials, watchmakers' tools and equipment.

Mr. Fried opened his own Trade Watch Repair Shop, which he operated until 1938, when he became connected with the New York City school system as instructor of applied theoretical and practical horology at the George Westinghouse Technical High School, Brooklyn, N. Y., which position he now holds.

He is an H. I. A. Certified Master Watchmaker and a member of the Advisory Board of that organization. He was recently re-elected executive secretary of the New York Horological Society for the eighth consecutive year and is also vice-president of the New York State Watchmakers Association.

L. & R. Introduces New Jewelry Cleaning Kit

The Ellanar Jewelry Service has been placed on the market by The L. & R. Manufacturing Co., of Arlington, N. J., to enable the busy housewife to preserve the new look of her jewelry.

The new Ellanar Jewelry Service is safe, simple to operate, requiring but a few moments to restore favorite pieces of jewelry, diamond rings, etc., to their original beauty.

The jewelry service kit includes a 16 oz. jar of the famous Ellanar Jewelry Cleaner, an exclusive designed safety cleaning tray, which eliminates any possible damage or loss of the articles while being cleaned, and a washout brush.

The complete home jewelry cleaning kit comes attractively packaged in an eye-appealing three-color carton, which adds to the beauty of a counter display or show window.

Complete information on this new L. & R. product can be obtained by writing to the L. & R. Manufacturing Co., 577 Elm Street, Arlington, N. J., or its branch offices, 55 E. Washington Street, Chicago, Illinois, and at 335 S. Broadway, Los Angeles, Cal.

BREQUET HAIRSPRING: A hairspring originally a flat spiral, but with the outer coil bent upward and its end then bent toward the center, to form the overcoil with its plane mostly parallel to the plane of the lower coils of the spiral.

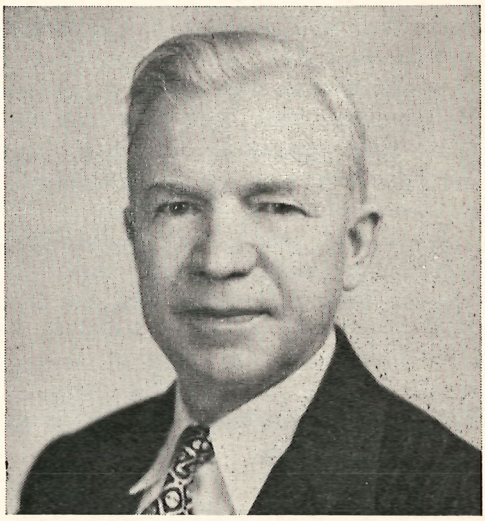
CROSSING FILE: A file made of special form for forming curved-profile arms in train wheels.

"The Half-Century Club"

(EDITOR'S NOTE: *"Something new has been added." We plan to honor in the H.I.A. JOURNAL those watchmakers who have had fifty years'—a half century—experience in repairing and servicing of timepieces. If you can boast of this length of service, Mr. Watchmaker, send in your photo and a short biographical "background" sketch to: "THE HALF-CENTURY CLUB," 921 State Life Bldg., Indianapolis, Ind.*)

James L. K. Sorensen, a native of Denmark, was graduated from one of that country's leading technical schools, and began his watchmaking apprenticeship in 1891. After serving his apprenticeship, and securing his journeyman's certificate, continued his watchmaking education in Sweden, Germany, France and England.

Opportunities offered to watchmakers of his skill and experience in America prompted Mr. Sorensen to come to this country in the 90's. As many of his countrymen had located in Minnesota, he decided to come to Minneapolis, where he at once found employment as a watchmaker, with S. Jacob's Company, leading retail jewelers of that city. His skill and ability were soon recognized and he was placed in charge of their watch repair department.



James L. K. Sorensen

Mr. Sorensen has been active in Watchmaker's Association work, having been vice-president of the Master Watchmaker's Association of Minnesota, and chairman of the Educational Board of the Minneapolis Watchmaker's Guild. Mr. Sorensen has been an active member of the Horological Institute of America, and recently became a life member.

CIRCULAR PALLET: One of the design-types of lever escapement pallets, in which a circle struck from pallet center passes through the center of lifting faces of both pallet stones. This type escapement has unequal locking resistances on the two pallets, but equal lifting leverage effects.

CONTRA-CLOCKWISE: Moving in a direction contrary to the motion of clock hands; from right to left, viewed above the center of motion.

New H. I. A. Insignias

No.

No.

Reproduced above are the three designs which have been approved by the H. I. A. official insignia for "Certified Watchmakers" (formerly "Junior Watchmaker") and "Certified Master Watchmaker" (formerly "Certified Watchmaker") and "Certified School."

The "Certified" Master and "Certified" Watchmakers cuts may be obtained by remitting $1.50 to Ralph E. Gould, Sec'y, Horological Institute of America, Inc., Washington 12, D. C., giving your certificate number. "Certified School" cut may be obtained by remitting $1.50 to Secretary.

NOTICE

Due to the unprecedented increase in membership in the past three years, we have outgrown our present facilities to adequately serve our members with the efficiency and dispatch which they have a right to expect.

We are pleased to inform you that larger quarters have been provided which will assure prompt and efficient handling of your inquiries and correspondence.

However, all testing of watches for H.I.A. certification will continue to be handled at the National Bureau of Standards, Washington, D. C.

In the future, address all communications relative to certification, membership, H.I.A. certification cuts, technical books, bulletins, unset jewels, taps and screws, for plate jeweling tests, etc., to

RALPH E. GOULD, Sec'y
Horological Institute of America, Inc.
Washington 12, D. C.

NOTICE

Unset jewels, taps and screws for Jeweling Plate used in H.I.A. CERTIFIED MASTER WATCHMAKER examination can be obtained by remitting $2.00 to Ralph E. Gould, Sec'y, Horological Institute of America, Inc., Washington 12, D. C.

Classified Advertising

CLASSIFIED—Payable in advance. Rates under all headings, except "Positions Wanted," $1.50 for first 25 words, five cents for each additional word. "Positions Wanted," 75 cents for first 25 words, five cents for each additional word. Bold face type five cents additional per word; capitals, also five cents additional per word. Box numbers for "Blind" advertisements, 50 cents additional for postage and handling.

● SPECIAL SERVICES

A FEW OPENINGS now available for watchmaking in a Certified Horological School by the H. I. A. Jes I. Hansen Practical School of Watchmaking, Denver, Colo.

HAIRSPRING VIBRATING — Same day service. Flat, $1.75; Breguet, $2.50. Fitted to bridge—leveled—poised—checked. Write today for mailing envelopes. CHARLES THOMAS & CO., P. O. BOX 330, Union City, N. J.

● HELP WANTED

WATCHMAKER — First-class, experienced man only; exper. with Timemaster, ctf'd man pfd.; good salary; permanent. Can provide lvg. qtrs. State age, experience and ref. ERNEST BURK, INC., 614 - 13th St., N. W. Wash. 5, D. C.

● SITUATIONS WANTED

WATCHMAKER, 30 years experience, wishes to take over repair department on a commission basis. Only reputable concerns on West Coast or South Atlantic states need reply. Box B1, H. I. A. JOURNAL, Indianapolis 4, Ind.

WATCHMAKER, 38 years experience, wants position. Moderate salary or will take over repair department on commission basis. E. J. Hall, 507 South Sixth St., Champaign, Ill.

● HOROLOGICAL BOOKS

OLD - NEW—Practical, Theoretical, Historical, all phases Watch and Clockmaking. Liberal estimates entire libraries, books, periodicals, embracing horological subjects. Advise requirements; or what have you? "HOROLOGIAN," 841 S. Park, Springfield, Illinois.

"RULES AND PRACTICES for Adjusting Watches" and "Practical Balance and Hair Spring Work," strictly practical books by Walter Kleinlein. Your jobber can supply these books.

WATCHMAKERS, Apprentices, Students, Instructors—THE WATCH REPAIRER'S MANUAL, by Henry B. Fried. A complete Manual on every phase of watch repair. See page 2. D. VAN NOSTRAND CO., Publishers, New York City.

WATCHMAKERS—Increase your earning power. Increase your skill quickly and easily; 7th edition, "PRACTICAL BENCHWORK FOR HOROLOGISTS," by Louis and Samuel Levine; 20,000 copies sold. FOR SALE AT ALL LEADING WATCH MATERIAL AND JEWELERS SUPPLY HOUSES. PRICE $5.00.

JOSEPH BULOVA School of Watchmaking Technical Training Manuals—$5.00, including 1-year membership in the Horological Institute of America, Inc., 1 year's subscription to the H. I. A. JOURNAL. The MANUAL contains more than 250 pages of practical information on every phase of successful watch repairing and more than 600 accurate drawings. Ralph E. Gould, Sec'y, Horological Institute of America, Inc., Washington 12, D. C.

WANTED — USED PAULSON TIME-O-GRAF OR WATCHMASTER. MUST BE IN GOOD CONDITION AND OF LATE MODEL. BOND JEWELERS, 5529 E. WASHINGTON STREET, INDIANAPOLIS 19, INDIANA.

● TRADE WATCH REPAIRING

HIGH-GRADE WATCH REPAIRING for the trade. Work time and checked on the WATCHMASTER. Satisfaction guaranteed. Complicated watches a specialty. 10-day service. Write for price list. CURTIS V. HASKINS, 1215 West 32nd Street, Indianapolis, Ind.

BALANCE STAFF to watch, $2.00; order and balance staff, mainspring, $4.00. Estimates and mail shipments solicited. H. L. Simon, Box 116-C, Central Islip, L. I., New York.

RELIABLE WATCH REPAIRING to the Trade. Prompt, efficient and dependable, guaranteed service. All work tested on "Time-O-Graf" instrument. Robert A. Nicholson, 415 State Life Bldg., Indianapolis 4, Ind.

● BUSINESS OPPORTUNITIES

FOR SALE—Watch movements for sale. For practice, hobby, or material. Sold 'as is'. Hundreds listed. Send 25 cents in stamps. Leo. Khalif, P. O. Box 2441, New Orleans, La.

FOR SALE—1 to 3 WW and Moseley No. 2 wire chucks, JIH wire chucks, special, $3.50; 4 to 10 inclusive, $2.50, sizes and ½ sizes. Regular chucks, 1 to 80, $1.50. Wheel chucks, $1.75. Special watch and clock parts made to order. Several slide rests and wheel cutters and jeweling calipers for sale. Write for price list. Also a few openings for students who want to learn watchmaking. School certified by H. I. A. JES I. HANSEN, 331 Steel Building, Denver 2, Colorado.

FOR SALE—Long established jewelry store. Very good opportunity for a young watchmaker. Will sell at inventory price, or reduce stock to suit your pocketbook. Very good reason. Box 111, H. I. A. JOURNAL.

"As the Pendulum Swings"

In our January issue, an article written by A. S. Rowe, president of the Horological Institute of America, entitled "Put HOROLOGY to Work in Your Store," touched upon a new EMPHASIS that should be given to watchmaking and watchmakers.

As a practical watchmaker and jeweler, Mr. Rowe knows well the many problems confronting the watchmaker and he is alert, too, to the kind of "folks" who leave their watches to be repaired.

It should be the business of the qualified watchmaker to impress upon the public the fact that he is a HOROLOGIST—and he is that if he has passed the tests to become a "Certified Master Watchmaker."

There have been far too many mere "service men" in the watchmaking field who are NOT qualified to work on watches, and thus the QUALIFIED watchmen should acquaint the public that "an expert HOROLOGIST" IS available at various shops.

No longer do we hear or read about "under takers"—they are "morticians," you know. Other fields have "dignified" the workers in them, too. An "HOROLOGIST" suggests a dignity that a "watch repairman" does not.

If you "skimmed over" Mr. Rowe's article in the January issue of the H.I.A. Journal, then RE-READ IT TODAY, please. It has a lot of "meat" and "commonsense" in it, if you please.

A great NEW packaged combination that's vivid value for only $1.00

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ELLANAR JEWELRY SERVICER

ELLANAR, the fastest selling Jewelry Cleaner, now offers three Plus selling features for you. 1. A new L&R exclusively designed Safety Cleaning Tray. 2. A new giant size 16 ounce wide-mouth jar. 3. A new eye-attracting, self-selling, 3-color counter display carton. Ellanar Jewelry Servicer is nationally advertised. Imprints free on gross orders, of course.

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***ELLANAR JEWELRY CLEANER** also available in the popular 8 ounce jar with brush — the product that has made over a million steadfast friends — only **50c**

REPLACEMENT OR A REFUND OF MONEY
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ELLANAR SILVER GLEAM "The Cream of Silver Polishes" is the only silver cleaner "Argenium Processed" for smoother cleaning and longer lasting luster.
8 oz. 65c • 16 oz. 1.00 • 32 oz. 1.75

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