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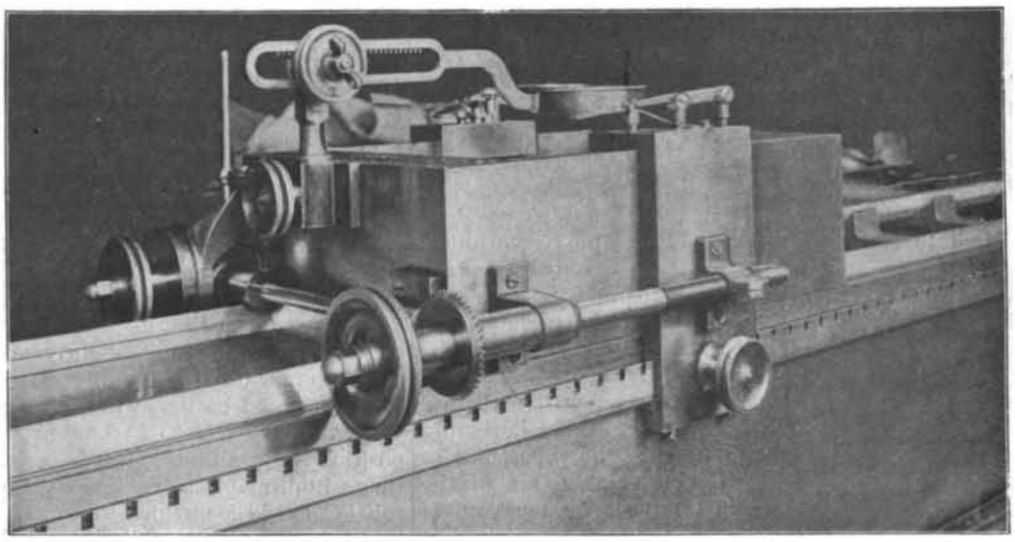
MEASURING AND TESTING INSTRUMENTS USED IN THE MANUFACTURE OF NAVAL ORDNANCE.

BY E. J. PRINDLE.

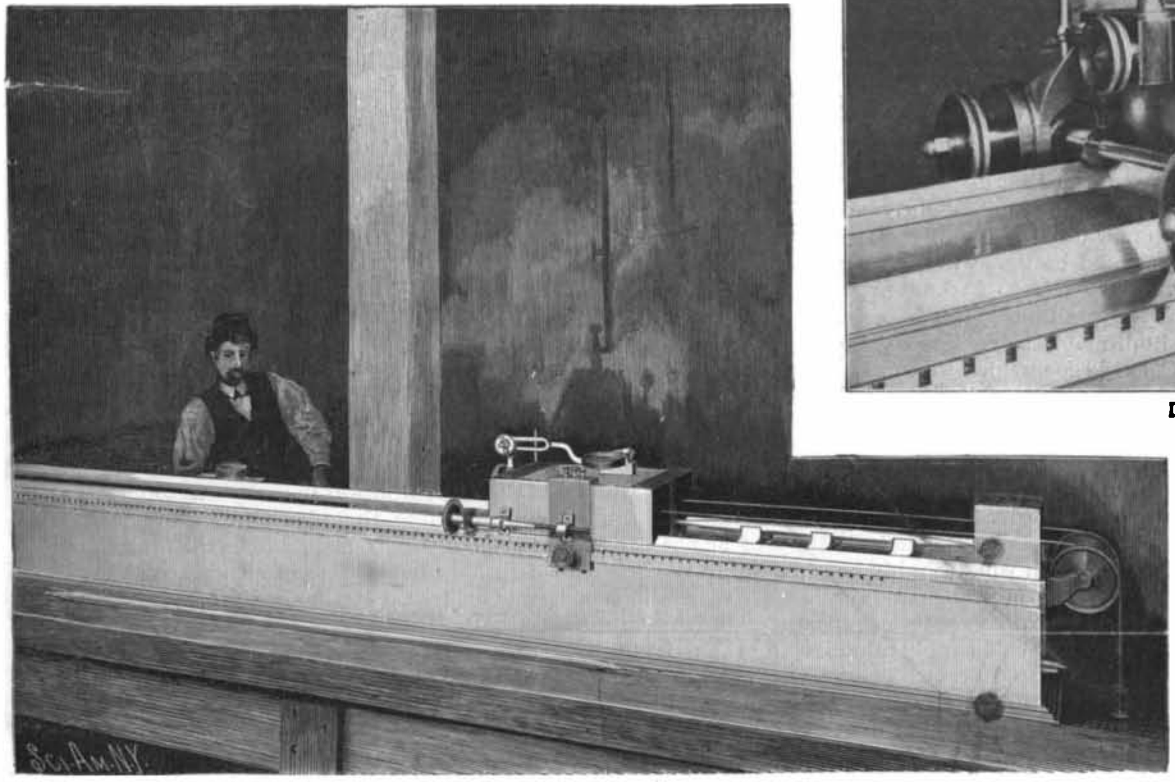
When one considers that, to be of any practical value, a naval gun must direct its shot in the comparatively short distance of, at most, 30 feet so exactly that, after traveling 2 miles, it will strike within a circle 20 feet in diameter, some idea may be had of the great accuracy with which such guns must be constructed. This high degree of precision is obtained by the use, in connection with the finest of machine tools, of methods which represent the highest development of machine shop practice, a most delicate sense of touch, and measuring and testing instruments of the greatest obtainable accuracy.

In the construction of its measuring and testing appliances the Naval Gun Factory, at Washington, D. C., has shown much originality. The work done in these shops is suffi-

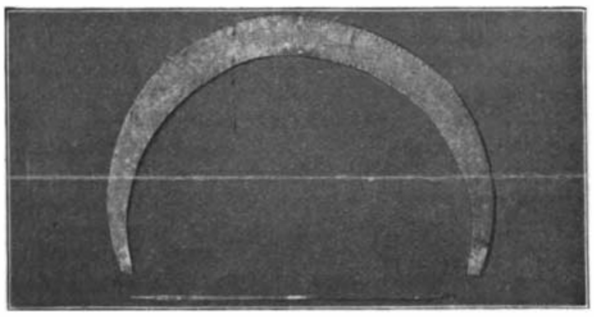
(Continued on page 117.)



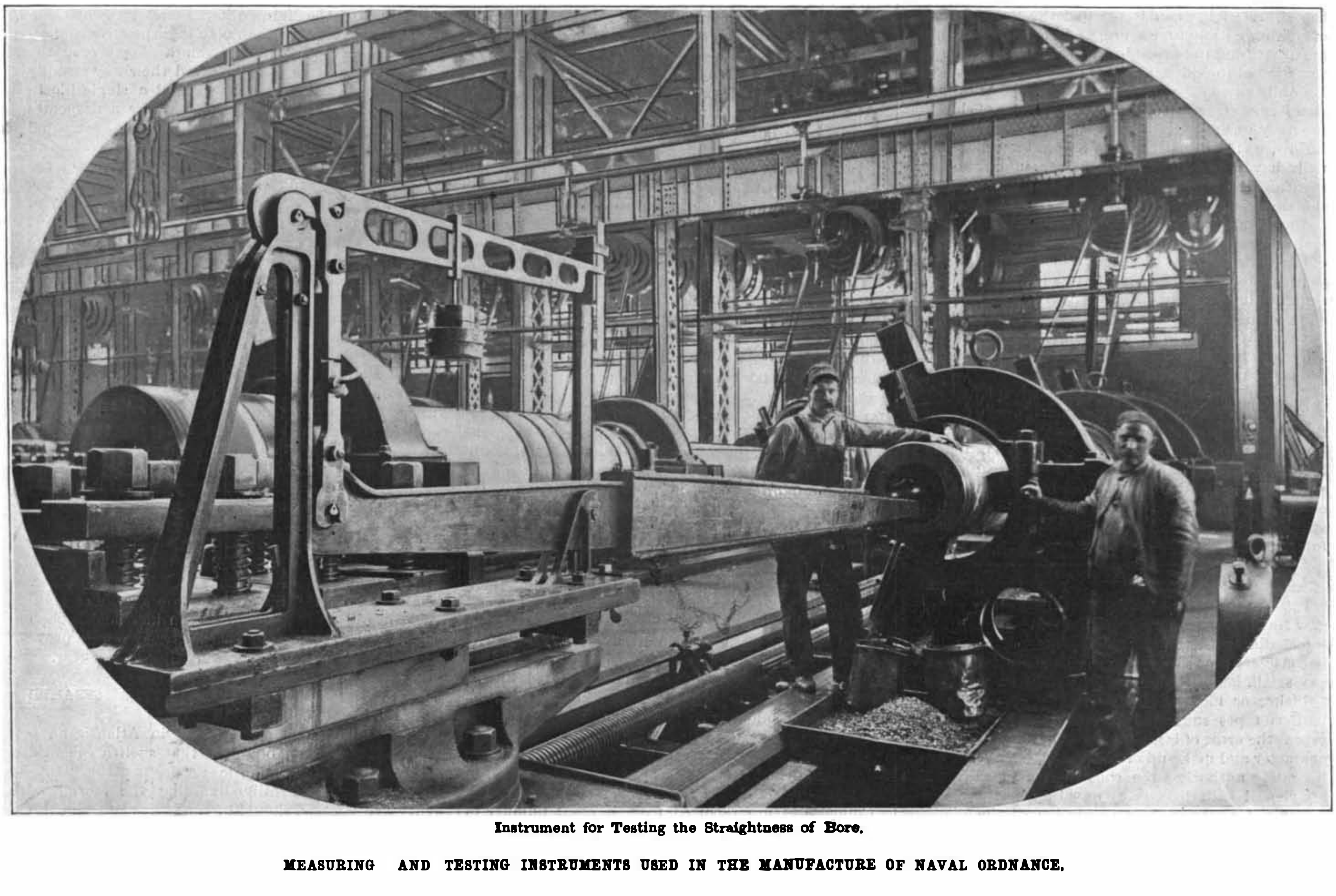
The Adjustable Head of the Measuring Machine.



The Measuring Machine for Testing Length of the "Points."



Snap Gage and Point.



Instrument for Testing the Straightness of Bore.

MEASURING AND TESTING INSTRUMENTS USED IN THE MANUFACTURE OF NAVAL ORDNANCE.

INTERESTING STATIC MOTORS.

BY HOWARD B. DAILEY.

The amateur worker in static electricity who possesses a good influence machine finds himself equipped with a source of much instructive entertainment for himself and scientifically inclined friends. To the experimenter any piece of accessory apparatus having novelty of design is always a welcome acquisition. The experiments possible with a six or eight plate Wimshurst machine, such as is described and illustrated in SCIENTIFIC AMERICAN SUPPLEMENT, No. 584, are of endless variety, and, when aided by suitable accessories and manipulative skill, luminous effects of great brilliancy and exceeding beauty may be produced. Such manifestations naturally appeal chiefly to the eye, but not less interesting to the student of physics is that class of experiments dealing with the conversion of mechanical energy into electrical and back again into mechanical energy in a manner readily perceived by the eye at a glance.

To demonstrate this principle, as well as to exhibit in a striking way the operation of electrical attraction and repulsion, the writer has devised two forms of static electrical motors. Fig. 1 is a small horizontal engine. At the ends of a vulcanite lever or walking beam are two wooden balls covered with gold leaf to give them a conducting surface. These play up and down between upper and lower sets of stationary brass balls.

The two upper balls, which are in metallic connection with each other, are supported above the walking beam upon four perpendicular glass pillars and are connected with one of the conductors of a static machine. The lower balls, which are not insulated, are given an earth connection through a binding post in the ebony bed frame of the engine. As the upper balls become charged through the action of the machine, their attraction causes the nearest of the two movable balls to rise within striking distance, when it receives a spark, thus becoming itself electrified, and is immediately repelled downward to one of the earth-connected balls, to which it yields up its charge. Being now in a neutral condition, it is again attracted upward. As the material separating the moving balls is an insulator, the action of each is independent of the other, one being repelled while the other is attracted. A reciprocating motion is thus given to the lever which is communicated to the flywheel shaft by means of a connecting rod and crank disk.

Since the attractive and repulsive force of static electricity is far from powerful, it is essential that machinery operated by it should be very light and freely running. To this end the moving balls, which are about 1½ inches in diameter, are made hollow and very thin, being turned in halves and glued together. The flywheel, which is of gilded wood, is very light and runs in pivoted bearings, as does the walking beam. This beautiful little machine, highly finished in all its parts, presents a very attractive appearance and runs at a rapid rate of speed; the click of the sparks as the swiftly flying balls charge and discharge themselves being strongly suggestive of the puffs of a steam engine. Watching the instrument in operation, an observer, unaware of the lightness of the moving parts, is impressed with the idea of considerable power, but is somewhat surprised to find that a sheet of note paper standing upon edge and leaning at a slight angle against the rim of the flywheel soon brings it to rest. Fig. 2 is a simple rotary motor. Into the hub of a horizontal spindle, whose indented ends receive pivot pointed screws passing through the tops of two upright brass standards, are inserted four slender vulcanite rods carrying at their outer ends gilded wooden balls. At the opposite sides of the instrument and very near to the revolving balls are placed two larger balls of polished brass, supported upon glass rods and connected respectively with the opposite poles of a static

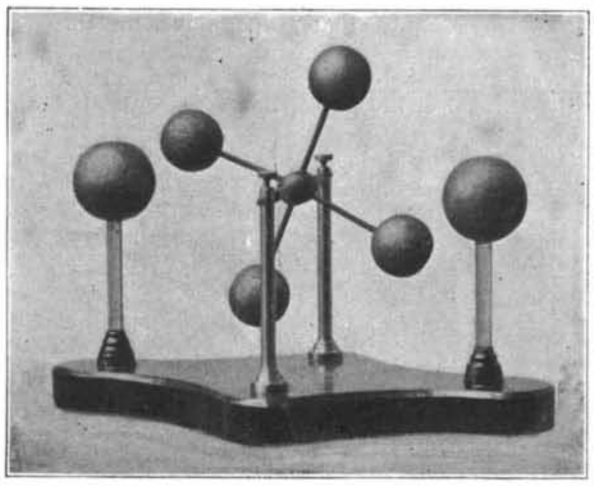


Fig. 2.—ROTARY ELECTRIC MOTOR.

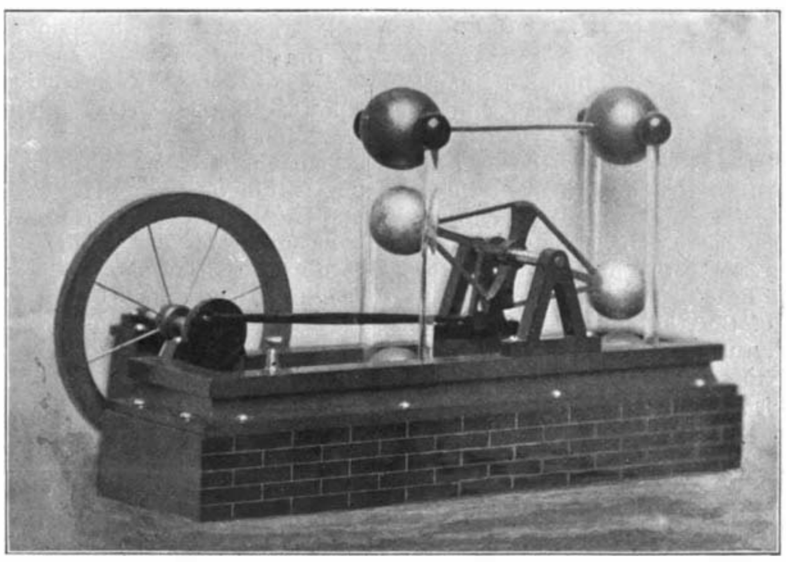


Fig. 1.—STATIC ELECTRICAL MOTOR—RECIPROCATING.

machine. The current being turned on, attraction and repulsion cause a rapid rotation of the spindle.

This motor, from its continuous rotary action, is much the more powerful of the two, and has about it a sensitiveness and life that is wonderfully taking, while its appearance in the dark is highly interesting. Both these instruments run very satisfactorily either from a small influence machine or an ordinary frictional machine, furnishing an excellent illustration of the reappearance as mechanical energy of part of the power applied to the static generator after having been transformed largely into electrical energy.

IT is said, according to press reports, that in Stuttgart, Germany, all horse trucks and wagons are to be banished from the streets after a certain period of time. Stuttgart is the home of Herr Daimler.

MEASURING AND TESTING INSTRUMENTS USED IN THE MANUFACTURE OF NAVAL ORDNANCE.

(Continued from first page.)

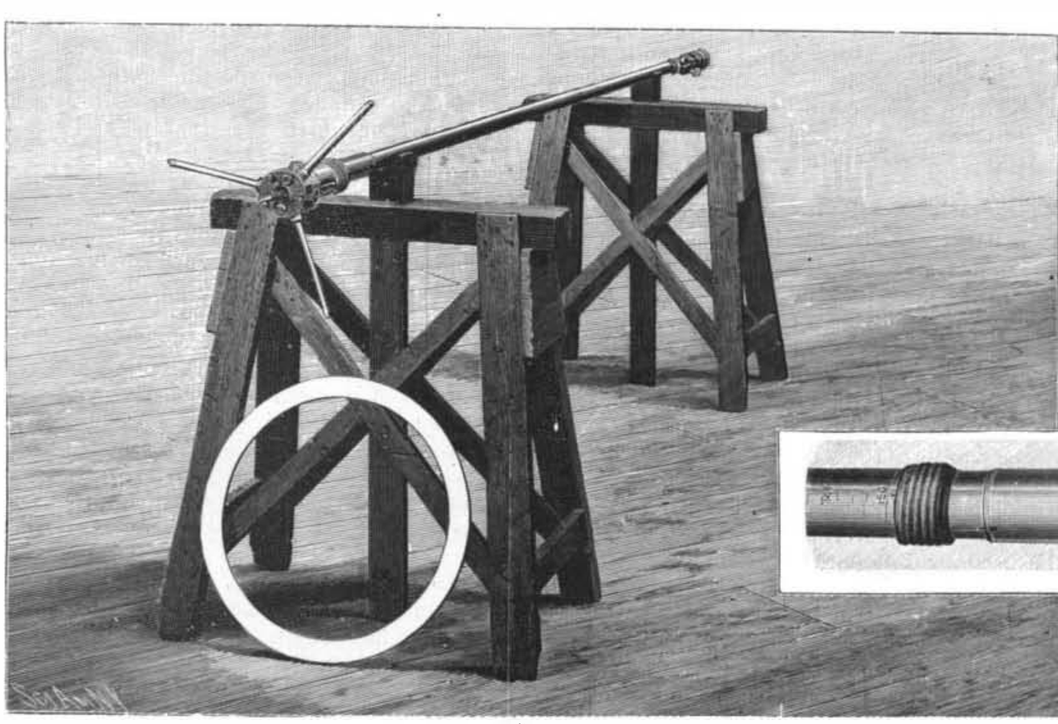
ciently different from that of other classes of machine shops to necessitate special appliances for performing and testing the various operations, and these appliances have been invented largely by the naval officers in charge of the work and have been constructed in the gun factory.

All measurements are given to the machinists in the form of steel rods, called "points," which are about ⅜ of an inch in diameter and of a length which corresponds to the desired measurement. The rod is rounded on the ends and is ground off on an oilstone to the exact length required, this length being determined in a measuring machine. The length of the rod is stamped on the rod in figures running to the third decimal place.

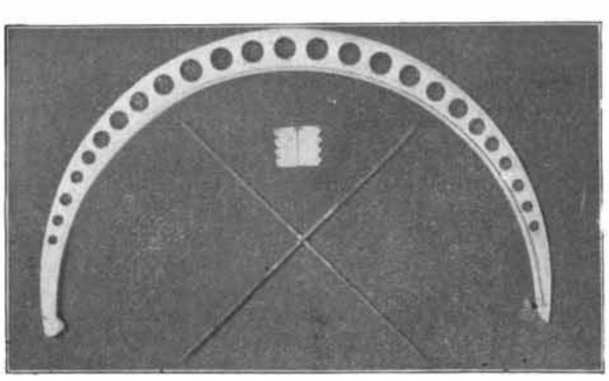
The measuring machine in which the length of the "points" is tested was invented and built in the Naval Gun Factory, except for the graduation of its scales. This machine has a bed 7 feet long, which is supported on a heavy wooden stand. The entire machine, including the bed, is machined all over. Two V-shaped guides are formed on the upper face of the bed. A fixed head is secured at one end of the bed between the guides, and an adjustable head is mounted on the guides. Each head has a hardened plate secured in the face which is opposite the other head, and it is between these plates that the measuring is done, and against them that the ends of the "points" rest. A scale plate, which is 67½ inches in length, and which was graduated by the Brown & Sharpe Company, is sunk in the beds between the two guides, and it is graduated with the utmost precision in hundredths of an inch.

The adjustable head consists of a rectangular box which is open at the top and bottom. It is held firmly down on the guides by two straps which fit over the upper edges of the sides of the head and which slide on guides formed on the sides of the bed. The under sides of these latter guides are at right angles to the side wall of the bed, while their upper faces are inclined downward toward the bed. Gibs carried by the straps, and held against the under sides of the strap-guides by setscrews on the straps, serve to prevent wobbling of the straps on their guides. Notches are formed in the strap-guides at intervals of half an inch, and bolts which are guided in vertical holes in the straps engage these notches and lock the straps. The upper ends of the bolts are pivoted to spring-pressed thumb-levers which are fulcrumed on the straps and serve to operate the bolts. Hand screws are carried by the straps, and they may be screwed against the strap-guides as an additional locking means for the former.

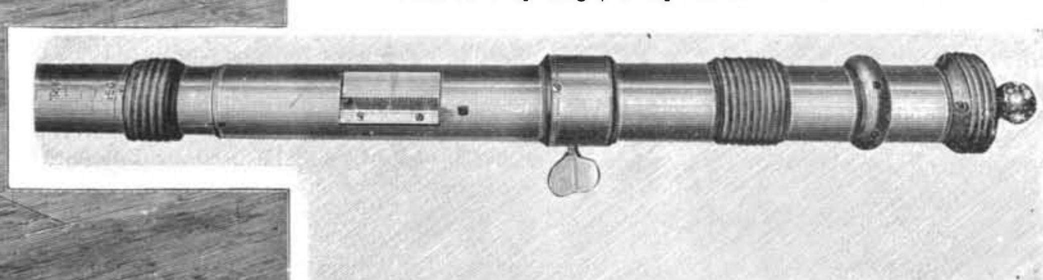
Screw shafts are journaled on the adjustable head, one on each side, so that they can have no longitudinal movement relatively to the head; and their threaded ends engage screw-boxes which are fastened to the straps. These boxes are split, and the cut is drawn together by a screw to compensate for wear. The threads on the screw shafts are very perfect and are cut forty threads to the inch. Each shaft, besides having a hand-wheel by which it may be turned, carries a bevel gear which meshes with a similar gear on a shaft that is journaled on the end of the adjustable head, so that the screw shafts are geared together.



Star Gage and Rind Gage.



Vernier Snap Gage, Templets and Crossed Points.



Handle of the Star Gage.

MEASURING INSTRUMENTS USED IN THE MANUFACTURE OF NAVAL ORDNANCE.

This gearing, when the straps are locked to the bed by means of the bolts, engaging notches on the strap-guides and by the clamping of the hand screws, enables the adjustable head to be moved back and forth by turning either of the screw shafts. Two wires are fastened in the front of the adjustable head, and, after passing over guide pulleys back of the fixed head, have a weight attached to their ends. This weight draws the locking bolts in the straps against the front walls of the notches in the strap-guides, and it also forces the screw-shafts against the front surfaces of the threads in the screw-boxes, thus eliminating any error due to looseness or wear of these parts. Two vernier plates, one on each side. are secured to the inner sides of the adjustable head in an inclined position, so that their graduation lines, coming down on a sharp edge, reach the surface of the scale plate in the bed for the purpose of accurate reading. A magnifying glass is supported above the verniers by a slotted arm having a rack formed along the upper edge of the slot. The rack is engaged by a spur-gear on a stud that is carried by a vertical post which may be turned on its axis or clamped in a vertical bearing on the adjustable head. A hand-wheel attached to the spur-gear enables the glass to be moved back and forth, and the post permits it to be swung from side to side. By the use of the vernier plates, measurements may be read to the one-thousandth part of an inch. One of the screw shafts is provided with a vernier wheel, by means of which measurements may be read to the ten-thousandth part of an inch. A small magnifying glass for the vernier wheel is clamped to a vertical rod that is fixed on the adjustable head.

In measuring a "point" on this machine, the "point" is laid on two or more loose blocks which lie on the bed and support the "point" centrally over the long scale-plate. One end of the "point" is made to rest firmly against the fixed head, and the adjustable head is moved by hand until the locking bolts of the straps can engage notches which place the head at the next half-inch mark beyond the end of the "point," and the hand-screws on the straps are set up. The screw-shafts are then turned to bring the adjustable head against the end of the "point." This end of the "point" is then repeatedly lifted off its support, while the adjustable head is given a final adjustment to secure with the end of the "point" a contact that is firm but which does not amount to compression. The inches and thousandths of an inch are then read on the vernier plates within the adjustable head, and the ten-thousandths of an inch are read on the vernier wheel on the screw shafts. In practice, however, instead of using the vernier wheel, the ten-thousandths are usually interpolated on the vernier plates.

When a "point" is to be used in applying a certain measurement, the adjustable head is first accurately placed by means of the readings on the large scale and vernier plates (and also, if desired, of the vernier wheel) and then the "point" is cut as near as possible to the given length, taking care that it be too long rather than too short. The ends of the "point" are then shaped with a file and are rubbed down on an oilstone between repeated trials until the "point" will lie between the heads of the measuring machine with the desired firmness of contact.

The measurement having been transferred to the "point," it is used directly to apply the measurement to an inside diameter; but, for gaging an outside diameter some form of calipers must be used. For the rougher cuts, jointed calipers and beam calipers are used, the latter having verniers thereon. But the finishing cuts are tried by use of "snap gages." These consist of crescent-shape pieces of soft steel (for the larger measurements, about one-fourth of an inch in thickness), having their horns tempered and formed on the insides into flat faces, which are at right angles to a line connecting the horns. Owing chiefly to changes in the temperature, the horns of the "snap gage" do not remain at all times the same distance apart. On each occasion when the "snap gage" is to be used it is carefully adjusted to the "point" in a most ingenious manner. If, on attempting to place the "point" between the horns, the latter are found to be too close together, a blow of sufficient force to dent the metal is struck with the edge of a hammer near the inner margin of the crescent. This denting of the gage forces the metal laterally and lengthens the inner curve of the crescent, the outer curve remaining of the same length. The result is to separate the horns very slightly. If, now, they are found to be too far apart to properly contact with the ends of the "point," another blow is struck with the hammer edge near the outer curve of the crescent, with the effect that the horns are made to approach each other. When the "snap gage" is adjusted, the mechanics of the Naval Gun Factory will, in spite of the fact that the gage may weigh five pounds and be more than a yard between the horns, get the work almost without exception correct within three one-thousandths of an inch.

While the plain "snap gage" is used in most of the outside measurements, there is a vernier "snap gage" made of aluminum that is used for some of the larger outside measurements. This gage consists of a crescent-shape aluminum frame, having steel blocks dovetailed upon lugs on the inner sides of the horns. One of the steel blocks has its surface at right angles to a line joining the horns, and the other steel block has its surface inclined at an angle of about thirty degrees. Upon this inclined surface is mounted a sliding block, having a face that is opposed to the face of the block on the opposite horn. The sliding block is adjusted by a screw journaled in the block on the horn and engaging a lug on the sliding block. Each of these blocks carries a scale plate, which plates together form a vernier for measuring the increase or decrease of distance between the measuring faces on the horns, due to the travel of the sliding block up or down the incline.

For measuring the inside diameter of the jacket, when it has been expanded by heat for shrinking on the tube, to see if it has been sufficiently enlarged, two "points" of the proper length are fastened at their middles and crossed at right angles to each other. These "points," secured to a handle, are thrust back and forth through the interior of the jacket, and the degree of expansion in all parts is thus tested.

Templates are used to determine the curves at the ends of the jacket and of the hoops and to turn the threads in the breech and breech-block.

In testing the bores of the great guns two delicate and ingenious instruments are used. One of these instruments is used to test the straightness of the bore and the other to test its uniformity of diameter. Between each of the final cuts in the bore of the gun the straightness of the bore is tested. At least for the last 10 feet of its length it must not run out of a perfectly straight line more than four or five one-thousandths of an inch. It is usually true within two one-thousandths of an inch. The testing for straightness is done by an instrument which consists of a compound lever one arm of which carries a roller which rests transversely in the bore of the gun and rises and falls as the gun turns on its axis in the lathe, if the bore is out of true, and the other arm of which is formed into a pointer that moves over the face of a scale with motion to correspond to the movement of the roller. The instrument is supported by a metal base plate which is bolted to two bars that are clamped in the tool post of the lathe on which the boring is being done. At the forward end of the base plate rises a pair of short standards which have slots in which rest two knife edge lugs that are carried by the long lever. The rear end of the base plate carries a pair of tall standards which have slots that receive the upward thrust of a pair of knife edges formed on lugs at the rear end of the short lever. Similar lugs at the rear end of the long lever-and a pair directly above these lugs on the short lever are connected by a link which transmits the motion of the long lever to the short lever. The two arms of each lever are proportioned to each other about as one to ten. The link is made of two end pieces bolted to an intermediate piece, so that its length may be adjusted to bring the short lever to a horizontal position. The short lever carries a weight which is shifted along the lever until it nearly but not quite counterbalances the weight of the long lever on the roller in the bore. On the end of the short lever is a finger which stands against an ordinary steel scale that is clamped to a standard. The short arm of the larger lever is of metal, but the long arm is of wood (having considerable depth) to reduce the weight. The wooden arm is removable, so that arms of different length may be used, as may be most convenient. The roller consists of a hardened steel disk that has a diameter of about four inches.

In testing a bore, the slide-rest, to which the base of the instrument is attached, is run up until the roller on the long lever has reached the point at which the bore is to be tested, and the slide-rest is then stopped. The gun is now slowly revolved, while the pointer is carefully watched to note its movement over the scale. The bore is thus tested at stated distances throughout its length.

The instrument used to test the diameter of the bore is called the "star gage." This instrument is so delicate that readings may be taken upon it in ten-thousandths of an inch. It consists, essentially, of a cylindrical casing or pipe having a head in which are three sockets carrying steel rods or "points," the sockets being acted upon by springs that force them against the tapered end of a rod that slides in the casing. By measuring the difference in the movements of the rod which are necessary to force the "points" out against the bore of the gun at different points along its length, the difference in diameter is determined. The "points" are threaded into the sockets so that those of different lengths may be used for different sized guns. Two of the sockets are mounted in sector-shape blocks that are held between the plates of the head by screws passing through arc-shape slots so that the radial position of these sockets may be changed. Back of the three spring sockets is a set of four holes in the head, in which four guide points may be screwed. These points in the spring sockets are set at equal circumferential distances apart and used without the guide points when the bore is to be tested before it is rifled. But, in testing the bore after it is rifled, the guide points are put in place and run in the grooves of the gun, and the movable points are set to run either on the lands or in the grooves as is desired. The casing is made in sections, so that it may be put together to any desired length; and a scale is marked upon it, so that the location of the points in the bore may be measured. The rod (whose tapered end forces outward the spring sockets) has a handle that fits over the cylindrical casing, and the handle is made in two sections that are screwed together for adjustment and are locked, when adjusted, by a thumb screw. The forward section of the handle carries a vernier plate at the side of a slot through which shows a short scale plate on the casing.

In using the star gage, a ring gage whose internal diameter is the same as the correct bore of the gun is placed outside of the movable points, the latter are forced firmly against the ring by the action of the tapered end of the rod, and the vernier on the handle is set at zero by screwing one of the handle sections upon the other. The handle sections are then locked in adjusted position by the thumb screw, and the gage is ready for use. The head of the star gage is now inserted into the bore to the point to be tested, and the rod is slid forward until the movable points are in firm contact with the bore, when the reading is taken on the vernier, as plus or minus the indicated number of ten-thousandths of an inch, according as the bore is larger or smaller than the standard of the ring gage.

It is by the use of such ingenious and accurate instruments as have been here described that the great guns of our navy, with their parts varying in dimension from a fraction of an inch to forty feet, are built as accurately as the highest class of smaller machinery, and they demonstrate that the American naval officer is not only a fine sailor and a powerful fighter, but that he is a mechanical engineer of the highest order as well.

Miscellaneous Notes and Receipts.

Decorating Wax or Stearine Candles.—This is done mostly with decalcomania (transfer pictures). Coat the candle first with a warm gelatine solution prepared in water, then lay on the transfer picture firmly and smoothly and allow to stand for several hours. After that dip the candle in water, so that the paper upon which the picture is printed is soaked and can be so removed that the picture remains on the candle. When this is properly done, remove the gelatine with a soft sponge and water, allow to dry, and dip the candle in melted paraffine, so as to give the picture a protective covering. Instead of the gelatine, spirit lacquer may be used, but this cannot be washed off.—Die Mappe.

Reliable Hair Remedy.—Dieterich gives the following prescription for a good hair water, furthering the growth of hair: Quinine hydrochlorate, 0·4; tannin, 1; spirit of wine, 80; tincture of cantharides, 1; glycerine, 6; eau de Cologne, 4; vanillin, 0·01; and powdered sandalwood, 0·005 gramme. This liquid is allowed to stand five days and then filtered. The head should be washed with it every two days. A hair pomatum, serving for the same purpose, which has been found especially valuable to prevent the falling out of hair with nervous headache, is recommended by Leistikow in the following composition: Tincture of cantharides, 3; chloral hydrate, 2; lanolin, 5; vaselin, 10; cherry laurel water, 10; and lime water, 10 grammes.—Pharmaceutische Centralhalle.

The Japanese Watch Industry.—According to the Deutsche Uhrmacher Zeitung, the Swiss consul at Yokohama reports:

The production of the Osaka Watch Company in 1897 amounted to about 2,500 watches, mostly silver. During the time of its existence the factory has produced about 10,000 watches. Since a year ago the factory in Osaka imports movements and cases from America, but the watches thus produced are dearer than the American, which they imitate, and are no better.

The factory which is being founded in Tokio, and is to make watches of Swiss models, under the direction of Japanese who have learned the trade in Switzerland, has not yet completed its outfit of machinery. It possesses a steam boiler of five horse power, a machine for making watch cases, as well as some machines for making arbors, wheels, screws, etc. This "factory" has, after an existence of four years, not yet produced a single watch, and can only be regarded as a watch making school, which now employs about twenty young persons. Besides, it will, like the factory at Osaka, import a number of ready-made watch parts, and, according to the new treaty, will have to enter them as articles of luxury, dutiable at the highest rate, for watch parts, as well as finished watches, are subject to the rate of 25 per cent. Both establishments are now working with Japanese forces. The Osaka Watch Company has dismissed its manager as well as the American operators.

"According to these statements, it seems that the civilization of Japan, progressing in Western fashion, which in other fields can boast of considerable achievements, did not yet afford an adequate ground for the watch industry," concludes the above-named journal.