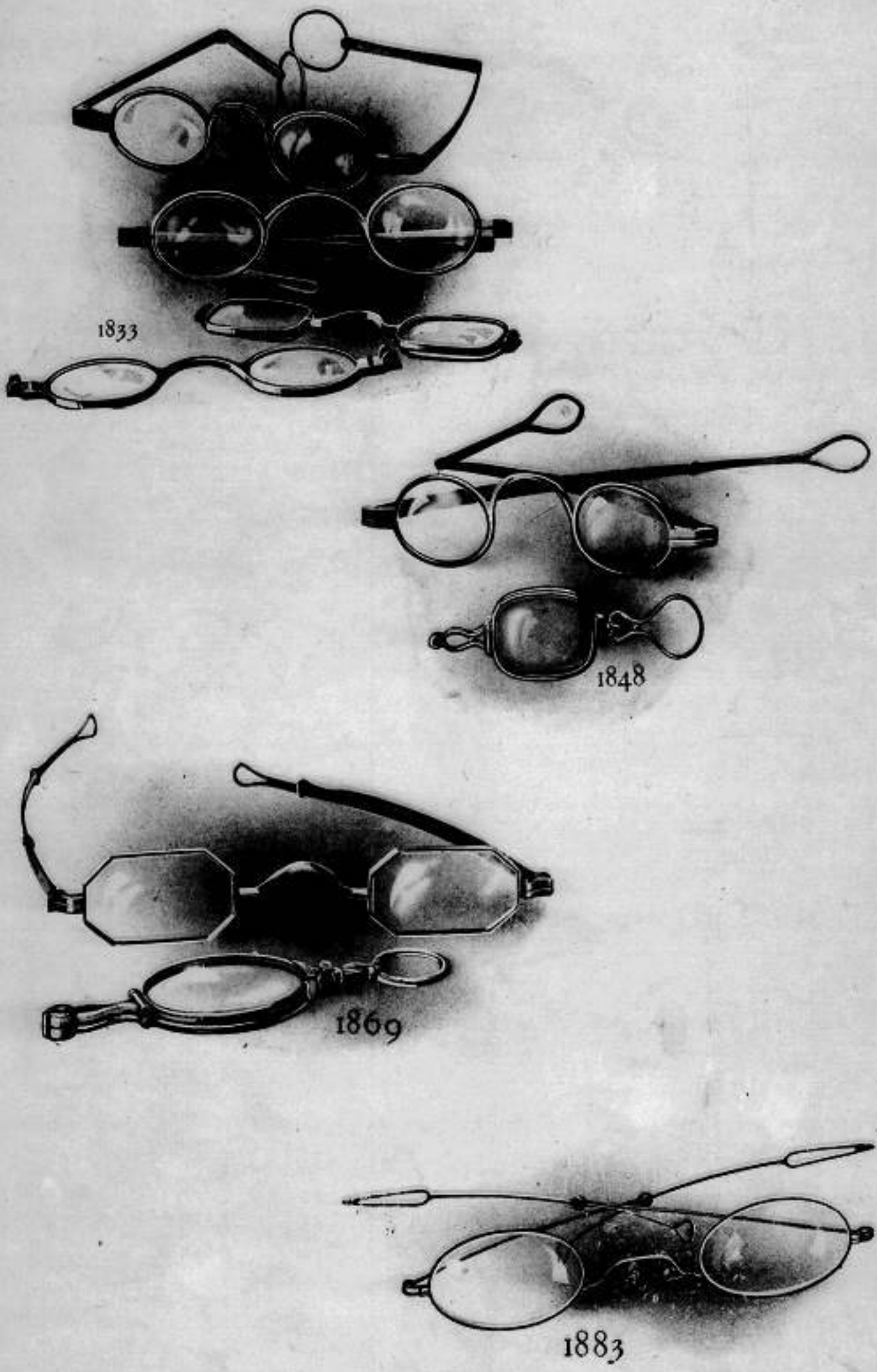
THE STORY

IN A

PAIR *of* SPECTACLES

AO

AMERICAN OPTICAL COMPANY



The Progress of American Spectacles

A Spectacle of Today

The Story in a Pair of Spectacles

When There Were No Spectacles

Nowadays we are so thoroughly familiar with the appearance of grandma's gold-bowed "glasses," mother's "eyeglasses," and the "shell" spectacles which father wears to business, that we find it hard to realize that there was a time not only when there was not a different kind of glasses for every member of the family, but when there were no glasses at all. The details of these early days are very hazy. Because there were no books or papers, stories of what was happening were often passed on from one to another by word of mouth, and we have no way of knowing the changes which may have taken place in this constant telling and retelling.

So far as we know, however, the Phoenician merchants were the first to discover a way of making glass. And that discovery took place in the delightfully casual manner which characterizes almost all prehistoric discoveries.

How Glass Was Discovered

A little band of mariners, landing at night near the mouth of the river Belus, in Galilee, built a fire on the sands to cook their supper. And as the fire burned they noticed that the ashes of the herb kali, which grew abundantly all about the place, mingled with the sand, and that the two melted and ran together into a clear whitish substance. And they picked it up and carried it home with them, and called it glass.

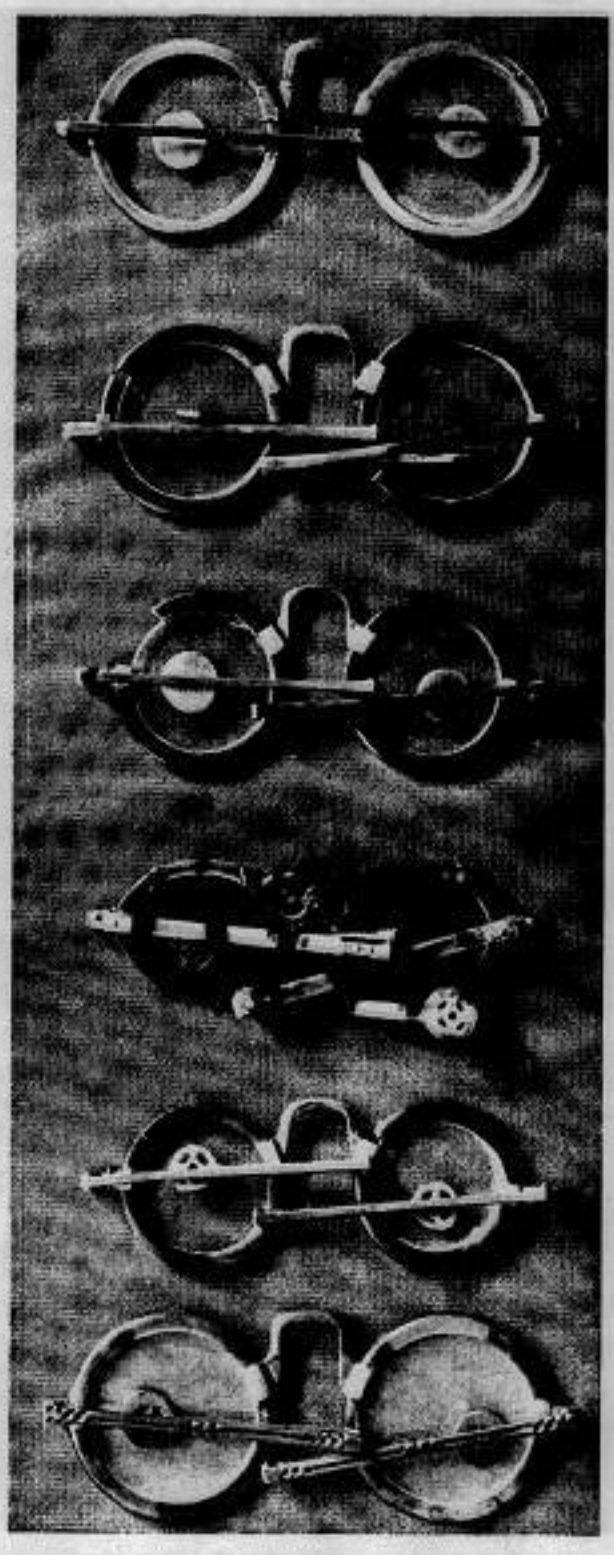
Knowledge of the new discovery naturally spread slowly. But it did spread, and in time it came to Egypt. There they not only made glass, but they learned how to make colored glass, which they used lavishly for beads and ornaments in the half barbaric splendor of the early Egyptian courts. When the conquering Roman generals, however, came to Egypt in 146 B. C., they took back with them to Rome, along with their captives and their riches, the knowledge of glass-making. Here too, the art was still further developed. The Romans were the first to make plate glass, and tradition even has it that they possessed secrets of the craft which are now hopelessly lost—such, for instance, as the making of glass dishes which would stand extreme heat. There is an ancient story, too, of how a man with a goblet of rare and beautiful

workmanship demanded one day to be brought to the emperor. The emperor was delighted with the gracefulness of the shape and the exquisite tracery of the design, but as the precious cup was passed from hand to hand around the banquet table, some unlucky noble let it fall. To the surprise of everyone, however, it was not broken, but instead was badly dented; and to their still further surprise, the workman, on seeing the result, produced a little hammer from his belt and pounded the goblet back again into shape. We today should be very glad to know some equally simple way of repairing our slips 'twixt the cup and the lip!

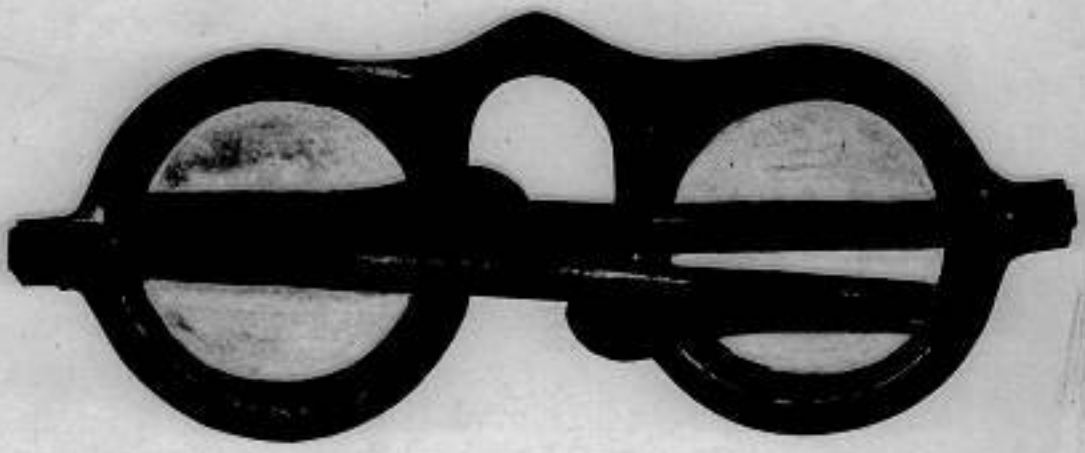
Who Made the First Spectacles?

All this time, however, we have been talking not about glasses, but about glass, and thus far we have found no indication that anyone had ever thought of using the new material to look through. Nero, to be sure, has been placed on record as having used a jewel through which to view the gladiatorial combats, but this was in very truth a *jewel*, and not in any sense a pair of glasses. It is even quoted, not as a comment on Nero's eyesight, but merely as one of the mighty extravagances of that mightily extravagant monarch. To find the real beginnings of glasses, therefore, we must go still farther back, and look in the most ancient of all civilizations—that of China. Here, of course, we get at once still deeper into the land of tradition and hearsay. For the Chinese, whatever they may have known (and there is no doubt that they knew a great many things that we are just beginning to think of), they succeeded excellently well in keeping it to themselves.

According to the early Chinese legend, the first glasses were made by Cho Tso, who lived on a sacred mountain in the Middle Kingdom thousands of years ago. The lenses for his glasses Cho Tso made from crystals which the gods had left for him; ground them with sand from the sacred rivers; and framed them from shell from the backs of the sacred tortoises that swam the mountain streams. Wearers of these wonder glasses from the sacred mountain could do marvelous things—they could see through the darkness, look into the future, or spy out the secret places where treasure was hidden in the earth. But Cho Tso himself, looking one day through a pair of his own spectacles, spied out the day of his death approaching, and true to the vision of the magic lenses, when the appointed day came he died. Even in his death,



A Group of Chinese Spectacles
Notice the heavy shell frames decorated with hand carving



This pair of spectacles was presented to the American Optical Company by a Chinaman in San Francisco. His great grandfather wore them in China in 1720

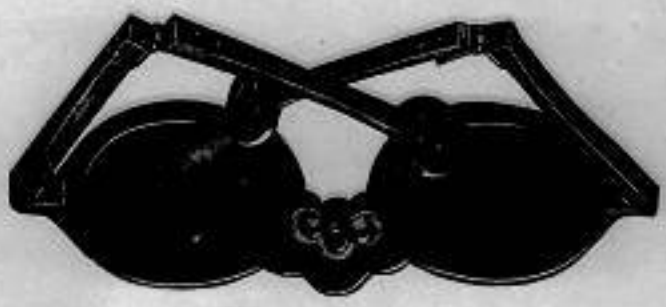
however, Cho Tso retained an interest in the optical business of China; for it was he who sent his messengers to put crystals on the sacred mountain where the glasses-makers of the future could find them.

Almost up to the very present, this tradition has been the background of all spectacle-making in China, and glasses have continued to be linked to a fund of myth and magic which has often made them more useful to the spirit than to the eyes.

When Spectacles Were Badges of Intelligence

The tortoise is a sacred animal in China, and its sacred shell was believed to supply good fortune and long life with every pair of glasses rims. The lenses, made from rock crystals (or quartz), or from other lucky stones, tradition claimed, still further insured the continued health and happiness of the wearer, and cured various diseases of the eye. Since, however, these lenses added to the luck and not to the vision of their owner, frames were also worn alone without lenses. Such glasses (if we can call them glasses when they had no glass) were regarded as badges of superior rank and intelligence. Many similar ideas and customs, based on the superstitions of the early days of glasses-making, have lingered on in China almost to the present day. There, for instance, when you met a friend on the street you politely removed your glasses instead of your hat. It was considered very rude at any time to talk to a person while you had spectacles on, and particularly was it a sign of grave disrespect to wear them in the presence of a judge. The judge himself, however, would undoubtedly have his glasses on as an aid to his dignity if not to his eyesight. For glasses in China have long been considered a mark of intelligence and literary attainment, and as such are worn by scholars, fortune-tellers and men of rank the country over.

Nor have these strange ideas and customs in regard to the wearing of glasses been confined wholly to the Orient. In Germany, too, it was long the custom to remove one's glasses when speaking to a superior, and in Spain they were worn as ornaments and as indications of rank and ability. As time went on there came a gradual development of the idea that if a pair of glasses indicated intelligence, that a larger pair of glasses would indicate more intelligence. The frames accordingly grew steadily larger and larger, until at least one nobleman appeared neatly decorated with a pair of lenses three inches in diameter. So pleased was he with the distinction which these



Chinese Spectacles

mighty frames gave him during his lifetime that he left instructions at his death to have a statue of himself set up on which the glasses were on no account to be omitted.

There could, of course, be no real advance in the making of glasses as we know them today except in connection with the advance of science. And for literally hundreds of years science did not advance. Even when scientific experiments in regard to light and the eye began to be made, it was again hundreds of years before the knowledge so gained was turned to actual use in the making of glasses. Alhazen, an Arab of the 11th century, has been called the pioneer in the science of optics. It was he who first noticed that light became bent under certain circumstances, and who investigated somewhat the subject of lenses, or pieces of glass fashioned in such a way as to bend the light where he wanted it to go. He later wrote a book on the reflection of light, the structure of the eye, and the philosophy of vision which proved of value to investigators two hundred years later.

The First Spectacles for Correcting the Sight.

It was not until that time—early in the thirteen hundreds that is—that there is any authentic record of glasses which were worn for the improvement of sight. There are, to be sure, pictures of men who lived much earlier, reading or writing with the aid of glasses—one of St. Paul, for example, writing the first epistle to the Romans—but such pictures are misleading. Painted long after the men whom they portrayed were dead, they represented the ideals of the painters rather than the actual originals. And so it is not surprising that the artists of a day when glasses were worn by everyone of superior rank or learning, should paint in a pair on the nose of his favorite saint, however little it belonged there.

The first claimant to the honor of the discovery of glasses is an Italian, on whose tombstone this inscription may still be read: "Here lies Salvino d'Armati of Florence, the inventor of spectacles. God forgive him his sins. Died in the year of our Lord 1317." Whether the invention of spectacles is classed as one of his sins is not entirely clear, but whatever may have been the attitude of his own day, his discovery is now known to be the means of bringing health and sight and happiness to millions of people all over the world.

At about the same time an old Latin document, found in the convent of St. Catherine at Pisa, tells of a monk—Alexander de Spina—who was so good a mechanic that he could make anything in the world if he had but once seen it. And having seen a pair of glasses, and having moreover been refused the secret of their construction, he straightway went back to the monastery and made a pair for himself.

And in the same century again came Bacon, "the father of science." It was he who first described convex lenses, but there is no indication that he ever made these lenses up into glasses. Nor does it any longer seem strange to us that this is so, when we understand the conditions of the days in which he lived. All during the Middle Ages scientific progress was at a standstill. There were several reasons why this was true. The most important one, however, was the fact that the period of the Middle Ages was essentially a religious era, when men's thoughts were turned toward the heaven above instead of toward the earth beneath, and when any scientific investigation was viewed in consequence as of slight importance in the face of all eternity, and even as a direct attempt to find out means for thwarting the divine will.

When the Churches and Doctors Tried to Suppress Spectacles

It is not surprising, therefore, that the clergy united with the medical profession in trying to suppress the doctoring of eyes with glasses as a deliberate interference with God's purpose of afflicting the aged. Bacon was himself several times imprisoned on the charge of dealing in black magic, and these frequent stays in prison (in the days when prison reform had not been

One of the Earliest Optical Shops

thought of), effectively cooled any desire which he may once have had for connecting his name with the introduction of spectacles into England. Besides Bacon was not primarily interested in glasses. The study of optics was merely one subject among the many fields of science in which he interested himself—from alchemy to the light of the stars, and from the cause of the rainbow to cold storage.

In addition to the religious scruples which checked the spread of glasses during the Middle Ages was the very practical fact that they were not nearly so much needed as they are today. There was no printing. Books, copied by hand in the monasteries at an immense cost of time and labor, were too expensive for the common people to own.

Our Ancestors Did Not Need Glasses

And because there was so little chance of using the knowledge, very few indeed even knew how to read. Nor did the people in general do other things which required close application of the eyes. The fine gentlemen and ladies—if we are to judge from ancient tales—spent their time respectively in tournaments and fainting fits, while the men and women of the lower classes tilled the fields and kept the homes, and went to bed o' nights and saved their eyes.

But with the introduction of printing a great change took place—not all at once, of course, but very, very gradually with the passing of the years. People all over the country began to read for themselves; religious prejudices gave way; interest in science increased; the beginnings of manufacturing crept in; international trade was organized; and Europe began to lead a more complex existence.

Europe, too, began to wear glasses. And strange enough these ancient and honorable eyepieces seem to us now, accustomed as we are to the daintest of combinations of glass and gold. It is interesting to know that while the earliest of Chinese glasses were spectacles, the first glasses in England were eyeglasses. And clumsy indeed these early

eyeglasses were. They had heavy rims and large lenses—sometimes one like the modern reading glass, but usually two connected by an inflexible bar. In other words, there was no means either of fitting them to the nose, or of holding them in position before the eyes. Now this was all very well if one were reading, and not impossible if one were writing; but it was not so simple to dash into battle with a pair of glasses held before a near-sighted pair of eyes, while at the same time the rider guided his horse and waved his sword above his head. Nor could a laborer hold his glasses and at the same time use his hands for his work. For the warrior, therefore, helmets were sometimes made with lenses riveted in. The first of these was presented to Henry VIII in 1535. For people in general various devices were gradually worked out. In Spain glasses were often attached to the hat, but since at that time glasses, which were still used more for looks than for looking, were worn chiefly at court, and since all hats had to be removed in the presence of the king, the system caused much discontent. In England glasses were fastened to hoods. And here we can trace a very interesting progress to our modern means of holding eyeglasses in place. Hoods, of course, could not always be worn, and at best they were hot and uncomfortable. The top and sides of the hood were therefore done away with, and the glasses were secured by a broad leather band which circled the head, and which among the nobility was decorated with painting, gilding or burning.

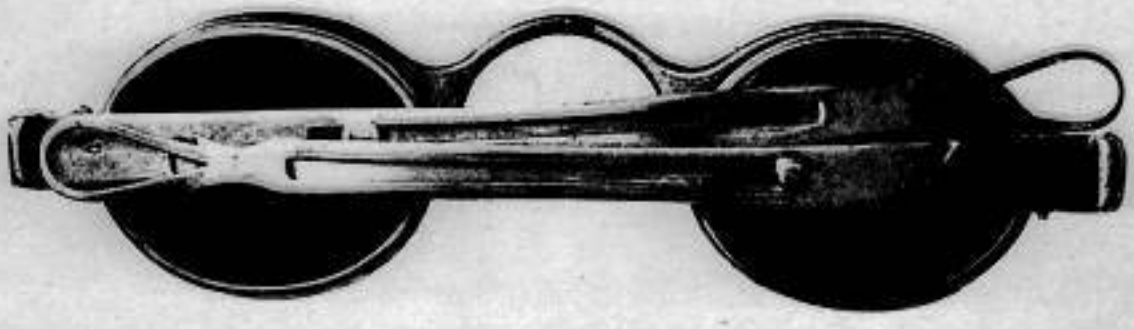
This band was made gradually narrower, until finally strings were used to tie around the ears. At about the same time a single hinge was made in the connecting bar between the lenses, and an apology for a fitting frame was established. Sometimes, too, the ear-strings were supplemented by a little band that went up under the hat from the nosepiece. This band, in pictures, gives a curious effect of having the glasses nailed to the forehead.

How Glasses Were Made to Stay On

An attempt was made to introduce these bands again as late as the 18th century, but the women refused to wear them because they disarranged their hair. To avoid this objection, someone thought of putting on two such bands and having them at the sides, and so glasses with "bows," or "spectacles," were introduced. At first these bows were short and fitted closely against the sides of the head—from which fact probably came their present official name of "temples." A little later they were made longer and heavier, with huge rings at the ends to fit in place either over or under the correspondingly huge wigs of that period.

And so by the 18th century, we find developing side by side in England and on the continent both the modern eyeglass and the modern spectacle. The early glasses frames were usually large and very heavy, with much more ornament than we now care for. That decoration in glasses frames is not entirely out of date, however, is shown by the fact that the world's largest maker of optical goods has a department for the engraving of spectacle frames for the Spanish and Chinese trade.

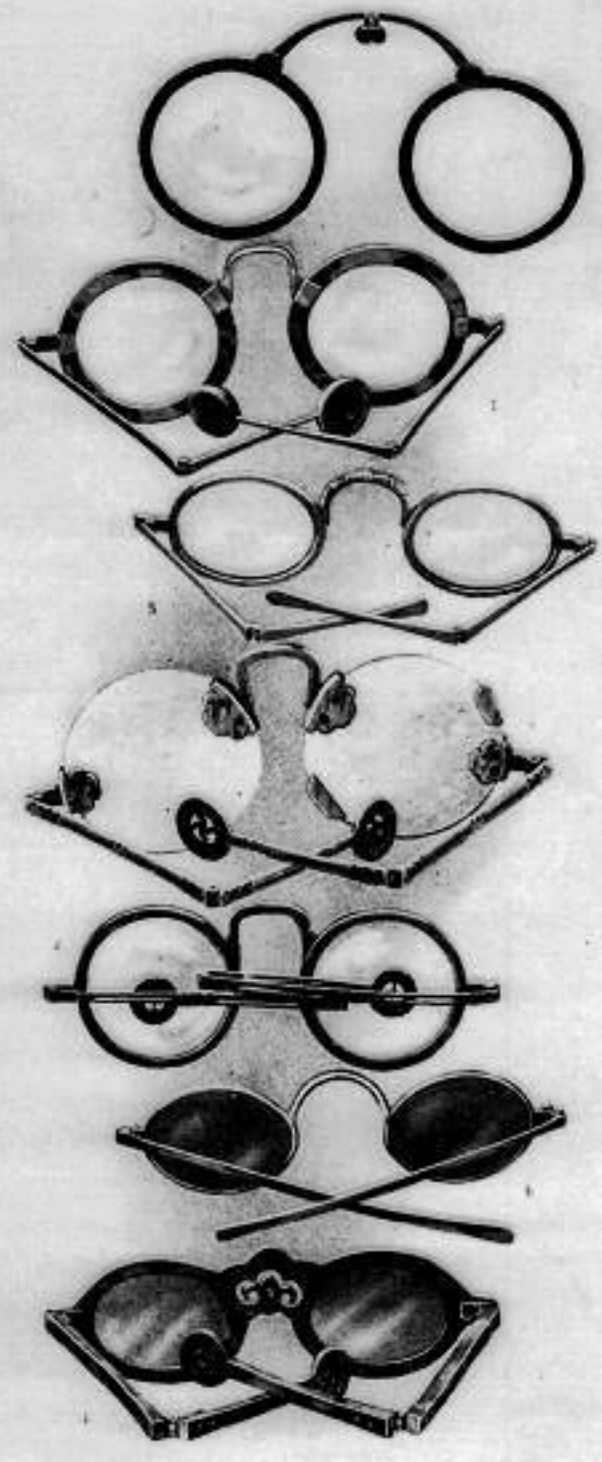
Early lenses, too, were crude affairs made of the inferior quality of glass then manufactured in Europe. The real *art* of making lenses was undeveloped before the 19th century. Venice was



Noah Brown wore these glasses when he fought under Perry on the Great Lakes in the War of 1812.

long the chief source of glass for optical use, but later England took first place. From England, too, have come some of the world's most successful inventions and discoveries in the field of optics. Among the recent English scientists who have been prominent in this field, no history, however brief, should omit the name of Sir William Crookes. At the request of the Royal Society, he undertook investigations for the purpose of finding a variety of

Sir William Crookes

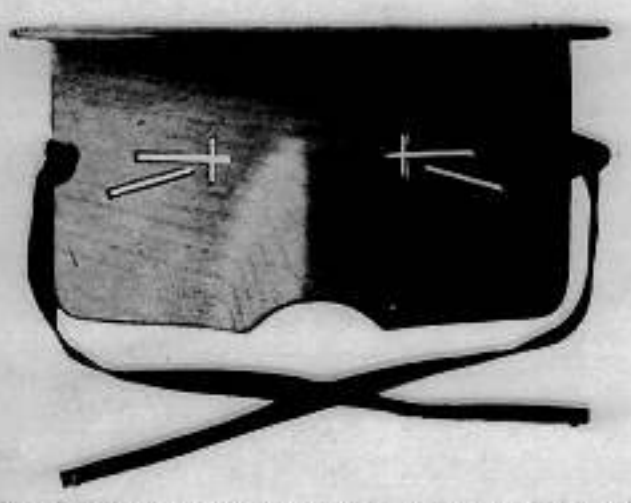


A group of early eyeglasses. Notice the earstrings, the joints in the nose-bars and the metal bar which rests against the forehead

glass which should afford ample protection to the eyes, and at the same time be so nearly colorless that it would not change the appearance of colors, or be noticeable when worn. The result was the so-called Crookes glass, which is bringing relief to so many uncomfortable eyes today. It is a far cry from the first colored "protection glass" of 1591, made by saturating amber in linseed oil, to the modern Crookes glass, but it is typical of the development of both frames and lenses from the ancient to the modern optical world.

Glasses Which Prevented Snow Blindness

In early America glasses were unknown. The very thought of an Indian brave, setting out on the war path in spectacles and war paint is amusing, just because it *is* so unheard of. The only device worn for the sake of the eyes in the New World, was the bulky wooden sun mask, which originated among the Eskimos out of the bitter experience of snow blindness. In these days of machine-made products, we can hardly imagine the time and skill and infinite patience which went into the



The Eskimo snow mask was made to shut out light and prevent snow blindness

making of one of these masks. The first step in the process was to wait—sometimes for years—for the material for the "Ikshaut" was driftwood, swept across by the polar current from north of Siberia; and the tools for its construction were nails, obtained in the same way, and sharpened against the granite cliffs. The picture shows what the Ikshaut were like—wooden shields about four by seven inches, with a rounded protrusion for the nose, slits through which to look, and walrus hide thongs at the sides by which to hold them in place. Rude though they were, however, they were an almost priceless treasure among people whose sight depended on their protection against the cruel glare of sun on snow.

Real glasses, in our sense of the word, came to America with Peter Brown in the Mayflower. How much they were worn in the New World, however, may be guessed from the fact that glasses, like all other manufactured products, came from England, and cost about seventy-five dollars a pair.

Among the most interesting of early spectacles in America is the pair worn by Washington in 1789—a pair now preserved in a museum at Philadelphia.

Franklin Invented the First Bifocals

It was Benjamin Franklin, however—quiet, practical, level-headed Benjamin Franklin—who gave the first decidedly American touch to the making of glasses. For it was Franklin who invented bifocals, the two-in-one glasses for near and far seeing which we all know so well today. Why he thought of bifocals at all and how he first made them, he tells in his own simple way in a letter to a friend.

"I had two pairs of spectacles," he wrote, "that I used alternately because when traveling sometimes I passed the time in reading, sometimes in looking at the country. The change from one pair to the other was troublesome and often was not effected soon enough to allow me to see what I wanted. So I had my glasses cut in two halves, one half of each being put in the same frame. In this way I wear my spectacles constantly, and I have only to look through the upper or the lower part in order to see distinctly far distant objects or near objects."

Since Franklin's time there have been many changes in the making of bifocals, just as there have been changes in the making of all other types of glasses, and his two-story lenses seem queer to us today. Nevertheless, we should not remember Franklin simply by the picture in the old history book of a man standing on a hilltop and drawing down the lightning from heaven with a huge door key; but we should remember that it was the same Franklin who gave the first tiny impulse to the development of the optical industry in America. And it is now America which leads the world in the production of glasses.

The manufacture of American-made glasses did not begin all at once, however. Like all great things it developed slowly. Indeed it was not until 1833 that a permanent business was established which resulted in furnishing American eyes with American glasses; and not only that, but in furnishing with American glasses the eyes of the whole world, from darkest Africa to the land of the Northern Lights. This business, begun modestly by William Beecher in a room on the second floor of his jeweler's shop, is now known everywhere as the American Optical Company, "the world's largest manufacturers of optical goods."

Cho Tso, when he ground his crystal lenses with sand from the sacred mountain rivers, would have been surprised

These are George Washington's own spectacles. He was wearing them at the time when the constitution went into effect in 1789, and when he was inaugurated as the first president of the United States

indeed if he could have looked through a pair of his own magic spectacles and seen the American Optical Company of today, with its acres of buildings, and thousands of workmen all engaged in carrying forward the great industry which he started thousands of years ago.

He would have marveled at the great white "daylight building," where, instead of grinding crystals with sand, the finest glass is put through hundreds of processes until it emerges at last in perfect optical lenses, round or oval, to suit the current fashion. He would have marveled, too, at the great brick buildings where the frames are made to fit the lenses. And most of all, he would have marveled at the finished product: dainty little eyeglasses framed in slender gold; equally dainty spectacles set in gleaming metal; fashionable combinations of gold and zylonite, deep wine-colored zylonite, clear crystal zylonite, green gold, white gold, yellow gold; a host of materials and patterns blended with the skill of science and trained workmanship. Very different are these glasses from Cho Tso's sacred crystals set in frames carved by hand from the shells of the sacred tortoises.

Let us suppose just for a little that Cho Tso had actually wished himself back to earth by the power of his magic spectacles, and let us accompany him on a trip through the biggest optical plant on earth, and listen while he hears explained to him how glasses are made nowadays.

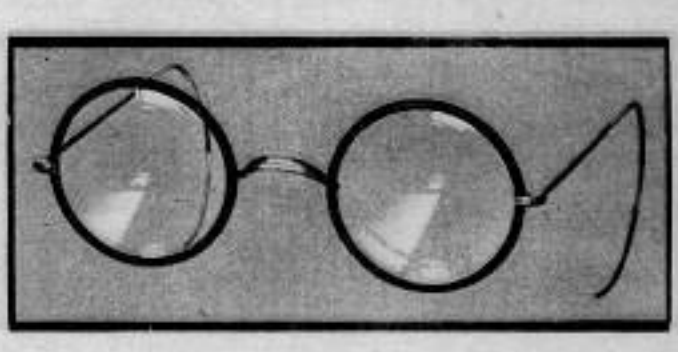
How the Lenses are Made

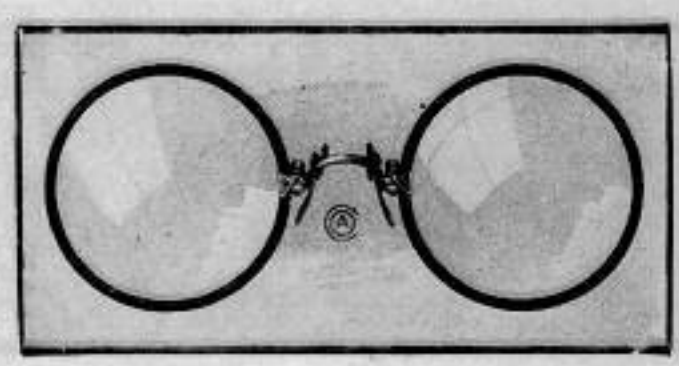
We should go first of all to "Lensdale," where shapeless chunks of rough glass are changed to clear, polished lenses. And we should walk first through the stockroom, where miles of glass stretch out endlessly, it seems—thousands of pieces packed together in cases—cases piled up to the ceiling and marked with pointed signs like so many railroad guides. When it leaves this room the glass is put through a sorting

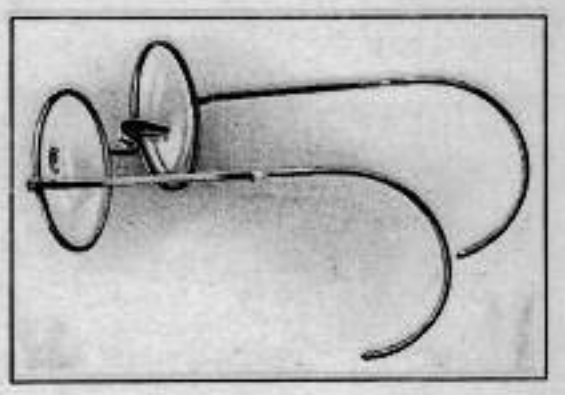
Benjamin Franklin Wearing the First Bifocals

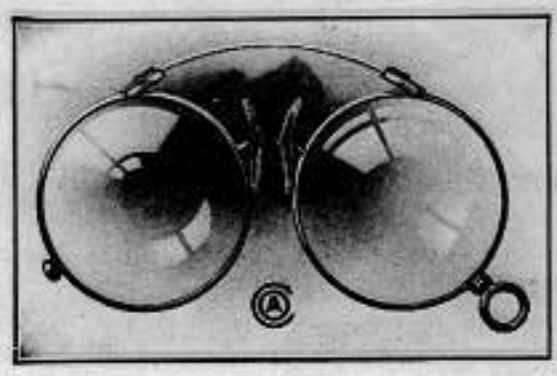
machine which divides it into groups, according to its thickness. So accurately is this work done that the little blocks of glass are sorted down to within 1/5 of a millimeter, or 1/125 of an inch—a difference so tiny as to be invisible to the human eye, but not to the unfailing mechanical eye of a machine. The sorted groups of glass are then sent on to the molding room.

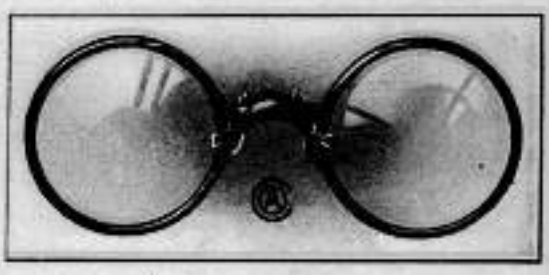
The molding room is always an exciting place for the visitor, with the white glow of the furnaces, and the low purr of the burning oil with which they are heated. An excellent place to work in winter, you would say, and not such a bad place in summer, either. For in front of the furnaces are shields to cut off the heat and glare, and from the ceiling hang balloon-like affairs from which streams of fresh, cool air from outside play constantly on every workman, as if Æolus had at last taken off the strings from his wind bags and let the breezes blow. Here the rough squares of glass are laid on the white slab at the bottom of the furnace, and heated until they are clear and soft, like so much pale lemon jelly, thick enough to be handled without breaking. Then they are slipped into little saucer-like molds and stamped out—at once rounded at the edge and curved over the entire surface. There is another way in which the shaping of the lenses may be done. The pieces of glass may be placed on a slab containing slight hollows like a very shallow muffin pan, and, again like muffins, baked. The glass then softens, of course, and drops to fit the hollows. Glass so "dropped," however, can not be used for high-powered lenses, and the method, though a trifle easier, is therefore not so extensively used.







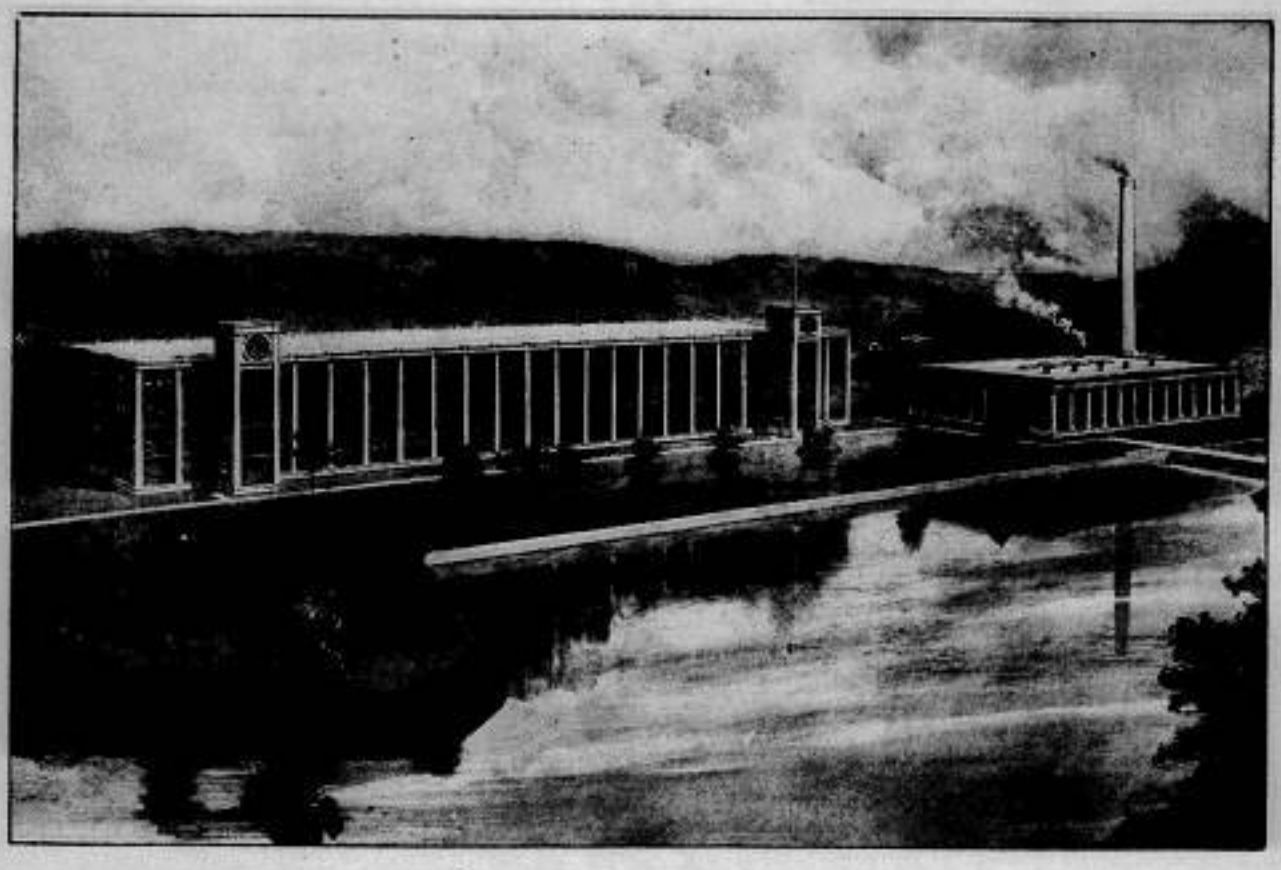




A Group of Modern Spectacles and Eyeglasses

Hardening the Lenses

When the molding is done, the next process is called "annealing." This is simply a long heating process, followed by a slow cooling, for the purpose of welding the particles of which the glass is composed firmly together and hardening them into their new shape. The rough lenses are then sent, still in the annealing racks, directly to one of the



"Lensdale"—the "Daylight Building" Where Lenses are Made

inspection rooms, where they are put through one of the many tests to which they are constantly subjected at every stage of the process. Here the imperfect ones are thrown out, and the perfect ones are "edged"—that is the rough shell left after the molding is removed—and sent on to the blocking department.

The blocking is again an unusually interesting process to watch. The lenses are arranged in spaces prepared for them on a rounded block like an inverted chopping tray, hot pitch is poured over them and a cap of exactly the proper size is fitted over the block. The pitch cools on to this cold surface, taking the lenses with it, and as it hardens fixes them firmly in place. Or huge shallow saucers are filled with partly cooled pitch, hot lenses are properly arranged on the block, and forced into place by mechanical pressure. These blocks are of various sizes and shapes, according to the kind of lenses to be ground on them.

When the lenses have been secured to the blocks, they are ready for grinding and then for polishing.

The grinding is done in this way: The blocks, covered with rough lenses, are secured in long rows to the uprights of a machine. Covers, properly fitted to the curve of the block, are placed over the lenses. These in turn are fastened to bars from above, and when the power is turned on these covers move with a back and forth or round and round motion, or both, according to the kind of lens which is being ground. And a strange seasick sensation, too, it gives the unaccustomed visitor to look down the length of a room filled with these machines, all heaving and rolling like so many little ships at sea.

Rough Glass Ready to be Made into Lenses

The Glass is Heated and Shaped in the Molding Room

Machines of this kind Grind and Polish the Lenses

Inspection Booths. The Girls are Trained to Detect the Most Minute Flaw in the Lenses

How the Lenses are Ground and Polished

The grinding is done with emery kept constantly wet. In the first stages a coarse grade is used, and its action wears away the larger roughnesses and imperfections of the lenses, but leaves them covered with fine scratches. They are then carefully washed to remove every grain of the coarser emery, and several finer grades are used successively, until the lenses are absolutely smooth. The polishing is then done in very much the same way, except that a preparation of oxide of iron is used for the purpose instead of emery.

When one side of the lenses has thus been finished, they have, of course, to be taken off, reblocked, and the process of grinding and polishing repeated on the other side.

When they are again removed from the blocks, smooth and bright and shining on both sides, Cho Tso—or you, perhaps—might think that they were finished. But neither of you have ever been more mistaken. For there are many more processes through which they must pass before they are ready to be fitted to the frames.

They leave the department in which they are ground and polished, put up in racks holding from seventy-two to one hundred and forty-four pieces, and are sent at once to what is known as "lens inspection." Here they are distributed among four departments according to their type—sphere, cylinder, toric or meniscus. The process through which each is put, however, differs only in detail, and in understanding one, you and Cho Tso will understand them all.

Making Sure the Lenses are Perfect

In these departments each lens is repeatedly put through the most searching tests by girls highly skilled in the detection of the most minute flaw. These possible flaws are of various kinds—grinding scratches, polishing scratches, holes, bubbles, greyness from insufficient polishing, and stria (a strange streaky appearance such as you sometimes see when you put medicine in water).

It is significant of the care which is

used to turn out perfect lenses that after the time and expense which have necessarily been spent on each lens up to this point, many of the thousands inspected daily by each girl are rejected here, and many more are rejected still later. All the imperfect lenses so discarded are sent to the reclaiming room, where they are re-examined, and where, if possible, the defects are remedied, in order to prevent all unnecessary waste.

The perfect lenses are sent on again to be centered. By this process the exact optical center of every lens is found, and is marked by a small ink dot. A swift series of short processes follows. The lenses are "revised." That is, they are tried by a diagram to see if the lens can be cut out without running off the edge of the glass. This, of course, is always possible except in cases where in some way the optical center has been ground too far away from the geometrical center. They are tested to be sure that the power and focus are correct. They are gauged for thickness, with a possible leaway of only two-tenths of a millimeter from the chart thickness. They are inspected. They are wiped. They are reinspected.

They are then passed on to the cutters, and cut out to the proper round or oval size. This is done by placing the point of a little machine on the ink dot at the center of the lens and turning a handle once. A diamond point revolves and cuts the glass in the size and shape to which the machine has been previously set.

Again the lenses go forward a step, this time to the edging department, where they are ground off on the edge to the smooth even finish to which we are accustomed. When they are finished they are fitted into standardized testing rings, to make sure that they are exactly the correct size. Next they are examined again for focus, to prevent any possible error in the placing of proper pairs together. Finally, after many inspections and reinspections, they are tagged and boxed and labeled. And at last they are ready for the frames. What *would* Cho Tso have said?

Hand Edging Smooths Away the Last Roughness

In the meantime, over at the "main factory," the frames are being made. There are many types of frames of course: frames of all kinds of material: gold, gold filled, silver, alumnico, zylo; and frames for all kinds of glasses: spectacles, eyeglasses, goggles. It would require a whole book to describe the details of these many processes, but perhaps none is more typical and more interesting than the making of gold frames.

The gold department is the very home of the romance of manufacture. From the time that the gold first comes to the factory in kegs of twenty-dollar

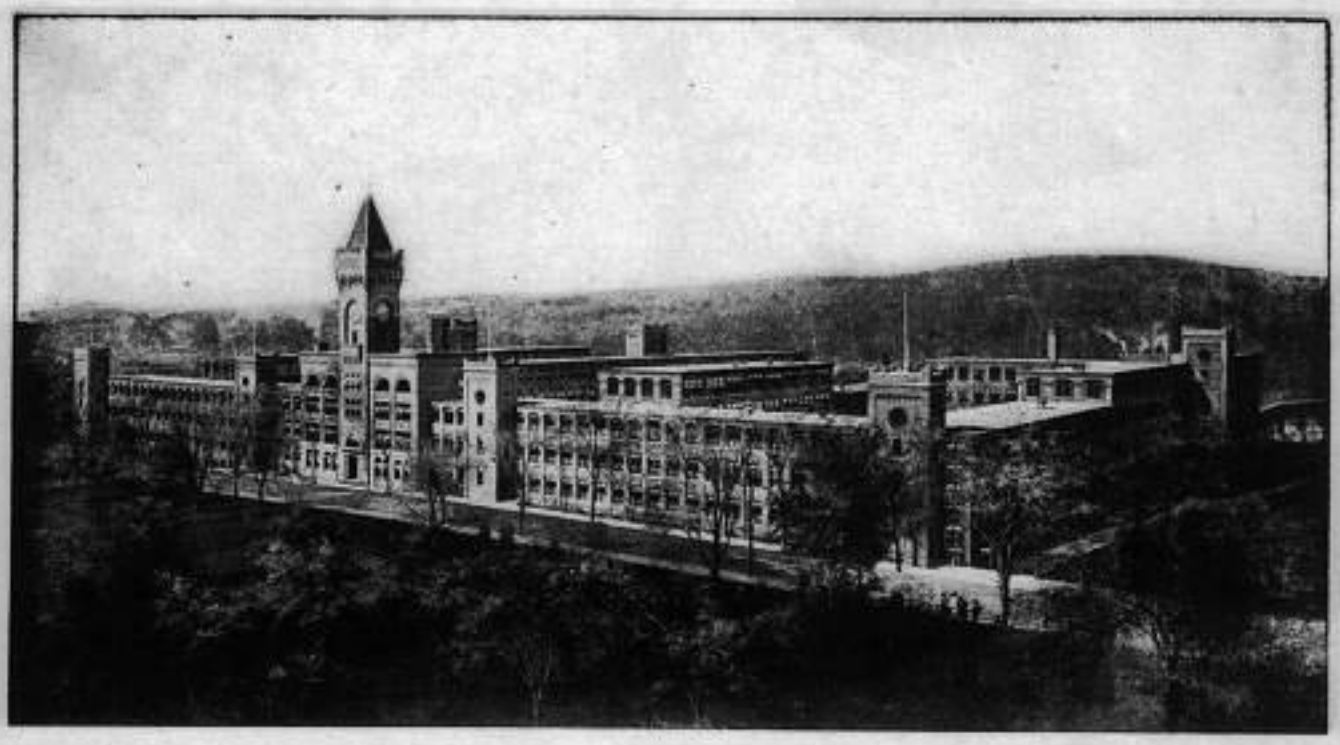
Centering

gold-pieces straight from the United States mint, to the day that it goes out in tissue wrapped dozens of slender golden frames, its progress through the department is a long series of processes that stir the imagination. The storeroom itself, where the gold eagles are lodged on their first entrance into the manufacturing world, is like a bit out of an Arabian Nights' Fairy Tale, with its gold blocks and bars, its gold double eagles, and its hoops of heavy gold wire. It is there that the gold pieces are run through a machine which cuts them half open, and thus marks them for purposes other than for circulation. And it is from there that they are sent on when the time comes to be melted.

Making Spectacle Rims Out of Gold Dollars

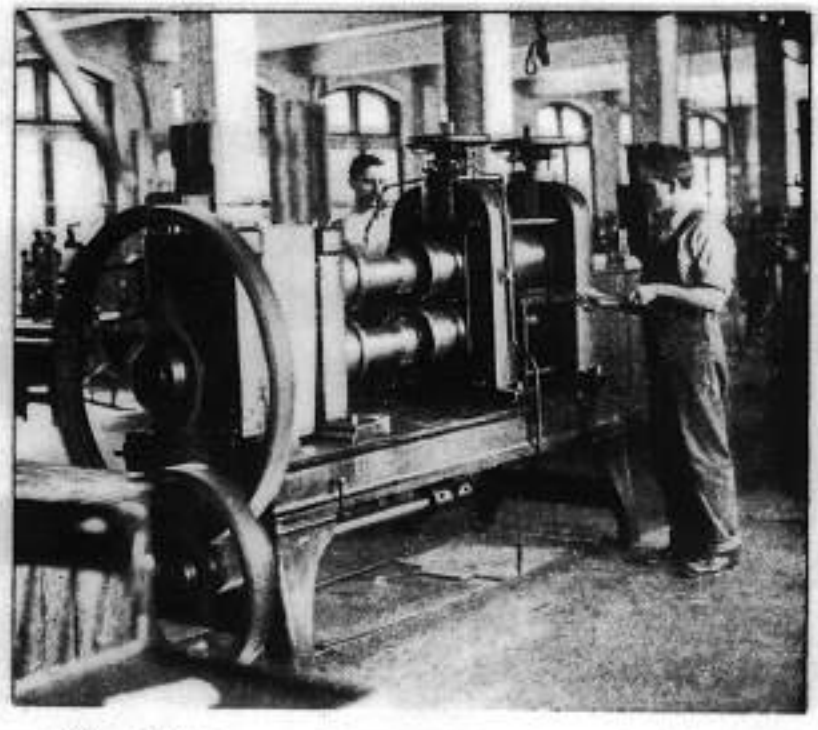
The melting room—which is really more like a huge wired-in cage—is a spot heavy with reminiscences of earlier days. The low roar of burning oil, the fitful flare of the flames around the black lead alembic on the furnace, the scattered vessels heavily gold-encrusted, the heaps of shining metal, the mysterious little piles of unknown substances, and moving strangely among them the silent figure in a long, white coat—one glance at these things carries us far away from Southbridge, and back into the dim days of the Middle Ages, when black magic was abroad in the land. We almost expect the magician to cast his bits of alloy into the white-hot crucible with incantations and weird gestures. And then he brings us back to earth again by explaining how he varies the amount of alloy according to the carat of each particular brew, and that there are one hundred and twenty ounces of gold then being melted. When it has reached exactly the right point, it is poured out into molds clamped upright to receive it, and cooled into bars about a foot long. These bars are rubbed down until the roughness and impurities on the outside of the pure gold are removed.

Then comes the rolling process. Back and forth between heavy rollers, like overgrown clothes wringers, these bars are passed, until gradually they stretch into lengths of heavy gold ribbon. Between the many rollings the gold is taken often to be annealed, very much as the lenses were. Annealing consists of a process of heating and slow cooling, in order to soften and press together more firmly the particles of which the gold is formed.



"The Main Factory" Where the Frames are Made

"White Magic." Pouring the Molten Gold into Molds



The Gold Bars are Flattened into Strips by Passing Repeatedly Between Heavy Rollers

At the point where the rolling is finished the process divides, and from the "flat stock" into which the gold bars are drawn, several different types of gold product are made. Some of it is taken directly to machines which stamp out such of the smaller parts of spectacle frames as can be made in one piece, and leave as temporary waste strips of gold delightfully patterned like so many yards of gold lace. The rest is cut and made into wire — some solid, some gold filled. The following illustration shows exactly how the gold filled is made. The flat stock is cut into squares and round pieces stamped out. These pieces are bent into successive shapes; first saucers, then cups, then hollow tubes closed at one end. When these tubes are sufficiently drawn out, a tiny metal core is slipped inside and the drawing process goes on until the little rod becomes yards of gold filled wire. So accurately is the work done that the wire can be reduced to as fine a point as is desired, without danger of wearing the gold down nearer to the core in one place than in another. An understanding of this process shows clearly the difference in meaning between "gold filled" and "gold-plated," and why the gold on gold filled "stays put."

How Solid Gold Wire is Made

The method of making solid gold wire is rather less complicated, consisting, as it does, of a constant pulling down of coarse wire to successive degrees of fine and finer and finest wire. This is done by passing it from spool to spool through a series of dies. This work is done in a soapsuds solution in order to keep the gold always clean and cool, by preventing both the heat of friction and the clinging of dust particles. For the very tiniest wires the dies are made of black diamonds from Brazil. These diamonds differ from those commonly found in rings only in color, and for an ordinary die a stone of about ten carat is required.

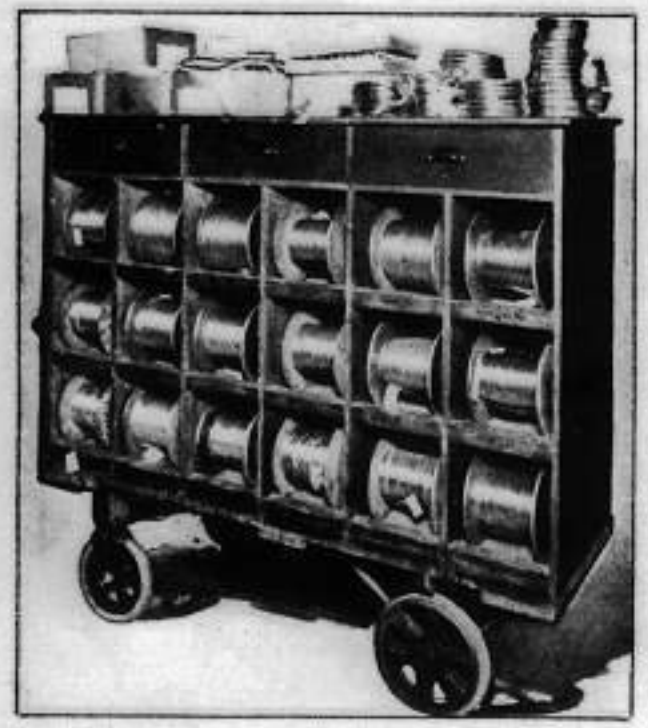
When the wire has reached the necessary size, it is tested in pure nitric acid, wound on spools or in coils according to its size, and sent to the stockroom.

The real forming and putting together of the spectacle frames then begins. As you will readily see by looking at any pair of spectacles, there are three main parts to the frame: the eye rims, the temples or bows, and the bridge or nosepiece. Cho Tso himself made his frames with these three parts, but the methods by which he did it were as different as the results which he obtained.

The making of the rims into which the lenses fit is done by winding the wire around long round or oval bars, which shapes and sizes them accurately. The wires are then cut open down the entire length of each bar, and the eye rims are ready to pass on and be fitted with endpieces.

The endpieces, in the meantime, have been made ready by another set of workmen. Tiny pieces they are, too, and unimportant looking in themselves, but, like many of the little things of the earth, they are of mighty consequence in the carrying out of the complete plan. The complete plan in this case is, of course, a spectacle frame. And the endpiece is the part which connects the

Annealing

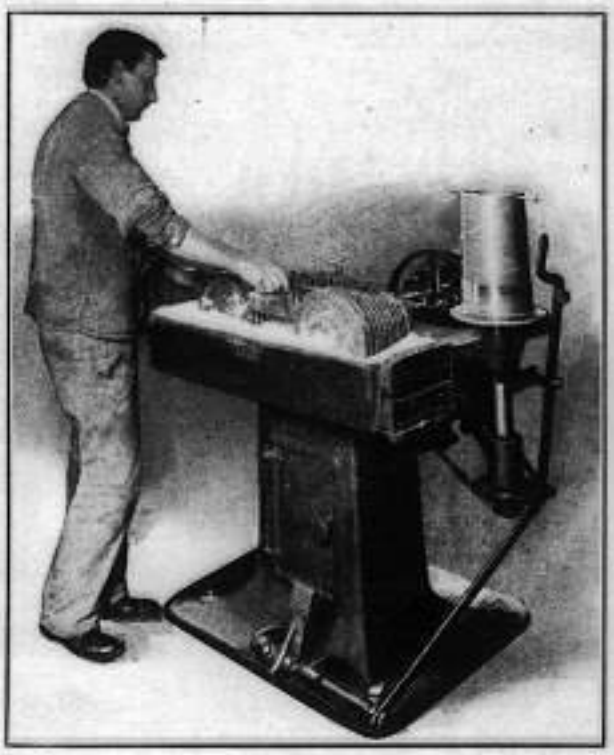


Miles and Miles of Fine Gold Wire

rim with the bow, and contains the joint which makes it possible to fold the glasses up and fit them into a case. These pieces are among those which are "blanked out" from flat stock. The plain rough parts thus cut out are put through a long series of processes; they are annealed, smoothed, pierced for screws, and finally "paened on" to the eye rims. This is done by clamping the ends of the wire firmly in place, and fastening on the endpieces with bits of gold solder.

Then the frames are put through the marking machine, which indicates the spot opposite the endpieces where the bridge or nosepiece is to be placed, and the frames go forward again to where the bridges are waiting for them. For while some men have been working on the eye rims, and some on the endpieces, still others have been preparing the bridges. These start as straight gold bands tapered at each end, and are next "swedged" and "formed." The first of these operations bends the band into the shape of a rectangle open at one side; the second into the half hoop with which we are familiar in finished glasses. Then they are "trued" (bent the slightest fraction of an inch this way or that for accuracy); milled (dented at the ends to fit on to the eye wire); and soldered in place. The whole central part of the frame is then in shape, and needs only the bows or temples to make it complete.

The making of the temples is a more complicated affair, and would seem a more complicated affair still if we (and Cho Tso) tried to understand the process involved in the making of all the many varieties of temples. One of the most popular kinds—the cable temple—will be enough. This temple is made by fitting inside a tiny coil of wire a still tinier gold core, and smoothing the whole so thoroughly that it looks like one piece, while it keeps the flexibility of the spiral coil. This construction extends for a little more than half the length of the temple, and includes the part which is later bent to fit around the ears; the rest of the temple is made flat to fit comfortably against the sides of the face. The bows are fastened to the rest of the frames by tiny screws and the spectacles are finished. But not quite finished yet, after all. Before they are, there are still several cleaning and smoothing and polishing processes through which they must go to bring out the bright finish and satin-like surface of the frame. They must be carefully smoothed down in every part



Drawing Out the Wire

Preparing and Putting Together Some of the Tiny Parts from which Spectacle Frames are Made

where a joining causes a slight roughness. They must be polished all over by skilled workmen who know how to hold them against a swiftly-moving wheel in such a way that every part shall be covered. They must be washed in water and ammonia, and dried in warm sawdust to clean and brighten them. Nor is this the first time that they have been similarly treated. Earlier in the process the various parts as they were finished have been put through "the rattlers." The rattlers are not by any means the forked-tongued monsters which their name suggests. Instead, they are simply white, wooden tubs, filled with soap-suds, and —strange as it sounds—shot. When the gold parts have been placed in them, the tubs turn with a gentle rolling motion, and the oil, dirt and waste are carried off by a combination of friction and washing.

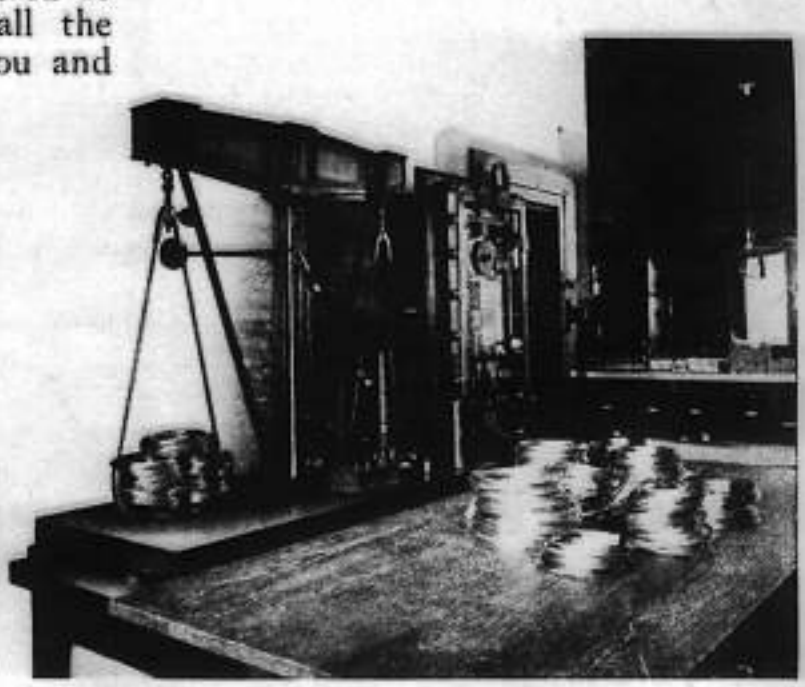
When the finished glasses frames emerge from their final drying, they are wiped carefully, inspected and sent for the last time to the stockroom. Thus far we have said very little about the stockroom, or about the way in which the gold department is organized. But that is not by any means because there is nothing to say. When the gold comes from the rough stockroom, where the gold eagles, and the bullion, bars and wire are kept before the process of making them into frames begins, it is weighed and placed in the stockroom of material parts, where two thousand five hundred different kinds of stock are kept. There are careful records of all the gold which is sent out from this room to the various parts of the department. After each operation, the parts, instead of being simply passed on to the next workman, are returned and again weighed. This is done in order that they may be checked with the standard weight for that particular process. Parts which are too light must be discarded; those which are too heavy must go back to be ground down to regulation size. Surplus stock is kept in drawers, each of which contains a card where the amount of stock is balanced each day, in order that the entire number of parts on hand at any given time be determined. When the finished frames come back for their

Hand Polishing Gives Better Luster to Gold Filled Frames

Reclaiming

final weighing, the most rigid exactness is required of them. In the weight of the completed frame a variation of only two grains of gold is allowed. How tiny a morsel this is we can hardly imagine —but such exactness is necessary if the quality of the frames is to be maintained.

You have probably all wondered as you read what happened to all the waste gold, which, as far as you and Cho Tso could see, was apparently scattered all along the wayside with an extremely lavish hand. You pictured the gold department, perhaps, as a spot where the gold dust lay thick in the cracks of the floor, and where medium-sized nuggets could occasionally be picked up. But nothing is further from the actual facts. The American Optical Company, like all good Americans, does not believe in waste. This is one reason why such accurate account is kept of every scrap of gold used in the department. It is the reason, too, why there is a force of reclaimers always at work. The picture shows one of these men melting down again gold scraps which have been already used. You can easily see how there would be many such scraps—yards of flat gold stock, for instance, from which small parts had been cut out; rough edges smoothed from the bars after melting; tiny bits chipped off here and there and everywhere during the many processes of manufacture. But this is not all. The dust around the grinding and polishing machines, heavy with particles of gold, is not wasted. The very sweepings from the floor, the very rubbish from the whole department, is saved. All that is burnable is burned and from the ashes thousands of dollars worth of gold is salvaged. Everyone who works on gold processes which involve the grinding off of chips or dust of gold, wears a special overall suit provided by the company. These suits are washed regularly in the plant laundry, and an unbelievable amount of fine gold which would otherwise be hopelessly lost, is saved from the water—a river of gold indeed.



Weighing the Finished Stock of Wire