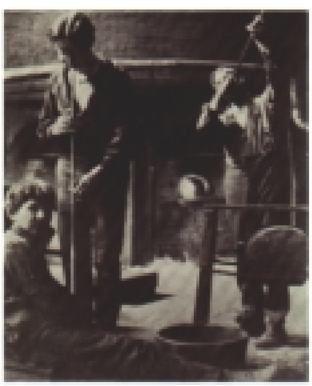
# The Corning Ribbon Machine
# For Incandescent Light Bulb Blanks

International Historic Mechanical Engineering Landmark
1983
American Society of Mechanical Engineers



A BOYISH WILL WOODS DEMONSTRATES THE GLASS-BLOWING TECHNIQUE THAT BROUGHT HIM SUCCESS.

When William J. Woods first came to work at Corning Glass Works in 1898, there was little — except for his shock of auburn hair — that would have indicated he was anything out of the ordinary.

Of medium height and weight, 19-year-old Woods — everyone called him Will — was a newcomer to Corning, N.Y., from the Pittsburgh area where he had been born in the town of Martinsburg to an Irish mother and a Scottish father. As a boy, he had learned to blow glass in the Westinghouse Glass Works, one of many such enterprises which flourished off the abundant coal that underlay the wooded ridges of western Pennsylvania.

Will Woods had come to Corning to pursue his calling as a glassblower. And despite his appearance, Will Woods was anything but ordinary.

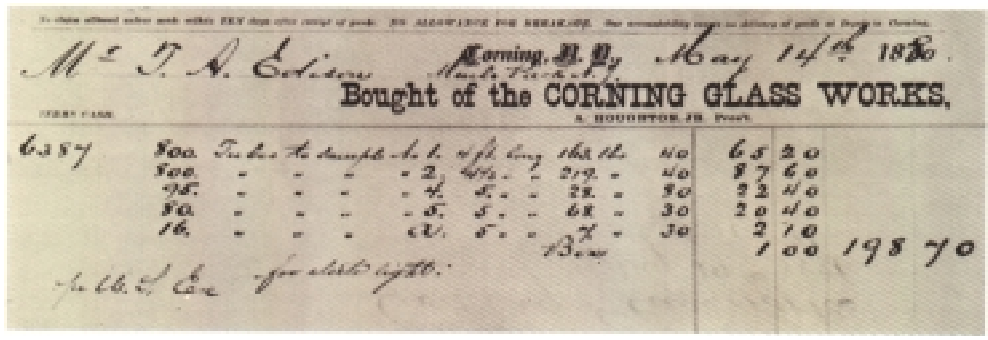
He was a man with an instinctive fascination for the inner workings of machinery. Although Woods had little formal education and no training whatsoever in the mechanical arts, his "open and independent mind," in the words of one Corning Glass historian, enabled him to see possibilities hidden to others of his trade.

It was a time for invention, one of those rare periods in human history when the activity of man's mind resulted in technological achievement that forever changed the face of the earth and man's outlook upon it.

One of these triumphs was the invention, in 1879 (the year of Will Woods' birth), of a successful incandescent electric light bulb by Thomas Alva Edison, the "Wizard of Menlo Park" whose keen intellect and driving spirit also produced the phonograph, the motion picture and countless other inventions and improvements.

'Let There Be Light Bulbs'

Aware of the company's dedication to science and engineering, Edison had chosen Corning Glass to manufacture the glass envelope for his first bulbs. The carbon filament that first glowed brightly in his New Jersey laboratories was enclosed by a bulb produced by Corning glassblowers to Edison's specifications.


NO ALLOWANCE FOR BREAKAGE.

Mr T. A. Edison Corning, N. Y. May 14th 1880

Bought of the CORNING GLASS WORKS,

A. HOUGHTON, JR. Pres't.

6387

65 20
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for electric light.

A CORNING INVOICE DATED 1880 SHOWS THE PURCHASE OF VARIOUS KINDS OF GLASS TUBING BY THOMAS EDISON "FOR ELECTRIC LIGHT."

That first bulb sparked a dream in the minds of many: a world where the sunset would no longer limit man's activities, a world where inexpensive electricity could illuminate even the darkest and most farflung of regions.

Electric light certainly was no myth, but in the years following Edison's invention, it proved more difficult to achieve than had been at first anticipated. Although its possibilities were immediately foreseen, production was difficult and expensive.

While filaments and bases could be manufactured, glass bulb envelopes could be made only by hand, or by mouth as it were, by glassblowers skilled in an ancient trade. These master craftsmen, called gaffers, learned their trade during a long apprenticeship and were few in number.

Working at top speed in the red-orange radiance of a glass-melting tank, a team of two men, gaffer and assistant, could produce two bulbs per minute in the glass works of the 1890s. It was clear that, at this speed, Edison's Age of Universal Light would be a long time dawning. To complicate matters further, the hand-blown bulbs were expensive by the standards of the time, so that, even if large enough quantities could be produced, they would be beyond the means of most people even in nations that were rapidly developing their industrial base.

Nevertheless, the concept of the electric light fired the imagination, and people embraced it eagerly. News of Edison's remarkable success spread over the globe with only slightly less speed than that of light itself.

## Towards Automation

Into this climate stepped young Will Woods, glassblower. In 1907, eight years after Woods had come to Corning Glass, the company began work on what was to become known as the "E" Machine, the world's first automated process for glass light bulb envelope production.

Automated, but hardly automatic, the Empire "E" Machine (Empire was a Corning Glass subsidiary founded to design and produce automated glass-making and finishing machinery) still required workers to "gather" the molten glass by hand for blowing into bulbs.

AT THE TURN OF THE CENTURY, A TEAM OF TWO MEN COULD PRODUCE THREE GLASS BULBS PER MINUTE.

By 1913, the "E" Machine was producing glass bulbs at the then- rapid rate of seven per minute. Corning installed numbers of these machines at its newly purchased plant in nearby Wellsboro, Pa. — where Will Woods had been transferred — and the race for automatic light bulb envelope production began in earnest.

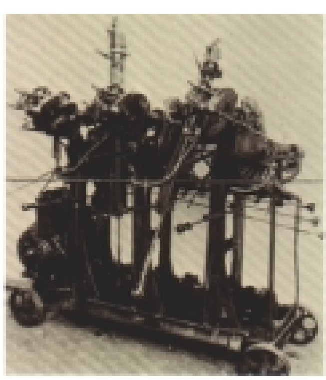
It had indeed become a race. In 1912, even before the "E" Machine began producing bulbs, Empire engineers had in 1912 begun work on its successor, appropriately named the "F" Machine. And even earlier, General Electric had begun work on its “Westlake” machine, which promised to eclipse the hard-working “E” types.

The “Westlake” and “F” machines were rotary-type machines, capable of producing 12, 24 or 48 bulb envelopes during each revolution. Glass was delivered to the machines as they operated, eliminating the cumbersome and time-consuming hand-gather system that slowed the operation of the “E” Machine to a relative crawl. Corning began installing the “F” Machines in its Wellsboro plant in 1923.

## A Shovel, A Gob And A Brainstorm

Will Woods was not idle during these years of machine development. First in Corning and then in Wellsboro, he actively studied the crafthe had chosen until he had become a master gaffer himself.

Greatly intrigued by the possibilities of electric light and the application of mechanical technology to the production of light bulbs, Woods had become instrumental to the success of the slow but effective “E” Machine at Wellsboro. rising to the post of production superintendent by 1917.

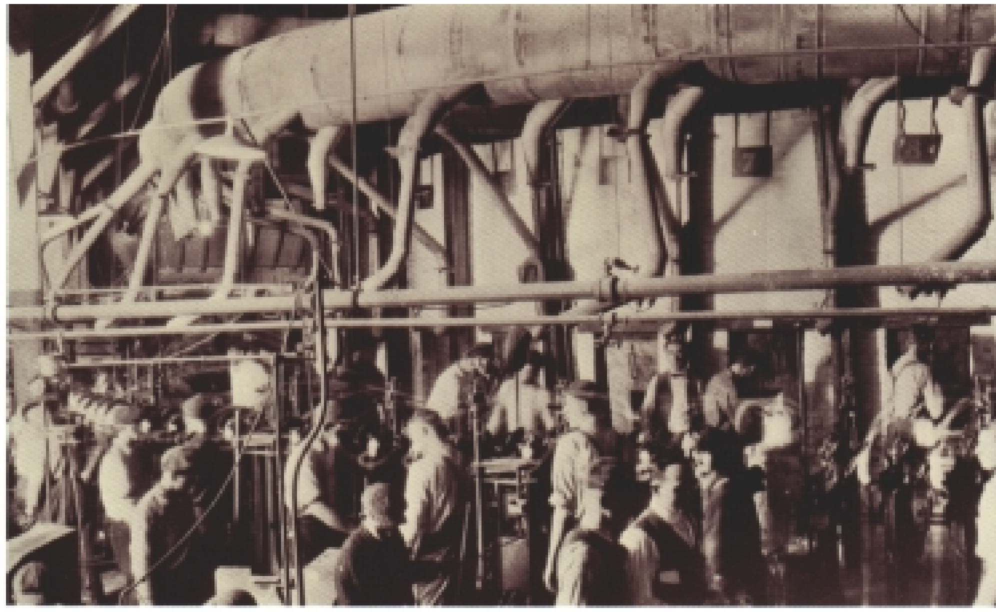


AN EARLY ATTEMPT AT AUTOMATING THE BULB-BLOWING PROCESS RESULTED IN THIS ODD-LOOKING MACHINE. THE AIR WAS STILL SUPPLIED BY LUNG POWER

Woods’s production efforts quickly became the stuff of legend. Corning Glass historian George Buell Hollister records that “With the help of a few bulb gatherers brought from the Corning plant he manned his battery of machines with boys from the neighboring farms, taught them to handle the equipment and in a surprisingly short time transformed them into a body of efficient workmen.”

Then, in the spring of 1921, Woods conceived the idea that would, if not bring him fame, at least secure him the enviable reputation of a man of mechanical genius.

Otto Hilbert, a companion of Woods, wrote in 1979 that Woods saw a shovel which had been used to collect glass. On that shovel was a still-molten gob of



THE "E" MACHINE WAS A DIRECT ANCESTOR OF THE RIBBON MACHINE. WILLIAM J WOODS APPEARS (IN BOW TIE) IN RIGHT CENTER BACKGROUND.

glass which looked like a light bulb blank.

Another account has it that the shovel had a hole in it, a hole through which the semi-molten glass had sagged in the shape of a bulb blank.

Whatever the truth, in the spring of 1921, Will Woods suddenly conceived the revolutionary idea of automatically blowing light bulb blanks through a hole in a metal plate.

It was a simple idea; simple, but elgant in its simplicity. Woods had gone to the heart of the matter, and his idea was to change radically the way in which bulb blanks were – and are – manufactured.

And like all ideas which promise radical change, it was greeted with skepticism on the part of Woods's fellow glassblowers, who preferred traditional methods of making bulb blanks to the newfangled machines that already were taking their places in the nation's glass plants. (In Europe, nearly all bulbs still were being blown by hand.)

Nevertheless, an undaunted Woods persevered with his conception and won the minds of Corning's engineering staff; the company authorized construction of a prototype – if indeed one could be constructed – to test Woods's theory.

That theory, basically, was this: If a gather of molten glass were flattened and then placed on a plate with a hole of the proper size, the glass might sag through the hole to form a globular bag. If air were then forced into this bag, it might be expanded to form the basic shape of a bulb blank. To perfect this shape, a mold could be closed around it and the air pressure continued.

Then carne the piece de resistance: If a series of such plates were hinged together to form an "endless chain" or belt, and a flat stream of molten glass were to be laid on the belt while in motion, perfect blanks might be made in continuous succession.

Historian Hollister continues: "With this basic idea in mind, Woods started to experiment with a single plate and a plunger or blowhead by which he could introduce air into the bag formed by the molten glass sagging through the hole or orifice in the plate, and after many attempts succeeded in forming bags which had all the earmarks of the beginnings of good bulb blanks . . .

"The full solution of the problem then resolved itself into the designing of a mechanism which would first form the desired blanks and, second, conduct them with properly maintained temperatures and predetermined speed through the elongating and blowing operations and, finally, to the finished bulb."

Will Woods had conceived the fabulous Ribbon Machine. The problem of building one remained.

## From Brainstorm To Bulb Blanks

The building known as Building 9 on Corning's Pine Street already was old when Will Woods moved in with his development crew of one person,

IN LATER YEARS, WOODS EN-
JOYED AN OFFICE – AND A
STRAW BOATER – OF HIS OWN.

David E. Gray. But Gray was no ordinary developer, just as Woods was no ordinary inventor.

Gray had been trained in mechanical engineering at the Massachusetts Institute of Technology. Experienced and competent, Gray was in 1922 Corning Glass Works' chief engineer and a man with a special interest in the development of machines to manufacture glass products.

It was Gray who, intrigued with Woods' idea for a bulb blank machine, had studied the possibilities and concluded such a machine was practical. Astonished at the results of his own study, Gray decided to produce the prototype and found the funds to proceed.

Woods and Gray didn't know they were working on the Ribbon Machine. On the origina1 books for the project, the machine was called, in code, the "399 Machine." Later, it became known, as if there were no other machine in the world, as "The Corning Machine."

Indeed, there was no other machine in the world like the one Woods and Gray were constructing in Building 9.

Woods's conception proved remarkably adaptable to design and construction, and the older machines had provided a wealth of experience that guided the Ribbon Machine's developers to a successful conclusion.

By 1925, it had become clear to Woods and Gray – and to others at Corning – that the Ribbon Machine had become a reality. By 1926 the ungainly creature began to produce bulb blanks, slowly at first, but with increasing rapidity. The derisive hoots which had greeted Woods's idea gave way to awe.

## The Ribbon Machine: A Runaway Success

As it emerged from its creative metamorphosis in the cocoon of Building 9, the first Ribbon Machine presented an awesome sight.
A glass melting tank sat above one end of the machine, feeding a stream of molten glass from its forehearth down between two metal drums, which flattened the glass into a thick, glowing ribbon. This yellow-orange ribbon was laid onto a series of square plates, each with a small hole in its center, which were linked together in the manner of a bicycle chain and driven by sprockets at either end of the oval.

As soon as the glass ribbon was laid on the chain, the glass began to sink through the holes, giving nascent form to the future bulb blanks. A chained series of moving plungers above the chain descended on the hot ribbon, pushing compressed air into the sagging glass. And a third chain, below and inside the first, thrust up a series of split molds which snapped together around the forming glass to give final shape to the bulb blanks before unsnapping just as quickly to revea1 the familiar light bulb configuration.

For each bulb blank, the entire forming operation lasted but a few seconds, resulting in what one observer termed “a veritable shower” of finished bulbs as the blanks were tapped off a fraction of a second apart.

The first production runs of the prototype Ribbon Machine were astonishing, especially to those used to the slower “E” and “F” machines. Actual records show runs of around 400,000 blanks in 24 hours, almost five times the output of the earlier machines.

## Bulbs For The Lamps Of The World

In the 1890s only 20 to 30 years before the advent of the Ribbon Machine, the slogan of American merchants seeking to participate in the Chinese market had been “Oil for the lamps of China.”

By 1926, when the first Ribbon Machines were installed in Corning’s Wellsboro plant, that slogan was irrevocably dated. The new machine would provide bulbs for the lamps of the world. And it was becoming more and more apparent that it wouldn’t take very many Ribbon Machines to provide those bulbs, either.

THE CORNING RIBBON MACHINE: DELIVERS FINISHED BULBS AT DIZZYING RATES UP TO 2000 PER MINITE.

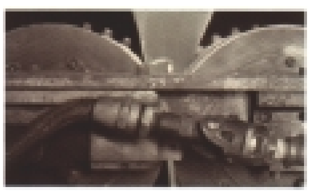
The Ribbon Machine was a marvel of efficiency. The astonishing figures of the early production runs were, by 1930, almost ancient history as the Ribbon Machine reached, and then surpassed, 1 million bulb blanks in 24 hours. This figure, in turn, receded as the Ribbon Machine was fine-tuned to its capacity of some 2,000 bulb blanks *per minute,* or nearly 3 million blanks in 24 hours, for smaller-sized bulbs.

With few mechanical changes, the Corning Ribbon Machine remains the highest state of the technology today, more than 50 years after its conception and construction in the old building, long since vanished, on Corning’s Pine Street. Fewer than 15 Ribbon Machines now supply the entire world’s consumption of glass blanks for incandescent light bulbs, with the exception of some small blanks that are hand-made for specialty lamps.

Ribbon Machines are flourishing in England, Belgium, Hungary, the Soviet Union, Japan and Iraq, providing inexpensive light bulb components for the light which now illuminates homes from the grandest of manors to the meanest of hovels.

## Ribbon Machines Today

Today, there are two different types of Ribbon Machine, the lower-volume Model 100 and the faster Model 400. Both have chain pitches of three inches and manufacture bulb envelopes in weights from eight to 45 grams, with maximum and minimum outer diameters of 67 and 19 millimeters respectively and maximum and minimum bulb lengths of 171.5 millimeters and 50 millimeters.



ROLLERS SQUEEZE HOT GLASS FROM MELTING 'IANK INTO THE CHARACTERISTIC "RIBBON" OF 'IHE CORNING RIBBON MACHINE.

HOT GLASS RIBBON SAGS 'IHROUGH HOLES IN PLATES BEFORE COMPRESSED AIR JETS COMPLETE THE BLOWING PROCESS.

Both machines have the ability to produce irregular shapes, and, by using a process known as the nonrotating-mold hot-iron process, both may manufacture nonsymmetrical shapes.

The 25foot-long Model 100 Ribbon Machine, operating at a standard speed of 275-300 pieces per minute (ED 60/A-type bulb blanks) can produce 100 million perfect bulb envelopes per year. Operating at a standard speed of 1000-1100 pieces per minute (ED 60/A blanks), the Model 400 can manufacture 400 million bulb envelopes per year.

These Ribbon Machines are little changed from the prototype model built by Woods and Gray. On the original, the holed plates were split, but on the modern versions, these plates are in one piece.

The single problem encountered by Woods and Gray – breakage of the blanks as they were separated from the plates – was solved before 1930 with a tap-off system that delivers a quick blow to the blank at the point where it joins the orifice plate, allowing a clean break with minimum breakage.

MOLDS CLOSE AROUND SAGGING GLASS TO GIVE FINAL FORM TO BULB BLANKS.

Today's Ribbon Machines manufacture not only light bulb blanks, but a wide variety of other glass components, including such seemingly divergent items as vacuum bottles and clock domes.

After 1930, it quickly was recognized that the Ribbon Machine would become the standard manufacturing technology for light bulb blanks. Corning retired its almost-new "F" Machines in favor of the quicker technology. General Electric did the same with its once-formidable "Westlake" machines, licensing the Ribbon Machine technology in its stead. By the decade's end, the Ribbon Machine had assumed its rightful place as the sole machine for production of incandescent light bulb blanks.

Even though Corning kept its "E" Machines in use into the 1940s for the production of items unrelated to lighting, an era that had begun with Edison had ended in the ultimate triumph of Will Woods and his marvelous machine.

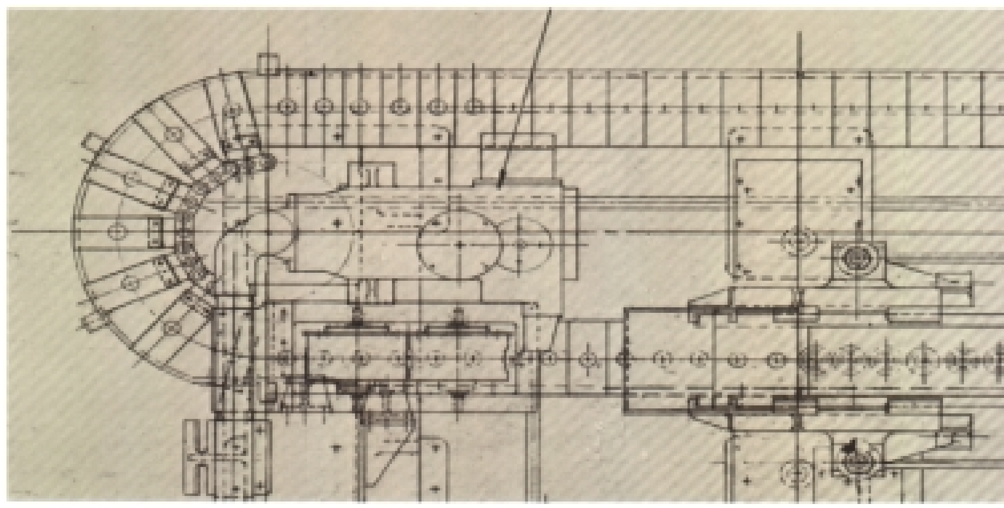
## Coda

Will Woods wasn't quite finished, however. Before his death on Christmas Eve, 1937, he also perfected what became known as the Woods Updraw Tubing Machine for the fully automatic production of thermometer tubing. But that's another story.

Corning Glass Works slowly is leaving the once-profitable business of manufacturing glass light bulb blanks. The famed specialty glass firm continues to license the Ribbon Machine technology worldwide, however, through its subsidiary company, Corning Engineering. And Corning has not forgotten its involvement with light – among its newer products are optical waveguides, hair-thin strands of glass that permit the long-distance transmittance of thousands of simultaneous telephone calls using pulsed light.

The company was proud to learn that the American Society of Mechanical Engineers had designated the Ribbon Machine as the tenth International Historic Mechanical Engineering Landmark, a ranking which places it on a scale with the first operational steam engine in considering mechanical devices that have changed the face of history.

Will Woods, the unassuming and unsung hero of the Age of Universal Light, would surely have been gratified.



SCHEMATIC RENDERING SHOWS AN ENGINEERING IMPROVEMENT. PLATES NOW MOVE ON CHAIN AROUND RIBBON MACHINE.

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