MAX LEVY AND COMPANY

PREFACE:

With the rise of photography in the 19th century, there arose the question of how to use photographs in publishing and printing. Photography had become useful and successful. Fine photographic prints were made on special paper made for that specific use. But printing photographs onto plain untreated white paper with black ink, such as that used in newspapers and magazines, was a problem. It was not possible then to translate the many continuous tones of a conventional photographic print onto plain untreated paper. How could this be changed?

Producing photographic prints from film (or plates) required using conventional photographic materials, that is, photosensitive paper onto which were exposed the many shades of black, gray, and white from the negative, which defined the picture. There was both contact printing, and enlargement and diminution by projection through a lens. Later, color printing was desired, and color film and suitable photo paper were used. However, for some time, mass printing on untreated white paper, as used in newspapers, was not able to render photographs.

In the late 19th century a large number of artists were able to make pictures using engravings on metal surfaces (mostly copper) by delicately incising an acid resistant coating on metal, using delicate tools and considerable skill. The metal plates were then etched in acid. The exposed copper, where scratched, was diminished by etching, but the untouched areas were not. After etching, the plate was cleaned, ink was spread on it, and it was printed. The resultant print had many grays which were rendered by the differing densities of the many varying black lines, heavy or light. Scribner's used that technique to a great success, and they employed many talented artists to create work used for illustrating books and magazines.

A signal event, not to be overlooked in the history of photo-engraving, occurred in Chalon-Sur-Saone, France. A man named Neipce (1765-1833) wanted to print a picture on paper. His approach was to take a copper plate, cover it with a thin film of bitumen, to which had been added something to make it photosensitive. Over that he placed a metallic mesh or screen, and over that was a negative of the Pope. He put it out in the sunlight on a roof for a week. After that exposure, he etched and cleaned the plate, and printed a recognizable image of the Pope using black ink and white paper. His work was later perfected by Louis Daguerre. A nephew of Niepce introduced the idea of albumen in photography, and produced photographic engravings on steel.

The above early steps were notable, and much later were extended to further improve the practicality of printing.

The major contribution of Max Levy and Co. was to be the first supplier of commercially available tools and materials that enabled mass printing of pictures, both color and black and white, on untreated paper. The products they developed were applicable to common printing in great quantities, and also to the finest quality of artistic printing, with detailed resolution, in black and white, and brilliant colors.

MAX LEVY AND LOUIS EDWARD LEVY

Max and Louis Edward were brothers. Both emigrated to the United States in the mid 19th Century. They were among many Jews escaping the prejudices of Europe, and seeking the opportunities of America.

Louis Edward studied at the University of Pennsylvania, I was told by his son, Lionel. Max was an architectural draftsman, who developed many interests. Louis Edward received a medal from the Franklin Institute in Philadelphia. In further development with his brother Max, he received a second medal from the Franklin Institute. He was also involved in a charitable organization called the Hebrew Immigrant Aid Society (HIAS). They assisted newcomers to find housing and a way to earn a living in the new World. One of the brothers was a member of the Board of Dropsie College.

Max was a mechanical genius. Louis Edward was a brilliant chemist. Both men had become knowledgeable about printing processes. Together, they founded and built a business called "Max Levy and Co., Inc." It was based on the singular developments of each, which became essential in producing both routine and fine printing of half-tone images for newspapers, magazines, and books.

Max designed the original building to house the brothers' new enterprise. It is (still) located in the Wayne Junction area of Philadelphia. Since Max was dealing with the mechanics of producing products with microscopic precision, he wanted a rigid building. He chose reinforced concrete with enormous beams under each floor. There was an old copy of the "Germantown Courier" in the Max Levy Co. office, which showed the testing of one of the beams. It passed.

(Enclosed is information taken from the "Web Site" of the present user of the building. The new company bought the assets of Max Levy and Co,. and have developed new techniques in many areas. Shown, is a view of the original Max Levy and Co. Building)

The fundamental concept which founded Max Levy and Co., was the idea that precise black and white printing, and fine color printing, could be done by taking the original picture, in continuous tones rendered by an artist, or by photography, and changing the image to a series of microscopic "dots". The dots were the carriers of the ink to the paper. The size of the dots were to be proportionate to specific areas in the original subject depending on color and intensity (brightness). The dots, in turn, could be thought of, as "wells" as a printing tool, holding ink used in a printing process. That kind of printing tool was made by photographing the original subject through a lens, and then through a "screen" just in front of a photo-sensitive film or plate....as did Niepce. The screen changed the continuous tones of the original print, into dots, whose sizes were commensurate with the intensity of light in any specific area. The dots composed the resultant image in the camera. The image on the film (with dots) was transferred to a printing plate, conveying dark and light by the size of the dots, which after etching became tiny wells, which, when filled with ink, made it possible to print continuously in color, or black and white, with all the proper tones in proper clarity, on untreated paper.

The challenge was how to produce a machine and techniques which produced the fine dots in the

printing? As described above, the "screen" in the camera produced the dots. But, how to make the screen was the major challenge. Together, Max and Louis Edward, solved it.

The Mechanics:

In the late 19th century, there was a lot of interest in measuring the various wavelengths of light. "Ruling Engines", were developed at MIT, Johns Hopkins, and the University of Chicago, to study the differing wavelengths of light. The studies of light depended on a significant "tool" of microscopically engraved grooves in a reflective surface, which broke up the visible light into its member wavelengths. They were called "diffraction gratings". They were made by "ruling engines" capable of extremely small, precise, linear, movements. Each movement when paused, allowed a diamond tool to incise a microscopic line into the substrate to form a reflective grating.

Max had to know all this. The scientific literature of that prior time was in the offices of Max Levy and Co. when the writer knew it, and studied it, in the 1950's. For Max, the challenge was to produce microscopic lines with extremely precise and equal spacing to make practical screens to convert continuous patterns in photographs into dots for printing. The accuracy was necessary, but the size of the machines was daunting; a screen used for commercial printing could be sizeable. 8" x 10" was the minimum production area. Larger screens had to be up to three or four feet in size, occasionally larger. The dots, in order not to intrude too much to annoy the viewer, had to be a few "thousands" of an inch in size, and very equally spaced to avoid seeing streaks or lines in the printing. Newspapers and "art books" had differing standards. In both cases, the size and quality of the final printing material required remarkable precision, but over larger working areas than those used to make diffraction gratings. Max and Louis Edward succeeded in producing fine rulings suitable for high quality printing processes in commercial quantities and size.

There were many mechanical hurdles to success in producing accurate screws of smooth and equal spacing of all turns in the ruling machines. The precisely even rotations of the screw were also paramount to the evenness of tones in the screens for printing without uneven intervals between the lines. The screws were lapped for even rotational accuracy. Max developed his own method for making the ratchet wheels which turned the screws. Each ratcheting "tooth" had to be equally spaced on the wheel to rotate the precision screws to a known degree of rotation. He took a conventional dividing head for milling machines, and used it to inscribe a pair of aluminum drums, nested together, approximately 15" in diameter. He used a very fine diamond in a fixed holder to inscribe lines on the outside edge of the drums, rotating them using a conventional set-up (diving head) for milling. When finished, he took the first pair of drums, and rotated one drum with the respect to the other to average the cyclical error. He repeated the rotate-and-scribe process cutting a second pair of drums on the other side of the same tool holding the first set of lines. He used a microscope to see the lines of the first pair, and "split" the discrepancies to establish a more accurate second pair. He then rotated the second pair with respect to each other, to make the final tool. The bronze ratchet wheels were machined using the average of the paired lines on the second tool under microscopic observation. The very precise and large ratchet wheels were made of bronze and rang as beautifully as a set of bells.

Max also decided that the screen business was to be based on the number 1200, which was the common multiple of 1, 2, 3, and 5, and obviously, multiples such as 4, 6, etc. All photoengraving

screens were described in lines/inch deriving from that standard, e.g. ....60, 80, 100, 120, 133 (actually 133-1/3), 150, etc. That also was easily converted to the whole number of teeth used in each rotation of the ratchet wheel turning the screw of the ruling engine. The multiple of the pitch of the screw and the teeth on the ratchet wheel was always 1200.

The Chemistry

The glass screens had to be etched in hydrofluoric acid to permanently engrave the lines. The lines were to be filled in with black pigment. The spaces between the lines had to be clear; the lines of coating to remain in situ to resist the hydrofluoric acid during etching. After etching, filling, and inspection, two such ruled and etched glass plates were turned 90 degrees to each other, and sealed, to make a screen. It was essentially a glass plate with crossed lines of black with clear windows in between, with an extraordinary evenness of tone.

The coating on the glass was to be ruled by a fine chisel-like diamond tool, which cut through the coating, down to the glass, making a clear, clean line ready for etching. When cutting the line, the coating had to have the necessary mechanical properties to have a sharp clean edge when viewed at high magnification. The challenge was also to create a coating to have the required chemical resistance, as well as the required mechanical character, easy to cut, and sticking to the glass. Louis Edward solved the problems of the coating, which he developed, using available materials, and a great deal of wisdom. He knew that the particles of photosensitive materials used in photography (silver halides) were among the smallest available. Therefore, he borrowed from photographic materials to include and form fine particles. He knew that the coating had to have a strong adhesion to the glass. He used an ancient formula for adhesion....egg whites... as used in frescoes on plaster in the Middle Ages. And, the coating between the lines had to perform its task of resistance to the bath of hydrofluoric acid.

Other matters

Diamonds were the tools used to rule off the coating. Gaining a clean edge at high magnification, required experience and skills to grind diamond tools, which under 100 -150x magnification showed no chips or defects. Each step in ruling had to preserve, in the final product, an equal spacing of line and space, each of correct width, as determined by the lines/inch requirement. For grinding diamonds a bench-tool was used, such as those made and used by famous jewel house of DeBeers in Holland. Each diamond had to be ground to a proper sharpness and size. That task was divided among 3 people. The writer was one.

The last new ruling engine was completed in the late 1950's by the writer. It was capable of ruling 200 lines/inch over an area almost 6 feet square. The base and lead-screw were found in another building adjacent to the Max Levy Company. The upper parts were missing. After testing, we found that over many years the lead-screw had "sagged" by a few thousands of an inch, due to persistent gravity. It was enough to adversely affect the ruling accuracy. We had the original "lapping" nut. We put the screw on a very large and long lathe, and lapped the screw with fine pumice and oil for weeks. It maintained its sag. New thought was needed. A motor plus an added "universal" coupling, were mounted in the ceiling, from which we hung the now vertical screw. Absent the force of gravity working against us, we produced a screw 4 - 5 inches in

diameter, and approximately 6+ feet long, with an overall accuracy of a few thousands of an inch, but with no non-linear changes over its length. The absolute accuracy was corrected by an additional mechanism mounted in the machine, as long used by Max.

Photo-engraving screens were ruled on one piece of coated glass in one direction on ruling engines. Two of the same overall size, and exact line size, comprised the halves of the final product. The processing of each half was: coating, ruling, etching, and removing the acid-resistant coating. The etched lines were then filled with black mastic. There ensued a long and tedious inspection for almost microscopic imperfections. If both halves were satisfactory, they were sealed with heated Balsam, the lines crisscrossing, then the screen was cut to final size, polished, and mounted in an aluminum frame.

Screens for color printing were different. Color printing was a multi-step process, required to make the final accurate rendering of a color by mixing a selected lot of colored inks in the printing. Therefore, the screen was rotated in the making of the final renditions, between color changes, so that the dots would not all fall on top of each other, and destroy the color and pictorial quality. The dots were so small as to be unseen and not disturbing to the viewer. After sealing the two halves together, the screens for color printing were cut into a circular form, and mounted in an aluminum frame, where rotation of the screen allowed making separate color renditions with precise placement of each for clarity, and for clean colors.

Photo-Engraving screens could be as large as 60 inches x 40 inches, and range from 60 lines/inch to 150 lines /inch. Screens for color printing were made up to 60 inches in diameter, and were a major product.

Further developments

Max Levy & Company was often asked by various individuals and companies for "special" rulings. As an example, we made linear scales for a company making early digital controls for machine tools. The rulings composed a ½" wide strip, 40 inches long, on a long rectangle of glass. One was 1000 lines/inch, another was 500 lines/inch. The lines were 0.0005" wide and .001" wide respectively.

We made many rulings for RCA, and other American television manufacturers, and the major Japanese manufacturers of electronics. They were squares of ruled area, each 2" - 2-1/2" square, with 500 and 1000 lines per inch. They were etched in a special acid mix which did not produce any deposits in the lines, only a clean "groove". They were used to make screens to diminish secondary emissions in television cameras and picture tubes.
We made rulings for Western Electric, who told us they were for making transistors. The writer thought that was fascinating, but had to ask what a transistor was, and what was its purpose.

We often made custom grids on glass for accurate optical measurement and alignment over sizes such as 12 - 15 inches, sometimes larger, with lines occasionally .001" wide. When asked why they were so expensive, the answer was that their absolute precision was extraordinary, and they were difficult to make. When asked for the price of a less precise instrument, we always informed the

buyer that we could not lessen the accuracy of our machines for a single customer. That would increase the cost, requiring additional calibration, not decrease the cost.

RCA asked the Max Levy Company for a camera to be used in the making of images used in fabricating semiconductors. The writer was running a division of Max Levy & Co., which made photo-engraving cameras. They knew that our knowledge of large camera systems, and fine mechanics, would be useful and applicable to making images used to make semiconductors larger than the then existing camera(s) on the market were capable of, and to a required microscopic accuracy of reproduction. It was to be used for making the first reduction of master images of micro-electronic circuitry. We designed and delivered a camera of a size and precision greater than the cameras then available.

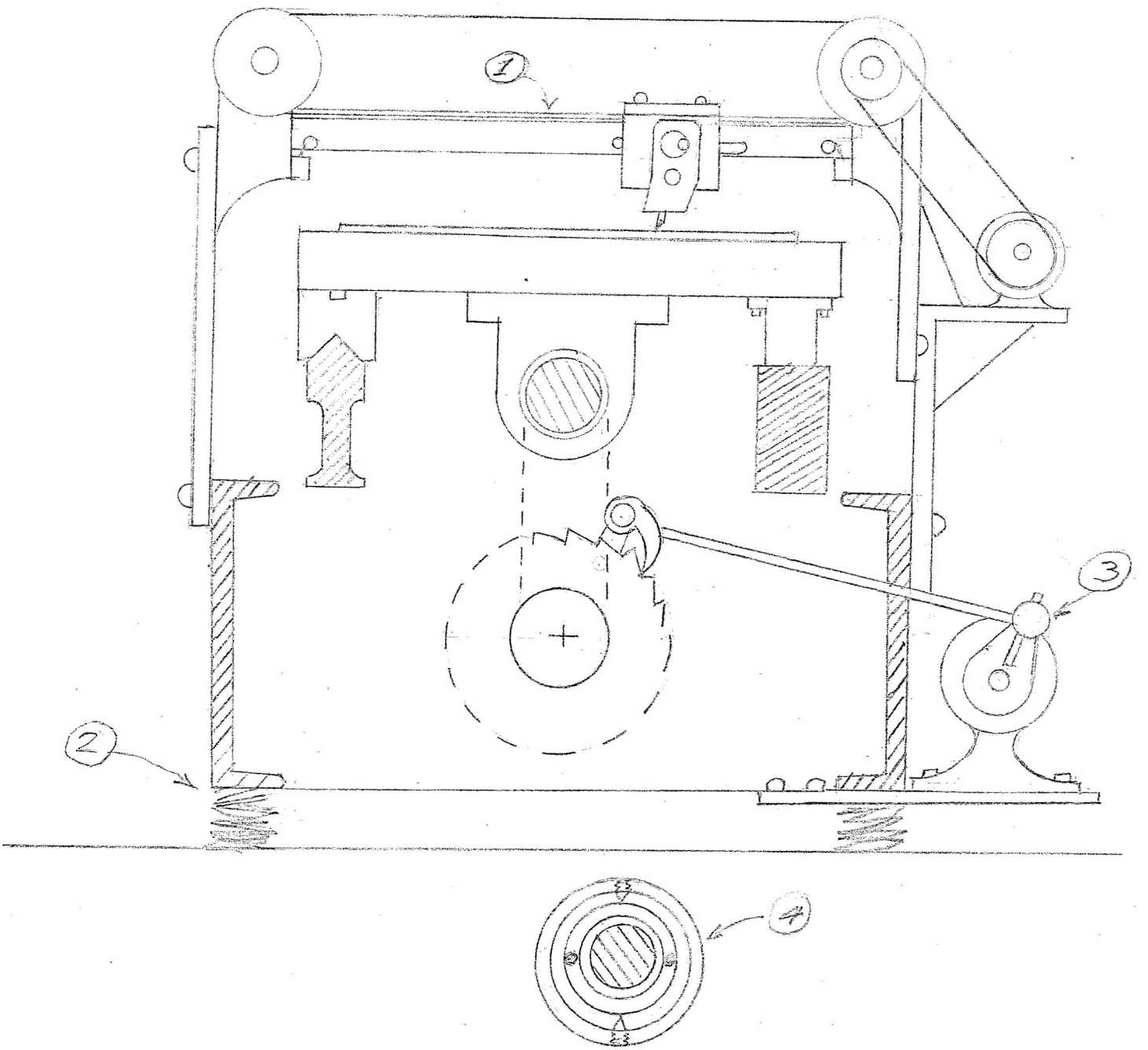
Howard and Lionel Levy, the sons of Louis Edward Levy, took over as co-owners of the Max Levy Company in the early 1920's. Howard Levy, was the older brother....always "the boss". He was a benevolent tyrant, penurious in the office, but very generous out of the office. A Russian agent showed up one day, to order some photo-engraving screens. He asked Howard "How do I know that the screens are 120 lines per inch? (Typical Russian...suspicious) Howard, in his usual fashion said, "Because I tell you they are, brother." The Russian persisted. Howard took him upstairs to the ruling room. Although he stood in the doorway, blocking entry, the Russian could see over him, and see the ruling machines tirelessly ticking away. He was apparently convinced.

Howard lived in Bucks County on a large property, and cultivated unusual and rare plants. He had an extensive collection of Hebrew books going back centuries, which he had inherited from his father. He died suddenly of a heart attack when recuperating from a fall. The time was approximately 1960. His younger brother, Lionel, was a brilliant engineer, a charming, sweet tempered, and cultivated man of many interests and high intellect, but at work, always the scientist, not "the boss" to run the business. Lionel lived in a splendid house in a Philadelphia suburb, where he painted, read, and enjoyed life, in the midst of a busy, resourceful family. He lived into his early to mid-nineties. His son-in-law had taken over running Max Levy and Co. Prior to that, the writer was conveyed the rights to the camera made for RCA, and assumed all responsibility for its maintenance. He gave some stock in Max Levy, previously received, as a gift to Lionel's son-in-law. He started his own business, and further developed cameras for many semiconductor manufacturers, worldwide, and made an extended line of equipment for the Semiconductor Industry, ultimately selling the business to a conglomerate.

Max Levy & Company was sold to an Italian company which made photo-engraving screens. Lionel's son-in-law continued to run the U.S. subsidiary company.

Later, the present occupant of the Max Levy building bought the assets from the Levy family. They have shown notable talents developing a new and exceptional small business.

Enclosed: a drawing of a typical ruling machine used to produce the photo-engraving screens.



Items of interest:

1. The "bridge" (item 1) runs across the ruling engine, and has a tape driven drive which propels the diamond cutter across the plate being ruled, in a straight line. It is driven on the cross set of ways. The table moves as the screw is turned. When the table is still after motion, the diamond is dropped, the carriage is pulled along the upper set of ways and the line is scribed. The return motion raises the diamond cutter and returns motion to the table, in that the two motion systems are interwoven.

2. The base of the machine is a massive cage of structural steel. The whole assembly sits on 4 heavy springs which absorb vibrations.

3. The number of lines/inch is adjusted by the position and length, of the arm which operates the pawl, which moves the table by turning the ratchet wheel, which turns the screw. Choices commonly vary from 50 lines per inch to 150 lines/inch, and more. The pawl mechanism is shown detached from the screw in the drawing.

4. The motion of the screw is transmitted to the table through a pair of gimbals which assure the motion is totally linear, absent of forces other than directly forward. The surfaces touching the table, and gimbals, are respectively, brass against polished diamonds.

LEVY, LOUIS EDWARD:

By : Cyrus Adler

American photochemist; born at Stenowitz, Bohemia, Oct. 12, 1846. He went to America in early life, and was educated at Detroit; he studied especially mathematics and astronomy at Michigan University in 1866, and optics at Detroit. He was connected with the meteorological observatory of the United States Lake Survey District in 1866, and engaged in researches in microscopic photography during 1869 and 1870. This led to his invention of a method of photochemical engraving, the "Levytype," which was patented in 1875. He established a company in Baltimore, but removed to Philadelphia in 1877, in which year he invented the "Levy line-screen," which was perfected by his brother Max. For this he received the John Scott Legacy medal at the Franklin Institute in 1897. He invented a new process of intaglio engraving, the "photo-mezzotint," in 1889. In 1896 he invented a new method of etching, the "Levy acid blast," for which he received the Elliott Cresson gold medal at the Franklin Institute in 1899. He was awarded a medal and diploma at the World's Columbian Exposition in 1893, and decorations and diplomas from the Imperial Photographic Society of Moscow and at the recent Paris Exposition.

From 1887 to 1890 Levy was publisher and editor of the Philadelphia "Evening Herald," and at the same time of the "Mercury," a Philadelphia Sunday paper. In 1896 he edited and published "Cuba and the Cubans." He is the author of "The Russian Jewish Refugees in America" (1895), an English version of Cabrera's "Cuba y sus Jueces," and "Business, Money, and Credit" (1896), a brochure on the relations of exchange to the medium of exchange. He has contributed to many technical journals, and represented the Franklin Institute

at the Scientific Congress of the Paris Exposition. In Jewish matters he is associated with many communal organizations, and he was editor, author, and publisher of "The Jewish Year" (1895) and of other publications.

Bibliography: *Who's Who in America.*