Chapter XXII

Glass Corneo-scleral Shells in the United States of America (1928-1940)

Introduction

Until the mid nineteen-twenties, American ophthalmic practitioners seemed to be unaware of the optic and therapeutic role of contact lenses. This was the situation with a publication in 1925 by *Virgil Westcott* on the treatment of conical cornea. The ophthalmic community made only a passing and erroneous mention of contact lens treatment, preferring management by surgery or choosing the very problematical treatment of keratoconus by glasses. In fact, the first publications of use of contact lenses on the American continent appeared when the *Zeiss* Company had just installed an active network of agencies and branch offices. [1]

1 - The First Publications (1928-1929)

1.1 - The First Ground Contact Shells of Zeiss

1.1.1 - Donald O'Rourke (1928)

Date	Author	Title
Oct. 15, 1928	D. O'Rourke	The Optical Correction of Conical Cornea with the Contact Glass
Oct. 22, 1928	R.v.d. Heydt	Demonstration of Contact Glass for Keratoconus
Nov. 20, 1928	G.S. Derby	Use of Contact Glass in cases of Keratoconus
Jan. 15, 1929	G.S. Derby	Contact Glass in Keratoconus
Apr. 15,1929	D. Katz	Contact Glass in Keratoconus

Table 22–1
The first communications and publications in the United States of America on Zeiss ground contact lenses for the correction of keratoconus (1928-1929).

Interest in contact lenses really started in the United States in October 1928, when *Donald O'Rourke*, a Denver ophthalmologist, made a presentation in which he described the successful fitting of a patient suffering from keratoconus. The publication included a historical synopsis of the period from *Fick* to *Dohme*. Unfortunately, this text had many errors, which have been widely disseminated since that time. The difficulties that both the author and his patients experienced while inserting the contact shells seemed to him to be the most important hurdle preventing their more widespread use. To remedy this problem, he proposed a hydraulic device of his own invention that would permit patients quickly to insert contact lenses without the interposition of air bubbles [(2)]:

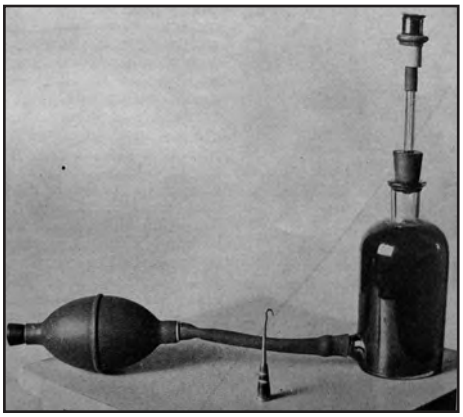
"*To the outflow neck of a small wash bottle is attached an ordinary hand bulb. The wash bottle is filled with water up to the lower margin of the neck, thus leaving a small air space. A piece of glass tubing six inches long and of small diameter is fitted at one end with a rubber cork. The opposite end is fitted with a piece of rubber gas tube an inch and a half long and fifteen millimeters in diameter. The free end of this tube is cupped out so that it may receive the convex surface of the contact glass, and over the free end of the tube is stretched a gun-rubber finger cot. A small pinpoint perforation is made in the finger cot at its center. The rubber cork is inserted into the bottle.*
Application of pressure on the bulb forces air through the pinhole in the finger cot. The shell is now moistened and placed in contact with the cot, and release of pressure on the bulb causes the shell to be held firmly in position by air pressure. The concavity of the glass is filled with normal salt solution. The patient retracts his lids as shown in fig 2 and places his eye directly over the center of the shell, the sclera in contact with the flange. He then permits the retracted lids to slip over the margin of the glass. Pressure is now applied to the finger cot and bulb, and the contact glass is released from the apparatus and remains in place on the eyeball."

O'Rourke ended his presentation with the clinical observation of a patient with keratoconus to whose eye he had fit a ground *Zeiss* shell with a corneal portion of 7.10 mm radius of curvature. The patient wore this every day and it allowed him to pursue his higher studies. The attached bibliography includes fifteen references to the German literature. According to the author, there were no American priorities and his publication was therefore the first on the continent.

1.1.2 - Robert von der Heyd (1928)

Several days after this publication, the ophthalmologist *Robert von der Heyd* (Chicago) demonstrated contact shells for keratoconus and presented their use in a patient with this condition. He had invented a gauge to measure the arrow of the cornea in order to simplify fitting [(3)]:
"*Dr. von der Heyd had devised and now demonstrated a simple small silver gauge on the order of a tonometer to measure the height of the cone. The necessity of trying all four of the trial contact lenses was thus avoided*."

For insertion and removal, he recommended *O'Rourke*'s device. We learn that the ophthalmologist *Blaauw* (Buffalo) had already been fitting contact lenses since 1925. In the course of the previous two years *von der Heyd* had fit six patients with keratoconus and significant visual improvements had occurred as a result.



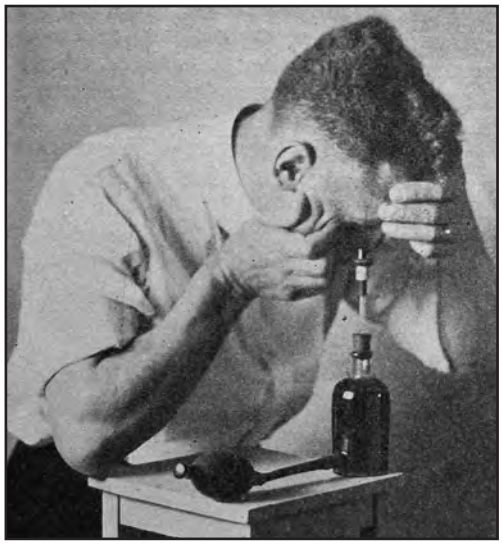


Figure 22-1
O'Rourke's apparatus for applying contact glass to the eyeball (1928).
At the time of the first presentation in the United States of America of the Zeiss contact shells, on the 15th October 1928, Donald O'Rourke, ophthalmologist in Denver, presented a new hydraulic apparatus for the insertion of contact glasses into the eye without the interposition of air bubbles. (O'Rourke D.H., 1929)

1.1.3 - George Strong Derby (1928)

In the following month, the ophthalmologist, *George Strong Derby* (Boston), presented his observations of two fittings of contact glasses for keratoconus that permitted good visual acuity thanks to the adjunct of spectacles with spherical lenses [4]:

"*Dr. George S. Derby called to the attention of members the possibility of using contact glasses in keratoconus. The first patient shown had had a cauterization of the apex of the cone in the right eye in 1913. With a -12.00 cylinder she was able to read the 6/20 line with difficulty. With the contact glass alone she read 6/12 easily. Her left eye, using a -15.00 cylinder, read 5/60. With a contact glass combined with a +1.00 sphere, she was able to read three letters of the 6/9 line.*
The second patient, also a schoolteacher, had a right eye, which had been useless for years. In 1928, with the left eye and the appropriate correcting glass, she was able to see 6/9. The vision had sunk to 6/6, so that she was greatly handicapped in doing her work. In the right eye, with a contact glass and a +4.00 sphere, the vision improved to 6/12-. In the left eye with a contact glass combined with a -3.00 sphere, the vision equaled 6/9. It was believed that each of these cases would be able to wear the contact glass, which was to be ordered for her."

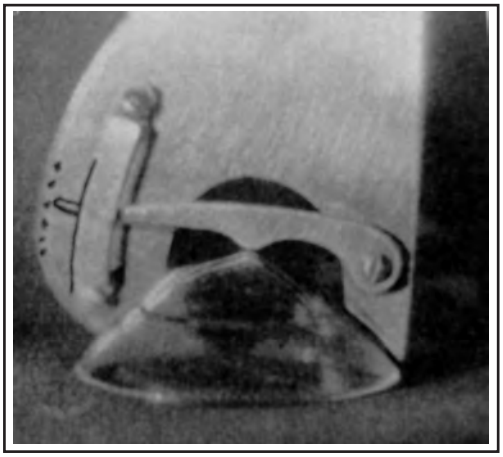


Figure 22-2
Robert von der Heydt's contact lens gauge (1928).
On the 28th October 1928, ophthalmologist Robert von der Heydt reported that he had constructed a silver gauge for measuring the height of the arrow between the cornea and the optical portion of the contact shell. This gauge facilitated the choice of Zeiss contact shells that he had fit in six patients with keratoconus. It should be noted that von der Heydt possessed a certain facility for mechanical activities, as he was the son of a Chicago clockmaker with whom he had done his apprenticeship before he commenced his medicine studies.
(Heydt R.vd., 1929)

Derby was to return several months later with a comment on the first case [5]. Now that the patient possessed her final contact glasses, she saw decidedly better, but suffered difficulties in handling them. Before inserting them, she instilled 0.5% holocaine and she did not succeed in removing them without difficulty:

"*Dr. Derby was trying to discover which of the four kinds of contact glass at his disposal was the best for the patient. Best vision was obtained with a -12.00 cylinder: a rather strong cylinder to wear. The only difficulty seemed to be in taking the glass out. She still had to use one half per cent solution of Holocaine before inserting it.*"

It was also reported that, in 1928, *Lewis P. Cooper*, an optometrist in Norfolk, VA had made a demonstration of *Zeiss* contact shells that his brother had brought back from Jena. After that, he was to keep in contact with *Victor Koch*, *Zeiss* correspondent in the USA, who, in the May of the following year, would make a presentation describing contact shells to the optometrists. [6]

1.1.4 - Dewey Katz (1929)

In April 1929, the ophthalmologist *Dewey Katz* (Chicago) presented his observations on a railroad employee with bilateral keratoconus who had been successfully fit with and wore contact lenses eight hours a day continuously and was able to go back to work [7]:

Date	*Author*	*Title*
Dec. 15, 1930	O. Sitchevska W.White	A case of Keratoconus with Müller's Contact Lenses - Discussion
Oct. 16, 1931	O. Sitchevska	Contact Glasses in Keratoconus and in Ametropia
Mar. 1932	N. Blatt	The Correction of High Myopia by Müller's Contact Glasses
Nov. 21, 1932	L.H. Hardy, C.E. MacDannald W.S. Knighton O. Sitchevska	The Technic of Fitting Contact Glasses Discussion Discussion

Table 22–2
The first communications and publications in the United States of America on blown contact lenses for the correction of keratoconus (1930-1932).

"*Dr. Dewey Katz presented a man thirty-three years of age, who had come to Billings Memorial Hospital clinic about one month ago with complaint of gradually blurring vision over a period of five years. (...) Examination revealed bilateral keratoconus. Vision R.E. 6/200; L.E. 3/200. R.E. -4.50 cyl. axis 90°=0.3-1. L.E. -3.75 cyl. axis 90°=0.1. With contact glass and -3.00 sph, vision in R.E. = 0.82; L.E. with contact glass = 1.0-3. The patient was an elevated railway guard, and had been using the Zeiss contact glass in the left eye for eight hours daily, with only slight irritation at the end of that period. He was able to insert glass without aid by keeping his head under water.*"

Figure 22-4
Presentation of blown Müller's contact shells by O. Sitchevska (1931).
In a communication on the 16th October 1931, Olga Sitchevska, ophthalmologist in New York, presented the differences between the contact shells of Zeiss and those of Müller-Wiesbaden. She reported the fitting of seven patients with high myopia or keratoconus with blown corneo-scleral shells of Müller Brothers of Wiesbaden.
(Sitchevska O., 1932).

1.2 - The First Blown Corneo-scleral Shells

The communications of the authors from Denver, Chicago and Boston concerned the fitting of ground corneo-scleral contact lenses for keratoconus imported by *Zeiss*. Other authors of the same era used blown glass lenses, either those of *Müller-Wiesbaden*, imported from Germany, or those locally produced by glass blowers making ocular prostheses, of which the most active was the ocularist *Danz* in New York.

1.2.1 - Olga Sitchevska and James Watson White (1931)

The first American communication on the fitting of blown contact shells was by the ophthalmologist *Olga Sitchevska* (New York City). A patient with keratoconus had been referred to her for follow-up in 1930. This patient had been fit previously by *Wilhelm von Clausen* at the ophthalmology Clinic in Halle with blown contact glasses made by *Müller Brothers* (Wiesbaden) [8]:

"*The patient was taken to Professor Clausen's clinic at Halle, Germany. There, of approximately 100 Müller's contact glasses, the patient chose three pairs, which he could wear comfortably. He also tried the Zeiss contact glasses, but could not wear them. The vision of the right eye with the Müller glass is 20/20; that of the left eye 20/30, without any other correction. He has worn them for one year and three months, from eight to ten hours daily. Occasionally, the eyes became irritated. For that reason, he wore one glass at a time, allowing the almost constant use of the eye.*"

Sitchevska thought that the blown glass contact shells of *Müller* were well tolerated:

"*The Müller glass allows free passage of the lacrymal fluid into the space between the glass and the cornea. When mercurochrome-220 was instilled into the patient's eye with the glass on, it fills the space and disappears within a few minutes.*"

In the course of the discussion, *James Watson White* announced that he too had obtained blown contact shells in New York [(9)]:

"*An artist with keratoconus was able to get a visual acuity of 20/20 in one eye with a blown contact glass, which he obtained in New York. He was able to wear it comfortably for six hours.*"

In fact, every skilled glass-eye maker considered that he was capable of blowing contact shells derived from ocular prostheses with transparent optical zones. *Sitchevska*, however, thought that the original *Müller-Brothers* contact shells were better tolerated:

"*There is a firm in New York City that makes blown glasses similar to the Müller glasses, but this patient could not wear them. The representatives of the firm said that Müller Brothers of Wiesbaden Germany use a certain crystal for the contact glasses that no one else can obtain.*"

Sitchevska completed this communication several months later, with a more detailed publication. After an historical survey, she described the *Müller* contact glasses and those of *Zeiss*. There followed a review of the literature comparing *Müller* contact shells with those of *Zeiss*. She used ample citations from the recent publications of *Heine* and *Hartinger*. [(10)]
Sitchevska then presented the history of the previously presented case in greater detail. In the course of the year 1931, she had fit six other patients with keratoconus and high myopia and had documented their histories. All of them tried ground *Zeiss* glasses, but were fit with blown *Müller* shells, the latter being distinctly more comfortable, though they gave inferior vision. The exception was one female patient who, in spite of trying for three months, could not tolerate any kind of contact glass. *Sitchevska* found that the use of fluorescein, as recommended by *Gradle* and *Heydt*, was not essential and that examination with the loupe was sufficient for the appreciation of contact between the eyeball and the scleral part of the contact glass. For insertion and removal, she recommended a simple method that did not require instruments:

"*The fitting of the glass is simple. My patients learned to insert and remove it on the first visit, without any devices and without having the cornea anesthetized. The glass, with the concave surface up, is filled with warm normal saline solution and is held between the thumb and index finger. The patient looks down as much as possible (in order not to hurt the cornea), lifts the upper lid with his other hand and inserts the upper edge; then he pulls the lower lid downwards, looks up, and inserts the lower edge. The removal of the glass is more difficult for some patients. The patient looks up, and then with his fingernail, he lifts the lower edge of the glass and pushes it out with the motion of the eyeball. A glass or ivory spatula is useful for its removal.*"

Sitchevska also considered a therapeutic effect:

"*The therapeutic effect of the contact glass is well demonstrated on one patient who has been wearing the Müller glass on the left eye for several hours daily for the past two and a half years. The opacity of the apex of that eye has diminished in density, and its vision improved from 20/30 to 20/20.*"

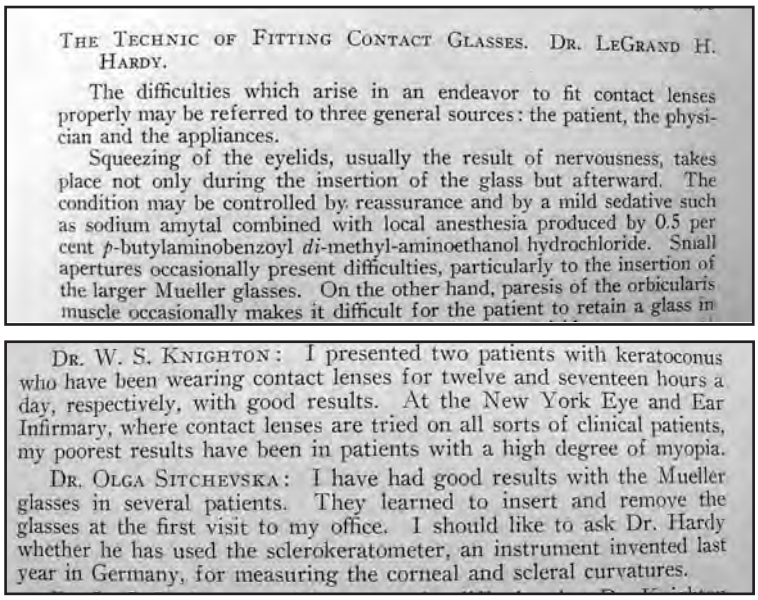
She concluded:

"*At present, contact glasses are the best means of treating those unfortunate victims afflicted with conical cornea at the prime of life. Surgical interference should be undertaken only as a last resort. All the disadvantages in selecting and wearing these glasses can be disregarded when one considers their incalculable physiological and psychological value.*"

The article ends with 34 bibliographical references.

1.2.2 - Legrand H. Hardy, Clyde E. McDannald and W.S. Knighton (1932)

On November 21st 1932, the ophthalmologist *Legrand H. Hardy* presented a communication concerning the technique of fitting contact glasses. He described the blown contact shells of *Müller*, but it is not clear if he had had any experience of fitting these because he cited only lengthy extracts from *Zeiss* documents



THE TECHNIC OF FITTING CONTACT GLASSES. DR. LEGRAND H. HARDY.

The difficulties which arise in an endeavor to fit contact lenses properly may be referred to three general sources: the patient, the physician and the appliances.

Squeezing of the eyelids, usually the result of nervousness, takes place not only during the insertion of the glass but afterward. The condition may be controlled by reassurance and by a mild sedative such as sodium amytal combined with local anesthesia produced by 0.5 per cent *p*-butylaminobenzoyl *di*-methyl-aminoethanol hydrochloride. Small apertures occasionally present difficulties, particularly to the insertion of the larger Mueller glasses. On the other hand, paresis of the orbicularis muscle occasionally makes it difficult for the patient to retain a glass in

DR. W. S. KNIGHTON: I presented two patients with keratoconus who have been wearing contact lenses for twelve and seventeen hours a day, respectively, with good results. At the New York Eye and Ear Infirmary, where contact lenses are tried on all sorts of clinical patients, my poorest results have been in patients with a high degree of myopia.

DR. OLGA SITCHEVSKA: I have had good results with the Mueller glasses in several patients. They learned to insert and remove the glasses at the first visit to my office. I should like to ask Dr. Hardy whether he has used the sclerokeratometer, an instrument invented last year in Germany, for measuring the corneal and scleral curvatures.

Figure 22-5
Communications and discussions in 1932 on blown contact shells.
Extracts from the communication in New York by L.H. Hardy on blown corneo-scleral shells, followed by discussions on the same subjects by W.S. Knighton and O. Sitchevska. (Hardy LGH., 1933).

and recommended the graphics supplied by *Zeiss-Hartinger* for making the optical correction.
During the discussion, *Clyde E. McDannald* and *W.S. Knighton* described the fitting of patients with keratoconus, the first with one case, and the second with two cases fit at the New York Eye and Ear Infirmary. They do not, however, describe the type of contact glass used. In the same discussion, *Sitchevska* reported good results that she had observed by fitting contact glasses in keratoconus patients using blown *Müller* contact shells:

"*I have had good results with the Mueller glasses in several patients. They learned to insert and remove the glasses at the first visit to my office*." (11)

1.2.3 - Blatt's translation (1932)

In order to complete the publications on blown contact shells of this time, we cite also the publication in America of the article written by the Rumanian ophthalmologist *Nicholas Blatt* describing the correction of 38 high myopes with blown *Müller-Brothers* contact shells. After a historical survey, he describes his clinical observations and the results of his fittings, namely that nearly all of his patients had obtained an improvement in visual acuity when the condition of the retina permitted. Only two of his patients wore the lenses for more than six months. Contact glasses are useful for the diagnosis and evaluation of the potential visual capacity of the retina. The text is relatively ambiguous, in so far as it is based on the fit of blown *Müller* contact shells, whereas lengthy extracts relative to *Zeiss* ground shells are quoted. (12)

Soon afterwards, several artificial eye manufacturers were involved in the manufacture of blown contact shells, following the model of ocular prostheses with a transparent optical zone:

"*Practically all of the artificial eye manufacturers in the United States make Müller type contact lenses today. While they are tedious and difficult to fit, they are generally more comfortable to wear than the spherically ground type. Their optical qualities, however, are inferior*." (13)

The most commonly cited are *Kohler and Danz*, in New York:

"*In the same year [1935], Kohler and Danz, artificial-eyemakers of New York, made blown lenses with ground optical portions. Both had translucent scleral portions, as had the F.E. Müller lens.*" (14)

2. The Contact Shells of Zeiss-Heine (1930-1933)

Whereas interest in contact glasses increased in the United States in the course of the years 1930 and 1931, *Zeiss* was meantime importing contact glasses via its branch offices in New York and Los Angeles. Very quickly, the first trial sets containing only four keratoconus contact glasses, as used by *O'Rourke*, *Heydt*, *Derby* and *Katz*, were replaced by larger sets of contact shells as recommended by *Heine*. These were intended to correct all refractive errors. The local production of contact glasses and the American market were locked out by the numerous patents registered by *Zeiss*. (15)

2.1 - Robert von der Heydt and Harry Gradle (1930-1932)

In 1930, ophthalmologists *Robert von der Heydt* and *Harry Gradle* of Chicago had published a new analysis on contact glasses. This took recent European publications into consideration, particularly that of *Heine* at the Amsterdam Congress as well as a number of sensational articles from major newspapers. The authors described ground contact glasses, their structure, the required methods of handling and the examination of

the patient at the slit-lamp. The ideal indications for contact glasses were keratoconus and irregular astigmatism, to which *Heine* had recently added a third group that consisted of simple refractive errors, the correction of which could be achieved by incorporating the refractive correction into the contact glass.
His conclusions were optimistic [16]:

"*The replacement of ordinary ophthalmic lenses by contact glasses is perfectly feasible, but it must be born in mind that the continuous use of a contact glass (more than six to eight hours at a time) is apt to be very irritating. Still, in actors, opera singers and other individuals whose ametropia calls for temporary correction without the use of spectacle lenses, there is a field for contact glasses*."

Their bibliography refers to *O'Rourke* and *Fick* and do not mention either the earlier publication of *Heydt* or those of *Derby* and *Katz*.

In 1932, *von der Heydt* described once again his experience as a fitter of the new *Zeiss* contact lenses. He expressed disappointment that, in spite of the recent enlargement of the trial sets from four to thirty nine contact glasses, *Zeiss* did not supply any detailed instructions and that the ophthalmologist was forced to rely on his own resources [17]:

"*Information as to the methods of fitting contact lenses has not heretofore been freely available. The subject has been glossed over as if it were a simple matter needing no elucidation. Sets of Zeiss test lenses have been made available for the use of ophthalmologists by certain optical houses, but directions for their use were not included. (...)*
The original set for fitting keratoconus consisted of glasses with four different corneal curves. There are now sets of twenty-two to thirty-nine or more different test glasses available for fitting purpose. It is questionable whether this large number is really essential for efficient work, especially when restricted to correction of keratoconus cases."

Heydt recalled how, in 1928, he had invented and described a gauge for measuring the height of the arrow of the cornea and of the contact shell. However, he had reservations on the so-called orthopedic effect of contact glasses and recommended the use of fluorescein for the evaluation of the fit:

"*In order to ascertain if the contact glass touches the apex of the cone, one may interpose a fluid layer of fluorescein solution. If the cone touches the area of contact it will be unstained, surrounded by a green ring. A more accurate method [to] ascertain the thickness of the fluorescein layer is by inspection with the narrow beam of the slitlamp. I do not think a slight contact is harmful but prefer a minimal layer of fluid.*"

2.2 - Louis Kazdan and Others (1931, 1932)

In 1931, one finds, like an echo from the American publications, an article by a Canadian ophthalmologist *Louis Kazdan* of Toronto. His historical review included hyperbolic spectacle glasses, the hydrodiascope of *Lohnstein*, the blown contact glasses of *Müller* and the recently available contact glasses of *Zeiss-Heine*. His description of the latter and their effectiveness were stereotyped. For insertion by the physician, he recommended a rubber pear syringe with a nipple covering its end. For insertion by the patient, he recommended *O'Rourke*'s device, but he modified this by replacing the glass tube that he considered too fragile, by a metal tube. The rubber glove finger was replaced by a nipple at its extremity [18]:

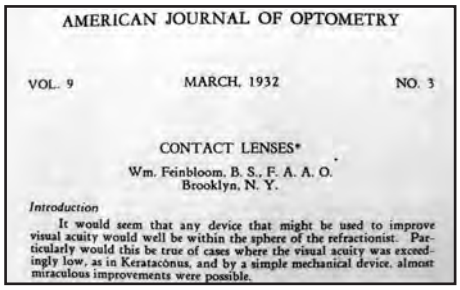
"*I have used a suction bulb improvised by cutting off the tip of an ordinary rubber bulb syringe and stretching the opening over an open thimble. Over this is then stretched the lower portion of a nursing nipple, the smooth rolled edge of which is left to engage the contact glass*."

Kazdan presented two clinical cases, but he did not, however, indicate the duration of the wearing of the lenses. In one patient, the correction was satisfactory for one eye, but failed in the other. In the second history, the contact glasses seem to have been tolerated in both eyes. According to *Kazdan* these were the first two patients fit with contact lenses in Canada. The eleven bibliographical references are a selection of publications prior to 1930.

It is to be noted that *W.F. Weyman* had also described the use of *Zeiss* contact shells in keratoconus and laid emphasis on the techniques for insertion and removal. [19] In December 1932, *R.T. Paton* and *Frank Walsh* presented their recent experience with contact lenses. One of these authors described the use of these in keratoconus, the other in aniridia, albinism, entropion, corneal ulcers and other indications. [20]

2.3 - William Feinbloom (1930, 1932)

In the same year, in 1932, *William Feinbloom*, an optometrist in Brooklyn, published a printed version of his Memorandum on Contact Lenses that he had presented to the American Academy of Optometry in 1930. This first article to be published by an optometrist started with a historical section that was quite confusing. (21)
The historical account became more precise and detailed in his description of *Zeiss* contact glasses in which *Feinbloom* included a new transcription of *Hartinger*'s optical theory. For the insertion of the lens, *O'Rourke*'s device appeared to him to be too complicated. *Feinbloom* proposed replacing it with a rubber suction device: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CONTACT LENSES*

Wm. Feinbloom, B. S., F. A. A. O.
Brooklyn, N. Y.

Introduction

It would seem that any device that might be used to improve visual acuity would well be within the sphere of the refractionist. Particularly would this be true of cases where the visual acuity was exceedingly low, as in Keratacónus, and by a simple mechanical device, almost miraculous improvements were possible.

Figure 22-6
Publication of the presentation of Feinbloom's memorandum (1932).
The publications of William Feinbloom in March 1932 repeat in part the subject matter of the Memorandum, which he defended on the 15th December 1930 at the American Academy of Optometry meeting, held in Omaha.
(Feinbloom WM., 1932).

"*The method desired is one that will enable the patient to insert the lens easily and quickly almost any place the patient might be. The following method has been finally evolved. A rubber nipple, from a baby bottle (...) is cut down to proper size, then possibly three or four scallops are cut at the edge, so as to permit the rubber to widen more easily. The contact lens is then placed onto this lens holder, as it will hereafter be designated. The convex surface is, of course, face down. The hollow or concave portion may then be filled with saline solution (an ordinary medicine dropper is used), about 10 to 12 drops fill the lens completely.*"

For the removal, *Feinbloom* recommended the use of a hook:

"*The contact lens is held onto the eyeball by suction due to capillary action. To remove the lens it is necessary to break up this suction. To break up this suction, it is necessary to raise one of the edges of the lens from the sclera. This is done with a blunt hooked device (...). This hook is introduced gently towards the outer canthus onto the lens, and slid along the lens until it drops onto the sclera. It is gently inserted beneath the lens, the lids drawn apart, or opened wide, and the hook pulled forward, and the lens will drop out.*"

After his presentation on the fitting techniques, he reported on the follow-up by *Salomon Feinstein*, the ophthalmologist, who was also his friend, of seven patients fit with *Zeiss* contact lenses. He also copied reports on ten cases published by *Heine* in 1930. He concluded that contact lenses gave superior results in some patients, but that the best method of assuring subjective tolerance and objective harmlessness without complications remained to be found.

2.4 - Milton F. Little, Daniel M. Rollet (1933, 1936)

In 1933, *Milton F. Little* (Hartford, Conn.) presented a historical summary and a synthesis of recent publications by *Rycroft* and *Heine*. This was followed by the clinical case history of a young man with unilateral cataract corrected by a contact shell of undisclosed type, but which gave him binocular vision and suppressed his divergent strabismus. (22)
Furthermore, in 1936, *Daniel M. Rollet* reported the therapeutic use of contact lenses in a patient with corneal ulcer, another patient with hypopion and a third with corneal changes of neuroparalytic origin. (23)

3 - Renewal of Interest in Ocular Moldings

3.1 - The Moldings of Joseph Dallos and C.L. Stevens (1936)

In April 1936, there appeared in Archives of Ophthalmology an English translation of the publication by *Joseph Dallos* on '*The Invisible Spectacles*'. Besides the history, it was equally the technique of fabrication of contact glasses and, above all, the confirmation that a well-made contact shell could be worn for the whole day that were revelations for American fitters. Attention was also drawn to the publications of *Dallos* from earlier years that were, until that moment, unknown to American professionals. (24)
These publications were completed opportunely in July of the same year with an article by *C.L. Stevens* (New York) on corneal molding. There he described with detailed illustrations the technique of molding with *Poller's* Negocoll and the preparation of a positive cast made from dental plaster. The technique of *C.L.*

Stevens had been conceived for follow-up of corneal geometry deformations in keratoconus patients. According to the author, moldings could be extended to the sclera and used for the manufacture of contact lenses. As *Stevens* did not refer to the studies of *Csapody* and *Dallos*, he would often be cited as the inventor of the technique of ocular molding with Negocoll. [25]

3.2 - Jacob R. Feldmann and the Lachrymal pH (1937)

In 1937, *Jacob R. Feldman* (Philadelphia) published a study on the pH of tears and collyria to which contact lens fitters would refer in the following years. He did not recommend either physiological saline solution or *Ringer*'s solution; instead he chose an acid-sodium-borate buffer solution, of which the pH was adjustable between 7.0 and 7.5 depending on the subject's tear pH [26]:
"*The burning sensation experienced with contact lenses after wearing them for a short period when using physiological solution of sodium chloride (pH 6.4 to 6.5) or Ringer solution (pH 7.45) is not noted so soon when a buffer solution of pH 7.0 to 8.0 is used*."

In the course of the same year, *Gordon M. Bruce* (New York) made an objective assessment of the contact lenses of his era. He concluded that the ground contact shells of *Zeiss* were more accessible, therefore more often used than blown contact shells. However, the latter sometimes gave better results in the hands of skilled prostheses blowers. In view of the fact that *Bruce* was working in the same institute as *Stevens*, he described the technique of molding, but did not quote his use of contact shells that had been manufactured according to these models. He described several liquids at the pH of tears, but thought that the haloes could also have resulted from other factors such as pressure zones. He alluded to *Feinbloom* who was also doing studies with contact shells, but using plastic materials. These contact shells were made in accordance with ocular moldings, but their use did not yet seem practical. [27]

4 - The Evidence of Mostyn-Brown (1936)

Interesting information from this period in history has come to us in the form of a report written by *Maurice Mostyn-Brown* at the time of a fact-finding tour in the United States of America the latter made on behalf of the firm *C. Davis Keeler* of London. [28]
According to his report, the dispensing optician *A. Haustetter* Inc. (New York) collaborated with four ophthalmologists, in whose offices the company had placed sets of *Zeiss* trial lenses. After the contact shells had been tolerated for four hours, they were ordered from Germany and delivered in six weeks [29]:

"*Haustetter (...) have just developed about six [trial] contact lens cases based on one tenth of a millimeter difference in scleral curves. (...) The big difficulty in the contact lens situation is to obtain good and accurate scleral fit. (...) Haustetter has about four ophthalmologists who are interested in the contact lens. First and foremost, special trial cases are offered. Secondly, Mr. Carlson, Haustetter's Manager, more usually attends the doctor's office when he has a patient to fit, and under the doctor's guidance proceeds to obtain a good scleral fit. The doctor refracts the patient and irrespective of sufficient correction value the nearest scleral fit in the trial case is set in the patient's eye and they are asked to wear it for about four hours or, in fact, as long as they can tolerate. (...) If the patient can tolerate contact lenses for four hours or over (...) the lenses are made up by Zeiss and delivery takes about six weeks to the optician*."

The visitor seemed very impressed by the ability of Mr. *Carlson* and the technical expertise of *Haustetter*:

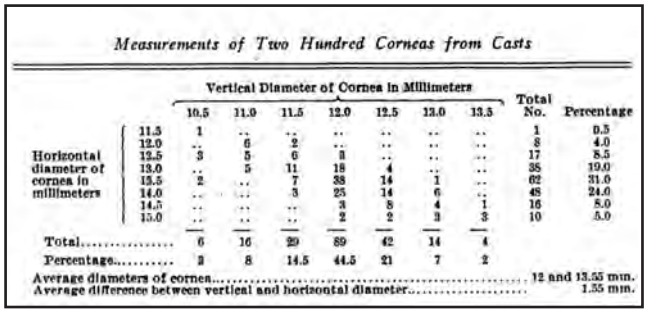
"*Incidentally, Haustetter fitted a contact lens to my left eye without any difficulty whatsoever. Lots of people have previously tried and failed. (...) Strange to relate, Haustetter reported that 45% of their contact lens customers are women and 55% are men. 5% have subnormal vision and 95% are worn by both sexes purely for the cosmetic effect*."

He also stated: "*Haustetter invariably uses raised corneal contact lenses and always continual transition and specifies that the edges of his contact lenses should be rounded so as not to cause irritation or discomfort when fitted*."

Mostyn-Brown also reported on his visit to the Institute of Ophthalmology of the Presbyterian Hospital of New York, where the physicians *Maynard Wheeler*, *McNie* and, above all, *Bruce* used *Zeiss* contact lenses and those modified by *Haustetter*. They also performed Negocoll moldings, following which the ocularists *E. & S. Danz* delivered their blown contact shells in the manner of artificial eyes. [30] The fittings at this Institute concerned essentially keratoconus patients, in view of the fact that the percentage of the successes for cosmetic cases was very limited:
"*The attitude of the Medical Centre Group in regard to the contact lens situation is to concern themselves principally with the correction of keratoconus and subnormal vision cases*."

He regretted not having met 'the young *Theodore Obrig*' and commented:

"*He is the deaf boy and son of the business. (...) But, on authority, I understand that the whole of his information is based on a minimum of two or a possible maximum of five cases only. I believe he is working with a doctor Brown, but the method is to take the usual Negacoll cast, go through the usual processes and submit a perfect mold to Zeiss of Jena. Zeiss themselves are sufficiently interested in the mould process to have undertaken to produce from a good-looking mold of a cornea, a contact lens to suit this mould. Delivery takes eight to ten weeks in the United States.*"
Mostyn-Brown had also visited *Feinbloom* in New York, who, from this era, was practicing molding with wax and was testing combined shells with a plastic haptic in Bakelite, into which he vulcanized a cornea of ground glass. (31)



Measurements of Two Hundred Corneas from Casts

		Vertical Diameter of Cornea in Millimeters							Total No.	Percentage
		10.5	11.0	11.5	12.0	12.5	13.0	13.5		
Horizontal diameter of cornea in millimeters	11.5	1	..	..	..	..	..	..	1	0.5
	12.0	..	6	2	..	..	..	..	8	4.0
	12.5	3	5	6	3	..	..	..	17	8.5
	13.0	..	5	11	18	4	..	..	38	19.0
	13.5	2	..	7	38	14	1	..	62	31.0
	14.0	..	..	3	25	14	6	..	48	24.0
	14.5	..	..	..	3	8	4	1	16	8.0
	15.0	..	..	..	2	2	3	3	10	5.0
Total		6	16	29	89	42	14	4		
Percentage		3	8	14.5	44.5	21	7	2		

Average diameters of cornea ..... 12 and 13.55 mm.
Average difference between vertical and horizontal diameter ..... 1.55 mm.

Figure 22-7
Obrig's table with measurements of the corneal diameters of ocular moldings.
In 1938, Theodor Obrig described measurements he had made on moldings of more than 200 eyes. He concluded that the average horizontal diameter of the cornea was between 12.00 mm and 13.50 mm and that the average difference between the horizontal and vertical diameters was 1.55 mm. (Obrig TE., 1938a)

5 - The Contributions of T.E. Obrig (1937-1938)

5.1 - The Fitting of Contact Lenses (1937)

In 1937, *Theodor E. Obrig* published an article, entitled '*Fitting of contact lenses for persons with ametropia. Evolution and modern technic*' in the Archives of Ophthalmology. This was a first report comprising 32 pages of personal experience. Backed by 72 bibliographical references, he described in detail the historical evolution of manufacturing and fitting techniques for contact lenses in the United States of America and throughout the world. He reported being disappointed by the blown contact shells of the *Müller* type, even if these were manufactured locally (32):

"*During 1934, a New York firm started the manufacture of a Müller type of contact glass. It has an improved corneal portion on which correcting powers may be blown. (...) Three patients with high myopia have reported that useful vision has not been obtained with them, although a large number were tried. Two other patients reported that comfortable scleral portions were yet to be given to them, although forty or more lenses had already been fitted. All five patients have requested a fitting of the Zeiss contact lenses.*"

Obrig preferred *Zeiss* contact shells and he was an assiduous promoter of these in New York. Those described by *Stock* in 1920 were reserved for the correction of keratoconus and improvements added in 1930 by *Heine* represented progress. However, the new lenses introduced after 1932, with their variable radii of scleral curvature and ground anterior refractive power, were preferable. He recommended the set of 24 shells and described in minute detail their insertion and fitting.
He had observed transient corneal opacities that he attributed to osmotic modifications and variations in the pH of tears. The pH could be measured with nitrazine paper strips:

"*A condition which is characterized by blurring of vision during the wearing and after the removal of a contact glass can also be attributed to a physiological imbalance between the water lens and the conjunctiva which causes an alteration and thickening of the secretion which adheres to the cornea. This can be overcome or lessened by determining the proper type and strength of the solution of the fluid lens.*"

The average toleration of *Zeiss* contact lenses was about two hours, but the shell could be worn twice a day. *Obrig* recommended contact lenses with molded haptics and ground optics. The procedure was still on an experimental basis in cooperation with *Zeiss*, who possessed exclusivity of manufacture of these shells with molded haptics. For taking of the imprint, he referred to the technique described by *Stevens* [33] for corneal moldings in keratoconus, which he tried to adapt to the scleral diameter: the Negocoll paste is poured into a *Müller*-type blown contact shell and the shell is then inserted under the eyelids without exerting any pressure. After two minutes, the contact shell is taken out and the level of the medial canthus is marked. His friend, ophthalmologist *Harry Eggers*, performed the moldings, using a special 'casting shell' of 22.00 mm total diameter and 7.00 mm in depth. It had a glass handle 25.00 mm in height. The molding obtained was first cooled for 15 minutes in cold water; it was then filled with dental plaster. When the dental plaster had hardened, the data was recorded and markings made on the cast.

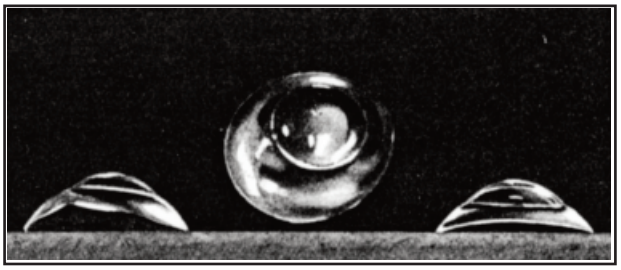


Figure 22-8
Glass contact shells with molded haptic and ground corneal portion. *In 1938, Theodor Obrig described his working relationship with Zeiss to whom he forwarded his ocular moldings and received in return a glass contact shell with molded haptic and with the corneal portion ground and polished according to the requested refraction.* (Obrig TE., 1938a)

For ordering, it was necessary to indicate the spectacle glasses refraction and visual acuities obtained, plus visual acuities obtained with a standard *Zeiss* contact shell. Also required was the distance between the corneal vertex and the corrective spectacle lens. The shells furnished by *Zeiss* had an oval diameter of between 19.00 and 20.00 mm. *Obrig* thought that, at the present time, the *Zeiss* scleral molded and corneal ground lenses were the best option for patients, above all for those patients in whom the sclera was irregular. He thought that, in the future, this type of contact lens would prevail. In conclusion, he commented:
"*Blown contact lenses with ground corneal portions, entirely different from the Müller type of lenses, can be made from a cast after they have been modified in form. The blown lenses are reported as being comfortable to wear during the entire day. Continued use and research with this type of lens may possibly result in the eventual use of this method to fit all contact lenses*."

5.2 - The Molded Contact Lens (1938)

In 1938, the year following, *Obrig* published two other highly significant articles. These were also intended for the medical world and marked a step in the evolution of corneo-scleral glass shells. [34]

The first of these, entitled '*Molded Contact Lenses*', was 24 pages in length and it described the technique, results and observations made on ocular moldings, contradicting the concepts traditionally repeated since *Stock*, *Heine* and *Hartinger*. *Obrig*'s publication was based on his observations of 250 eyes that did not tolerate standard contact glasses in spite of fitting according to the usual rules and which were subsequently fit with molded lenses in his hands.
The first issue to be questioned concerned corneal diameter. In fact, ocular moldings had shown *Obrig* that, contrary to what was generally accepted, the diameter of the cornea ranges between 10.50 mm and 13.50 mm in the vertical axis and between 13.50 mm and 15.00 mm in the horizontal. In *Obrig*'s opinion the discomfort often observed with the original contact glasses of *Zeiss-Heine* was explained by their standard corneal diameter of 12.00 mm, which caused pressure at the limbus. He quoted the extreme example of an eye of which the corneal diameter was 13.00 mm, which did not tolerate standard contact shells:

"*The primary difficulty in obtaining comfort with a contact lens is due to pressure at the limbus, particularly nasally and temporally. Contrary to the measurement generally accepted, the average diameter of the corneas measured were 12 mm and 13.55 mm, the smallest and longest horizontal diameter being 11.50 mm and 15.25 mm respectively. Vertically, the range was from 10.50 mm to 13.50 mm*."

The second cause of intolerance to *Zeiss* contact shells was attributed to the aspheric geometry of the human sclera. Taking a scleral imprint in vivo remained difficult, but measurements could be achieved on well-performed moldings:

"*The second most important factor in the inability to obtain a comfortable fit with a contact lens is irregularity of curvature of the sclera. (...) These differences in curvature consist mostly of short vertical radii and long horizontal radii. (...) Scleral irregularity, however, is tolerated by patients having no pressure from the lens at the limbus. The irregularity is not symmetrical on either side of the vertical diameter*."

Obrig was guarded in regard to wax moldings as performed by *Feinbloom* and *Prister*, where the wax layer in the eye is softened by the body temperature, then hardened using cold water before being removed from the eye with a suction cup. This method was a source of errors above all because of the reflex contraction of the eyelids. (35)
The method described by *Stevens* essentially involved the cornea and was not such as could be extrapolated to the sclera. (36) In conjunction with the ophthalmologists *Daniel B Kirby* and *Harry Eggers*, he researched improvement by avoiding pressure on the globe and by extending the molding process to the sclera by renouncing blown shells for molding in favor of a specific molding shell with a handle.

Obrig described the details of his molding technique at great length. He was satisfied with *Poller's* Negocoll and made nearly 400 moldings from that material without observing any epithelial lesions. For the cast, he used dental plaster, which he poured into the mold.
Contact shells with molded haptic were manufactured by *Zeiss*. They had oval diameters and the internal haptic surfaces were irregular, as is the surface of the sclera from which the mold is taken. The corneal portion of these shells was ground and polished according to prescription and resembled the customary ground contact shells of *Zeiss*. Pressure at the level of the limbus appeared also to have been eliminated by a special profile at this level. *Obrig* described a '*Science of Haptics*':

"*The fit of any contact lens should be slightly loose, principally near the insertion of the rectus muscles. Care must always be taken that the lower scleral flange of the contact lens is not loose enough to extend away from the sclera (...). The upper portion of the scleral band of the contact lens (...) does not seem to need as much bearing surface as the three other portions. Zeiss has apparently solved the problem of pressure at the limbus in the molded lens by the extra horizontal molding at the nasal and temporal sides of the corneal section, which can be obtained by building up on the original cast for a distance of 1 mm inside and outside of the sulcus*."

After numerous trials, the most satisfactory liquid for insertion is the '*buffer solution*' as described by *Feldmann* that had to be adjusted to the pH of the tears by the addition of doses of sodium-borate-boric acid buffer. (37) The publication was illustrated by the histories of 5 clinical cases. His conclusions on the two problems to be resolved were as follows:

"*First, a better buffer solution, more nearly identical with the lachrymal fluid and still flexible enough to be prepared in varying pH intervals, is essential.*
Second, some form of treatment must be devised to toughen sensitive conjunctiva which will not tolerate contact lenses however good the fit."

Absolutely convinced that fitting had now reached perfection, he proposed improving the tolerance of the lens using a liquid to act both as tampon and anaesthetic agent:

"*This seems to call for a properly buffered stringent combined with a suitable anaesthetic solution to enable the patient to bear the irritation of the astringent, which can be built up in strength as it becomes tolerated.*"

He ended his publication with four clinical examples, in which the fit of contact glasses appeared perfect, but where the tolerance was poor to average and was able sometimes to be improved by buffer solutions.

5.3 - The Cobalt Blue Filter (1938)

The second article of *Obrig*, published in 1938 under the title of '*A Cobalt Blue Filter for observation of the fit of contact lenses*' recalled that:

"*Pressure at the limbus or inside the limbus on the cornea itself is without doubt the reason for discomfort from contact lenses in at least 90% of the patients who complain of inability to wear them except for short periods. Any contact lens which rests on any portion of the cornea cannot be worn for more than an hour and often for a much shorter time*."

The publication proposed the use of cobalt blue light for checking by fluorescein the fit of contact lenses and, in particular, the corneal and limbal clearance. The use of fluorescein for this purpose had already been recommended in America in 1932 by *von der Heydt*. (38) With a dense cobalt blue filter placed on the slit-lamp, the liquid space between the cornea and the optical portion of the contact shells was, however, better visualized. In order to better appreciate the fit generally, *Obrig* recommended a '*New Hand Slit-lamp*'. (39)
The examinations with fluorescein observed through a cobalt blue filter revealed a brilliant yellow-green zone for the tear spaces and a darker zone the zones of pressure. He also confirmed, on this occasion, the observations already made on ocular moldings that one of the reasons for the discomfort of the contact

lenses was essentially indiscrepancies between the dimensions of the anatomical ocular limbus and the corneo-scleral junction of the contact shells.

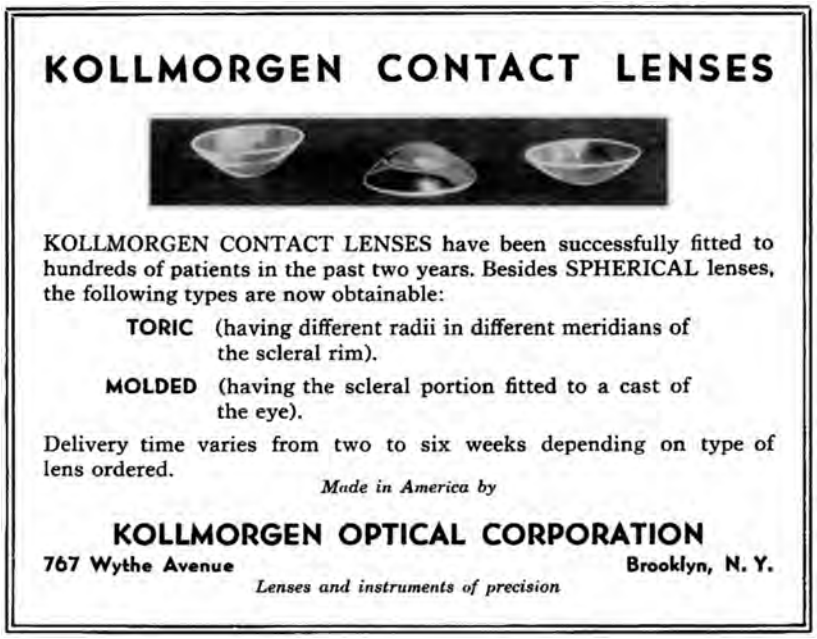


Figure 22-9
Advertising for Kollmorgen contact lenses. Kollmorgen Optical Co. advertised for spheric, toric and molded glass corneo-scleral lenses

6 - Other Contact Lens Fitters and Manufacturers

6.1 - Kollmorgen Optical Corporation

We should cite optical companies in New York other than *Obrig* who were also involved in contact lenses during this epoch, notably the *Kollmorgen* Optical Corporation. They manufactured and sold their first contact lenses made from ground polished glass of spherical type in September 1937. These were quite similar to the ground contact shells of *Zeiss*. They had a total diameter of 20.00 mm, an optic of 12.00 mm diameter and a transition zone at the level of the limbus.
Then, in imitation of the contact shells of *Müller-Welt* and *Feinbloom*, *Kollmorgen* also produced ground contact shells with a toric haptic: a difference of 0.60 mm between the haptic radii of curvature, which were recommended in cases of failure with standard contact shells. Finally, this manufacturer tried glass contact shells following individual moldings. *Obrig* was critical of his competitor for furnishing heavy contact shells that were both fragile and difficult to modify. [40]

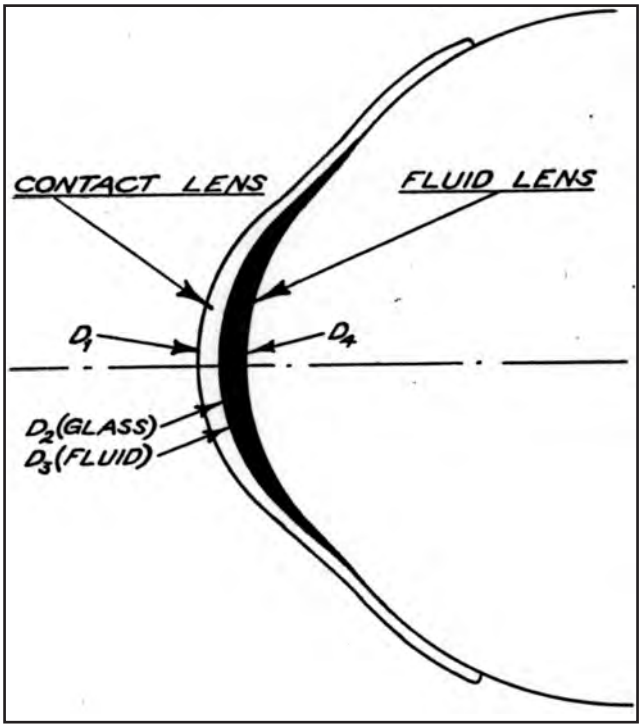


Fig. 22-10
Explanations by P. Boeder regarding the theoretical optics of contact lenses.
In 1938, Paul Boeder, engineer with the American Optical Company, addressed and finished the researches of Hartinger on the theoretical optics and the magnifying power of contact lenses. (Boeder P., 1938)

6.2 - Feinbloom and Others

In the course of the following years, publications on contact glasses multiplied in number. *Feinbloom*, who was to follow the development of contact glasses from close-up, presented a shell of which the scleral portion had its profile derived from an ocular molding. [41] His 'Semi-plastic Contact Lenses', which had Bakelite haptic into which a corneal part made from ground glass was inserted, were, however, fragile and the join between the Bakelite and the glass did not have the expected stability. *Feinbloom* registered a series of patents, first, in his own name, and then in association with *Bausch & Lomb*, with whom he had had discussions. [42]
In referring to the publications of *Bruce* and *Obrig*, *Paul Boeder*, engineer at *American Optical Company*, described in 1938 the optics and the power of magnification of contact lenses, thus completing the researches of *Hartinger*. *American Optical* was also very involved with the development of contact lenses and had registered several patents. [43]

7 - Müller-Welt Glass Contact Shells in the United States of America

7.1 - Fritz Nelson (1937)

In 1937, the ophthalmologist *Fritz Nelson* (Colorado Springs) was critical of *Obrig* for not having mentioned the firm *Gebrüder Müller-Welt* (Müller-Welt Brothers, Stuttgart) in his publications. Their '*Corneo-Scleral Shells*', described in 1934, represented a revolutionary change in the development of contact lenses. *Nelson* explained that he had had the opportunity of fitting these contact lenses in Germany at Professor *C.H. Sattler*'s Clinic in Königsberg. (44) From the fact that no patient had a regular sclera, but one that is always more or less aspheric, the haptic portion of the contact shells had also to be aspheric. However, the corneal and optical parts had to be perfectly spherical.

It turned out that standard contact shells combining those two requirements were difficult to make. Formerly, *Müller-Welt* had manufactured blown contact shells that more or less resembled *Zeiss* contact shells. (45) These had a fluid lens between the cornea and the glass optical portion of the shell as well as a spherical scleral portion. They had the same disadvantages as the *Zeiss* contact shells because of that feature. In 1933, *Dallos* had demonstrated that it was possible to make ocular moldings that served as a model for contact shells with an adapted haptic. The original method of *Dallos* required moldings in five directions of gaze. This was something that few ophthalmologists were capable of achieving.
In the meantime, *Müller-Welt* developed a model combining a ground spherical optical portion with a blown aspheric haptic. These contact shells were larger than those of *Zeiss*, which shared their zone of contact. The edges of these contact shells had a more refined transition in order to avoid compression of conjunctival vessels and their peripheral parts were asymmetric and flattened on three sides in order to enable the shells to center spontaneously. These shells were available in 9 haptic curves. The corneal portion was ground to the desired refraction. The posterior radius of curvature was in conformity with the corneal radius with "*only a very small degree [of variation] by a capillary layer of fluid interposed*"; from this fact, "*the inner radius nearly conforms [to] the radius of the anterior surface of the cornea and therefore only a very small amount of fluid is needed.*"

Only very few patients with keratoconus or high irregular astigmatism required a volume of liquid to fill the space between the spherical glass and the aspheric cornea. Furthermore, these shells had been made free of internal tensions, which rendered them more resistant to breakage.
Nelson cited no clinical cases. He used a set of 20 trial lenses, but a set of 120 contact shells would have given better results. For ordering from *Müller-Welt* in Germany, it was necessary to provide the corneal refraction from the keratometer, the total refraction, the diameter of the best-positioned trial contact shell, and the scleral curvature of the best-fit contact shell. The contact shell that is retained was worn for several hours on different following days in order to verify that it was tolerated. Checks were made at the slit-lamp after instillation of fluorescein.

7.2 - William F. Moncrieff (1938)

In 1938, *William F. Moncrieff* presented a communication in which he explained the technique of molding while expressing the wish that such contact glasses might possibly be manufactured in the United States of America. This would have made them more readily available. (46) In the course of the discussion, *Robert von der Heydt* confirmed that the 3% of individuals who could not be fit with contact shells with standard scleral radii of curvature could have been successfully fit later by means of the Negocoll method of molding. Molding was not easy, particularly if there were palpebral spasms or eyelid laxity. Another problem concerned the manufacture of the glass, starting with the cast. In the course of the same year, *Carol Weeks* made a projection presentation in Los Angeles, illustrating the technique of ocular molding. He remarked that, in certain patients, the globe was so asymmetrical that standard contact lenses were not tolerated and the transition between the corneal and scleral curves merited extra special attention. (47)

8 - Which Contact Lens?

8.1 - The Editorial of W.H. Crisp (1938)

Faced with the problem of choice for the best contact lens, the editorial writer of the American Journal of Ophthalmology, *W.H. Crisp* posed in 1938 the question '*Which contact lens* ?'. [48] He made a very interesting comparison between the contact shells of *Zeiss-Sattler* and those of *Müller-Welt*, admitting, however, that "*at the present time most American ophthalmologists are probably far from realizing the full possibilities for application of the contact lens*". He stated that *Nelson* and *Sattler* were in agreement with the fact that, in patients difficult to fit with the contact shells of *Zeiss* and those of *Müller-Welt*, it was necessary to have recourse to the molded contact shells of *Dallos*. However, the last-named had, at the present time, left Budapest. However, in the journal's '*Letters to the Editor*', *Margaret Dobson* (London) stated that *Dallos* had emigrated to England and had restarted his contact lens practice in London. He had already performed more than two hundred individual fittings on patients who were impossible to fit with other types of contact lenses.

8.2 - The Propositions of Harry Eggers (1939)

In 1939, *Harry Eggers* an ophthalmologist in New York, had worked with *Obrig* where he had examined 152 patients from which were taken the first 200 ocular moldings. *Eggers* presented two original conclusions from these observations. [49]
In his first publication, he described a simplified formula for the theoretical optics of the lachrymal meniscus, in which, broadly speaking, a change in the radius of curvature of 0.10 mm corresponded to a modification of the refractive power of 0.50 diopters. For the choice of the corneal radius of curvature, he proposed, for the myopic subject, the formula $Y = X + 30/4$, in which Y is the radius of curvature of the shell optic in mm, and X is the power of the corrective lens in diopters. For the hypermetrope, the situation was more nuanced and here he proposed the formula $Y = 34 – X/4$. According to *Eggers*, the error with these formulae did not exceed 0.5 diopters.
In his second publication, *Eggers* confirmed the observations of *Obrig*, that, on examination of the moldings, the sclera was not spherical, but parabolic and with an asymmetric profile. In 80% of cases, the toleration of the classical contact shells did not exceed 4 hours by reason of the sphericity of their haptics, which were unsuited to the geometry of the sclera. Besides, certain intolerances were often due to pressure on the cornea or to deficiencies of the lachrymal circulation that did not assure corneal nutrition. In order to avoid fastidious moldings, he recommended a set of 70 trial contact shells selected according to the most frequently occurring moldings. Their haptic radii of curvature ranged in the nasal portion from 7.50 mm to 9.50 mm, for the inferior portion from 7.00 mm to 8.80 mm and for the temporal and superior portions from 7.00 mm to 8.60 mm. The shells proposed would have a total oval diameter of 22.00 mm in the horizontal axis and 21.00 mm in the vertical axis, with the corneal portions ranging from 6.00 mm to 10.00 mm radii of curvature and from 8.00 mm or 9.00 mm in diameter. *Eggers* concluded:

"*The preceding observations and suggestions are published in the hope that some manufacturer will use them as a basis for new design of standard contact lenses*."

It seems, however, that his suggestions had little influence on the manufacturers, who persevered with the manufacture of contact shells with spherical haptics and continued with the research for an intermediate liquid that would suppress the inconveniencies of temporary limitation of tolerance.

8.3 - Moldings with Dental Wax by Arno E. Town (1939)

In the same year, *Arno E. Town* (New York), who also worked with *Obrig*, presented the correction of three unilaterally aphakic patients by means of contact lenses. These patients all regained binocular vision. He also described the technique of molding with 'Kerr's dental wax of gauge 13' with a positive in 'dental stone'. He admitted that the Negocoll-Hominit procedure remained "*the best for an impression of the cornea and limbus*", but described the dental wax procedure [50]:

"*The first strep is to determine the approximate scleral curve by means of ground glass of known curvature. A piece of wax of 7.5 mm is cut and slowly molded over a hemisphere of the same radius of curvature as the sclera of the eye. The center of the wax is punched out with a punch of 11 mm in diameter. A glass center 12 mm in diameter is placed over the hole. A convex glass of a chosen size is placed over the wax form. The wax form is now available with the approximate scleral curvature. This is placed in ice water for 5 minutes It is then put in the anesthetised eye for fifteen minutes. The form is then sprayed with ice water to harden it and removed. The positive form is made of dental stone. A skeleton glass is made from this form. After the fitting and correcting of the skeleton glass, a finished glass is made with the proper optical correction".*

The definitive contact shell in glass, with a ground corneal portion and a molded haptic, guaranteed good tolerance: "*For a good fitting the contact glass must cover a large area without any pressure on the peripheral portion, it must not be in contact with the cornea or the limbus. Air bubbles must not form under the glass. It must be worn for four hour trial periods with comfort on two successive days*."

Town made himself also the defender of fitting exclusively by physicians: "*Contact glass refraction is a part of ophthalmology and should be performed by oculists. The taking of impressions (...) should not be performed by opticians or technicians.*" (51)

8.4 - Various Interesting Publications (1939-1940)

Figure 22-11
The telescopic system of Bettman.
In 1939, Jerome W. Bettman and G.S. McNair of San Francisco presented the case of a patient in whom Galilean telescopic spectacles, as commercialized by Zeiss, had been replaced by a telescopic system in which a contact lens and a spectacle lens were associated. (Bettman JW, McNair GS., 1939)

In 1939, *Jerome W. Bettman* and *G. Stuart McNair* (San Francisco) presented the case of a patient improved by the enlargement of the retinal image with an inverse *Galilean* telescopic system using a *Zeiss* contact lens as ocular and highly convex spectacle lenses as objective. (52)
In the course of the same year, *Joseph I. Pascal* (New York) reported his experiments with contact glasses of various shapes, where he demonstrated the importance of the lachrymal meniscus on the final refraction. He also described a suction cup, 'The Rubber Sucker', which was equipped on one of its surfaces with a white reference mark for the correct insertion of the molded contact shells, for, in these shells, the horizontal diameter was greater than the vertical and the temporal portion was greater than the nasal. (53)
Also, in the same year *S. Maisler* (San Francisco) recommended a new hydrocolloidal gel called 'Kerr's Hydrocolloid' that enabled faster ocular molding. Presented in a tube like toothpaste, it is immersed into warm water to soften the contents before the gel is expressed. The product does not adhere to the silver molding shells, perforated for the evacuation of overfilling of gel. He preferred silver molding shells to glass molding shells because he considered that the latter were too fragile. Casting was performed in the classical manner used with dental plaster. (54)

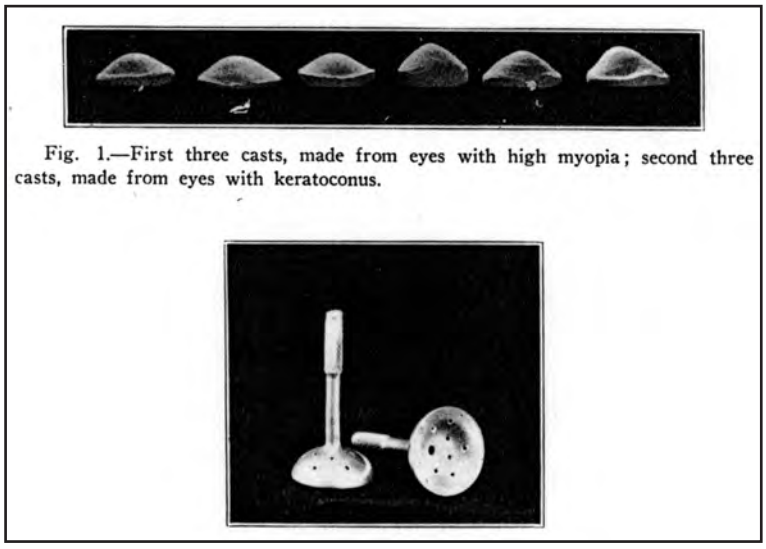


Fig. 1.—First three casts, made from eyes with high myopia; second three casts, made from eyes with keratoconus.

Figure 22-13
The 'Kerr's Hydrocolloidal' molding products (1939).
In 1939, S. Maisler of San Francisco described the use of a new hydrocolloidal gel, 'Kerr's Hydrocolloid' which required the use of silver molding shells. (Maisler S., 1939)

During the next few years, one notes that *Julian F. Chisholm* (Boston) proposed improvements in ocular molding technique, notably the use of a 'fixation target', a point of fixation, when the ocular molding was being performed. *Otto Barkan* (San Francisco) demonstrated a 'hammer lamp' for focal illumination provided with a cobalt blue filter for the fitting of contact glasses. *Frederic A. Wies* thought that the new ultraviolet filter 'Ortholite' of *Bausch & Lomb* was distinctly superior to the cobalt filter recommended by *Obrig*. Then, *P.H. Boshof* presented to his colleagues in the United States the Zelex, which was a new colloidal product manufactured in Great Britain as a replacement for Negocoll and wax. *Goldberg* meanwhile managed a strabismus patient by correcting the hypermetropia using contact glasses. (55)

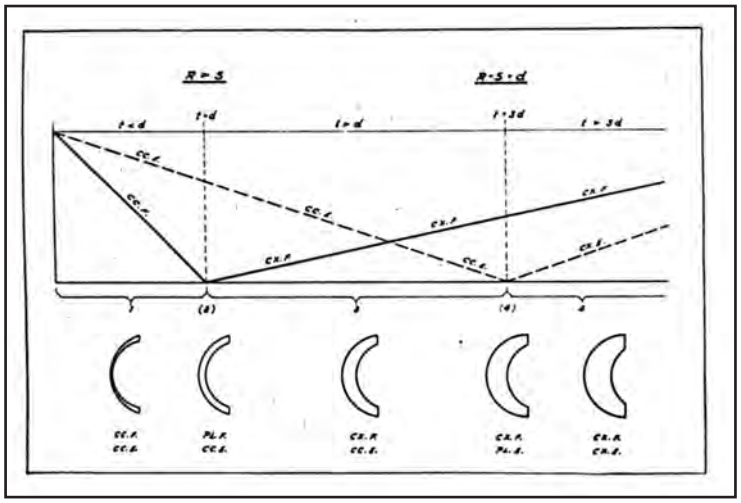


Figure 22-12
Study by Pascal of the lachrymal meniscus as a function of the curvature of corneo-scleral shells.
In 1939, Joseph I. Pascal of New York presented experiments with various curvatures of corneo-scleral shell and related these to the lachrymal meniscus therefore the refractive power. (Pascal JI., 1939a)

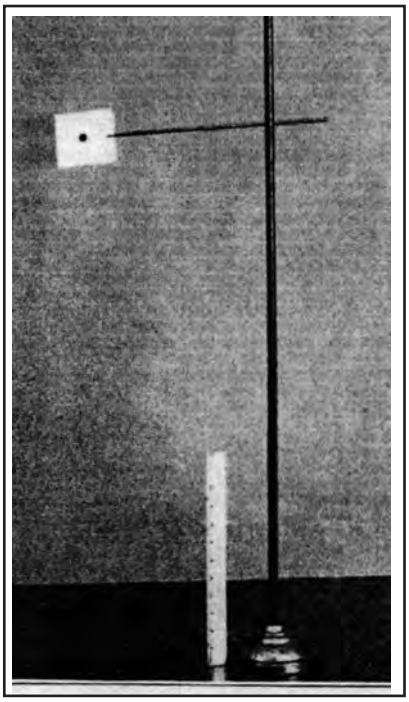


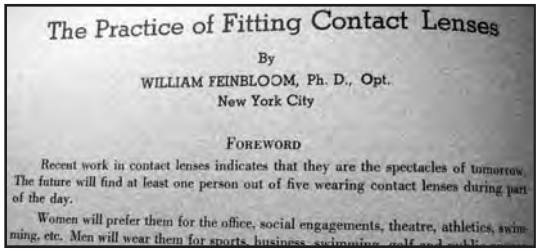
Figure 22-14
Chisholm's fixation target.
The fixation target of J.F. Chisholm was intended to result in superior immobilization of the eye for molding.
(Chisholm JF.Jr., 1940)

8.5 - Feinbloom, Greenspoon and the Growing Interest of the Optometrists

Under the example and initiative of *William M. Feinbloom*, optometrists started to pay attention to and interested themselves more intensively in contact lenses. Thus *Reuben Greenspoon* (Beverly Hills) successfully fit a keratoconus patient in 1933 with *Zeiss* contact shells. The patient was to become the subject of a new publication twelve years later.[56]

In 1939, *Greenspoon* described a simplified process of fitting of contact lenses and the observation of clearance with a mixture of 'Neo Silvol' and fluorescein before *John C. Neill* drew the attention of his colleagues in the following year to the use of cobalt blue light recently described by *Obrig*. [57]

In 1940, *Henry J. Hoff* (New York) described a procedure for fitting and monitoring contact lenses suitable for optometrists and *Greenspoon* reported fitting contact lenses to change the color of the eyes of actors in the MGM and Paramount Pictures studios in Hollywood. He thus 'aged' the eyes of *Orson Wells* and *Loe Cotton* in 'Citizen Kane', which event received editorial comments in 1940 from *C. C. Koch*. In the same year, *Lester Beacher*, who had edited a practical manual on



The Practice of Fitting Contact Lenses

By
WILLIAM FEINBLOOM, Ph. D., Opt.
New York City

FOREWORD

Recent work in contact lenses indicates that they are the spectacles of tomorrow. The future will find at least one person out of five wearing contact lenses during part of the day.

Women will prefer them for the office, social engagements, theatre, athletics, swimming, etc. Men will wear them for sports, business, swimming, golf and [illegible]

Figure 22-15
William Feinbloom's publication 'The Practice of Fitting Contact Lenses'.
In a series of 12 monthly lessons, William Feinbloom presents a detailed and didactic exposition of the fundamentals of fitting of contact lenses. These articles will be re-issued in a binder and are already attracting great interest from optometrists.
(Feinbloom W.M., 1939, page 88).

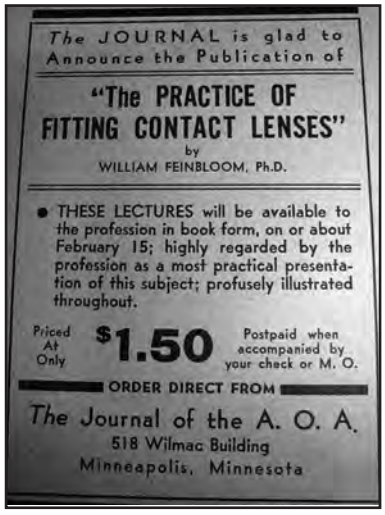


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Figure 22-16
Announcement of the publication of William Feinbloom's book (1942).
The editions of the Journal of the American Optometric Association have collected the series of Feinbloom's lessons in one large fascicule widely distributed amongst American optometrists. (Feinbloom WM., 1942)

contact lens fitting, described ocular molding in greater depth that, by reason of the restrictive legislation, had to be carried out in the presence of a physician. He foresaw that plastic contact lenses would soon become available. He also described a method of insertion using one hand only. *A.N. Even* proposed measuring the curvature of the sclera with calipers made from plastic material. (58)
Then *William M. Feinbloom* started a series of publications in the form of monthly lessons of which the articles were compiled in a volume that was to meet with great success. At the same time, he published texts for beginners, proposed to correct myopes and to perform ocular moldings and fittings without the instillation of topical anesthetic, therefore without the presence of a physician. This would have been made possible with the new plastic lenses materials that he had just introduced. In 1941, *E. Anderson* raised the question of psychological inhibition of candidates as far as fitting contact lenses was concerned and *Ewing Adams* dedicated some publications to the cosmetic fitting of mutilated eyes and to the correction of high astigmatism. (59)

8.6 - The last Glass Corneo-scleral Shells in the United States of America

In the course of the years before World War II, glass corneo-scleral shells benefited from a very interesting development in the United States. Up until 1930, contact shells, as provided by *Zeiss* to certain privileged sites in the U.S.A., were reserved for the optical correction of keratoconus. Then, *Zeiss* imported the broad range of trial contact shells that resulted from the researches of *Heine* and the modifications by *C. C. Sattler*. To that were added the blown contact shells imported by the *Müller-Brothers* or those blown on location by local (i.e American) ocularists. One of these was *Kohler and Danz* (New York).

As a reaction to the failures of contact shell fittings and also because of the researches of *Dallos*, *Obrig* and *Feinbloom*, an awareness of the importance of the geometry of the scleral portion and the corneal diameter gained credence. This awareness was confirmed by the success of the contact shells made with non-spherical haptics by *Müller-Welt* and the manufacture of similar contact shells by *Obrig*, *Feinbloom*, *Kollmorgen* and others. Thus, while equipping for production, several manufacturers proposed contact shells of which the haptic geometry was based on those non-spherical scleral profiles that were statistically the most common. For the most extreme cases, *Obrig* obtained contact shells from *Zeiss* with ground optics and haptics molded according to the ocular imprints he had carried out himself. However, whatever the origin of the imprints, the glass contact shells were imperfectly heavy and thick. They provoked visual haloes and symptoms of intolerance after a few hours of wear. These were most often attributed to the pH of the intermediate liquid. During this era, the precepts of *Dallos* in regard to fluidless corneal fitting with a haptic that ensured lachrymal circulation were not sufficiently known and the manufacturers of contact shells essentially attributed their failures to the inadequacy of the liquids used for their insertion. When, on the eve of World War II, glass was replaced by plastic material, American manufacturers were already mastering their techniques of production of contact shells and were ready to give new weight to this new material because of the ease of reshaping, fitting and wear.

Notes in Chapter XXII

1. Wescott V., 1925. Candidature Essay for membership of the Chicago Ophthalmological Society. One is surprised that Wescott found himself in a dilemma in regard to contact lenses, whereas he cited bibliographic references up to Dohme in 1922.
2. O'Rourke D., 1929. Presentation on the 15th October 1928 at the Congress of the American Academy of Ophthalmology and Otolaryngology.
3. Heydt R.v.d., 1929. Presentation of 22nd October 1928 at the Chicago Ophthalmological Society.
4. Derby G.S., 1929 a. Presentation of 20th November 1928 at the New England Ophthalmological Society.
5. Derby G.S., 1929 b. Communication of the 15th January 1929 to the New England Ophthalmological Society.
6. Bowden T., 2009, p. 128-130.
7. Katz D., 1929. Presentation of the 15th April 1929 to the Chicago Ophthalmological Society.
8. Sitchevska O., 1931. Communication to the New York Academy of Medicine, Section of Ophthalmology, December 15, 1930.
9. White J.W., 1931.
10. Sitchevska O., 1932. Presentation at the Lighthouse Eye Clinic, October 16, 1931, during the Clinical Congress of the American College of Surgeons. Note the often-repeated error: "Stock who had a keratoconus himself, had perfect vision with the Zeiss glass. After wearing it for two to three hours, the eye would become so painful and irritated that he would have to remove the glass." (In actual fact, Stock suffered from mild myopia. See his description in Stock, 1931).
11. Hardy L.G., 1933. Read before the New York Academy of Medicine, Section of Ophthalmology, November 21st, 1932. Discussions: McDannald C.E., 1933; Knighton W.S., 1933; Sitchevska O., 1933.
12. Blatt N., 1932. This refers to the translation of a communication presented on the 17th May 1931 to the Congress of the Rumanian Society of Ophthalmology. The article had been submitted to the Archives of Ophthalmology on the 23rd of May 1931, but was not published until a year later. This could be explained by the hesitation of publishers confronted by this novel means of correction of refractive errors.
13. Obrig T.E., 1942.
14. Dickinson F., Clifford Hall K.G., 1946.
15. Zeiss Carl Patents 1931 a, b, c, d, e, 1934.
16. Heydt R.v.d., Gradle H., 1930.
17. Heydt R.v.d., 1932. Presentation at the Chicago Ophthalmological Society, 21st March 1932.
18. Kazdan L., 1931.
19. Weyman W.F., 1931.
20. Paton R.T., Walsh F., 1933. Presented on 7th December 1927 at Baltimore City Medical Society (Section of Ophthalmology). The historical section is pure fantasy: "Dr Paton gave a short historical sketch of the use of contact glasses which were first mentioned in 1827, on through their use for conical cornea in 1879 by Rohlman, up until the present day when Zeiss in 1911 began to make them for general use." This three references are mistaken: the date 1827 refers to Herschel, the 1879 date to Raehlmann, who proposed hyperboloid glasses for the correction of keratoconus. The 1911 citation refers to the use of ground lenses of corneal diameter in Jena, intended for use in experiments in physiological optics. The marketing of lenses 'for general use' did not occur till 1929.
21. Feinbloom W., 1931, 1932. A note precise that the article is an abridged version of a memorandum presented on the 15th December 1930 to the American Academy of Optometry at Omaha, published in 1931. In view of the fact that certain elements of the publication, in particular the works of Heine and Hartinger, are at a later date than the present, it appeared that the text had been largely rewritten in order to take account of these new factors. According to the document: the contact glasses of Fick and Sulzer were corneal ("These lenses, though, were designed to rest on the outer edge of the cornea"), that would be the merit of the Müller ocularists to have added a scleral part ("Mueller's contribution to the problem was in adding a scleral flange"). August Müller and Eugène Kalt are omitted. For Fick, the biographic reference relates to the original German article and not to the English translation of this in the Archives of Ophthalmology.
22. Little M.F., 1934. Presentation of the 26th October 1933 to the New Haven County Medical Society.
23. Rollet D.M., 1936. Read before the New York Academy of Medicine, Section of Ophthalmology, February 17 1936.
24. Dallos J., 1936.
25. Stevens C.L., 1936. The technique was developed in connection with studies of human constitu-

tion in relation to keratoconus at the Institute of Ophthalmology of the College of Physicians and Surgeons and the Presbyterian Hospital, New York.
26. Feldman J.R., 1937. Read before the Section of Ophthalmology of the College of Physicians of Philadelphia, Jan. 21, 1937.
27. Bruce G.M., 1937. From the Department of Ophthalmology, College of Physicians and Surgeons, Columbia University, and the Institute of Ophthalmology of the Presbyterian Hospital, New York City.
28. Mostyn-Brown M., 1936. This document has been kindly communicated to me by Mr. Richard Keeler. I owe him special thanks. Maurice Mostyn-Brown visited the United States on behalf of the Charles H. Keeler Company between the 5th and the 25th of August. The actual year was not mentioned in his report, but various checks suggest the visit likely took place in 1936.
29. Dispensing optician A. Haustetter Inc., 2 East 45th Street, New York City.
30. E. & S. Danz, 122 East 42nd Street, New York City.
31. See chapter 24 § 2.2: 'Wiliam Feinbloom's Combined Contact Lenses'.
32. Obrig T.E., 1937.
33. Stevens C.L., 1936.
34. Obrig T., 1938 a, b.
35. Feinbloom W.M., 1937a.
36. Stevens C.L., 1936.
37. Feldmann J.B., 1937. Read before the Section of Ophthalmology of the College of Physicians of Philadelphia, Jan. 21, 1937.
38. Heydt R.v.d., 1932.
39. Obrig T., 1938b. This lamp is manufactured by Fryxell and Hill, New York.
40. Obrig T., 1942; Obrig T., Salvatori, 1959.
41. Feinbloom W.M., 1937a. See chapter 24 § 2.1.4 and chapter 24 § 2.2: 'William Feinbloom's Combined Contact Lenses'.
42. Feinbloom W.M., Patents 1936a, b, c, 1938; Bausch and Lomb, Patents 1936a, b, 1937; 1938.
43. Boeder P., 1938. Read before the New England Ophthalmological Society, Nov. 16, 1937. - American Optical, Patents 1937a, b; 1938a, b, c.
44. Nelson F., 1938. Presentation on November 20th 1937 at the Colorado Ophthalmological Society.
45. Müller-Welt, 1935a.
46. Moncrieff W.F., 1938. Read October 25th 1937, before the Chicago Ophthalmological Society.
47. Weeks C., 1939. Read September 26, 1938 before the Los Angeles Society of Ophthalmology and Otolaryngology.
48. Crisp W.H., 1938; Dobson M., 1938.
49. Eggers H., 1939a, b.
50. Town A.E., 1939. Read before the Section of Ophthalmology, New York Academy of Medicine, Feb. 20. 1939 - Town A.E., 1940. Presented at the convention of the American Academy of Ophthalmology and Otolaryngology, Chicago, October 10th 1939.
51. Town A.E., 1941. Presentation at New York Society for Clinical Ophthalmology, January 8, 1940.
52. Bettman J.W., 1939.
53. Pascal J.I., 1939a, b.
54. Maisler S., 1939. The gel is manufactured by the Detroit Dental Manufacturing Company.
55. Chisholm J.F., 1940; Barkan O., 1941; Wies F.A., 1941; Goldberg, 1941.
56. Greenspoon R., 1945. The initial fitting had been published in The Optometric Weekly, December 7, 1933.
57. Greenspoon R., 1939. Read before the Academy of Los Angeles County Association of Optometrists April 20, 1939; Neill J.C., 1940; Obrig T., 1938b.
58. Hoff H.J., 1940; Greenspoon R., 1940; Koch C.C., 1939, 1941; Beacher L., 1940, 1941, 1942; Even A.N., 1940.
59. Feinbloom W., 1940, 1941a, b, c, 1942; Anderson E., 1941a, b; Adams E., 1941a, b.