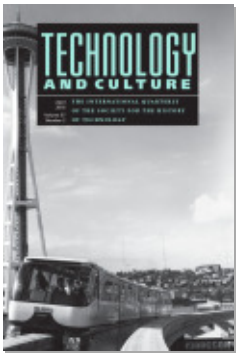
Zoomar: Frank G. Back and the Postwar Television Zoom Lens

Nick Hall



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Frank G. Back and the Postwar Television Zoom Lens

NICK HALL

ABSTRACT: In October 1946, optical engineer Frank G. Back introduced a new zoom lens designed for film and television cameras. The Zoomar lens was adopted by newsreel and television, and soon became ubiquitous in American television production. Zoomar lenses enhanced postwar television, and prepared the ground for the later popularity of zooms in film production. This article explores the wartime innovations and industrial collaborations which aided the development of the lens. It documents a neglected aspect of the history of American television technology, and sheds further light on relations between small inventors and large corporate bodies during the mid-twentieth century.

A variable focus lens fitted to the camera will guarantee an absolutely continuous picture flow and achieve the vividness and variety of closer and wider shots which up to now were only a cameraman's dream.[1]

On 25 October 1946, optical engineer Frank G. Back presented a new type of variable focal length lens to a convention of the Society of Motion Picture Engineers (SMPE) in Hollywood, California. Back told the meeting that the "Zoomar" lens had the potential to revolutionize filmmaking, whether in the field of documentary or education, sports or news, advertising or medical films.[2] Over the following years, Back's Zoomar lens exerted a substantial impact on the American moving-image entertainment industry. But it was in television, rather than film, that its effect was

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0040-165X/16/5702-0003/353–79

1. Frank G. Back, "The Zoomar Lens," 109.
2. Frank G. Back, "The Physical Properties and the Practical Application of the Zoomar Lens," 63.

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most keenly felt. The utility of the zoom lens lay in its ability to magnify or diminish the size of the contents of images without repositioning the camera—an indispensable function as television broadcasters sought to cover fast-changing action at sporting events, parades, and political conventions. By 1957 more than 250 television stations in the United States, as well as numerous broadcasters overseas, had purchased Zoomar lenses.[3] The device was praised in the trade press and described by one industry expert as being "probably the most important accessory to be added to standard TV equipment."[4]

Following their introduction in the mid-1940s, television zoom lenses permanently changed the style and quality of television broadcasts, and prepared the ground for a later increase in the popularity of zoom lenses in feature film production. Today zoom lenses are ubiquitous in professional and amateur photography and filmmaking. However, Back's innovative efforts, and the reasons for the success of the Zoomar lens, have scarcely been documented. Historians of film and television technology have emphasized the use of later zoom lenses in feature film production. Debates have focused on the expressive potential of the zoom's ability to transform perspective relations, marginalizing their more prosaic uses for television and newsreel sports and news coverage.[5] As a result, only slight attention has been paid to the history of the Zoomar lens's invention and innovation. Yet a rich seam of archival resources—including company records, court documents, archive film and television footage, articles in the trade press, patents, and newspaper reports—provides for a detailed history of the Zoomar lens.

The sources for the Zoomar story include: a folder of internal and external communications regarding NBC's first purchase of a Zoomar lens in 1947, held in the NBC Records at the Wisconsin Center for Film and Theater Research in Madison; the stenographer's transcript of *Zoomar, Inc. v. Paillard Products, Inc.*, a 1957 court case which ended Zoomar's control of the American zoom lens market, held among the Irving R. Kaufman Papers at the Library of Congress in Washington, D.C.; and the personal papers of Frank G. Back, held in the Mandeville Special Collections Library at UC San Diego. Oral histories have been taken from a number of television personnel who recall using the Zoomar lens in its earliest days. This study also draws on articles published in the trade press, especially the *Journal of the Society of Motion Picture Engineers* and *American Cinematographer*. Though the article refers to patents, missing from this

3. Transcript, *Zoomar, Inc. vs. Paillard Products, Inc.*, Box 9, Folder 1: 331, in IRKP.

4. Rudy Bretz, *Techniques of Television Production*, 470.

5. For three representative examples, see Barry Salt, *Film Style and Technology*, 258; David A. Cook, *Lost Illusions*, 361; and Geoffrey Nowell-Smith, *Making Waves*, 98. The various uses of the zoom lens in early postwar American television are briefly explored in Nick Hall, "Closer to the Action."

account is Frank Back's inventor's notebook: if he kept one, it is not to be found among his papers. Nor has any archive of Zoomar company records been located: a former firm employee told the author that such papers were destroyed when the company was sold in the late 1970s.

As this article demonstrates, wartime innovations commissioned by the U.S. Signal Corps and Navy Department played a highly significant role in the development of the core technologies within the lens. Through these projects, Frank Back developed a zoom lens that obviated the complex mechanical design of earlier models. Then, during prototyping and early marketing, Back and his fellow investors adopted a range of strategies in order to foster mutually beneficial, hands-on relationships with corporate bodies such as Paramount and NBC, as well as with the many local television stations springing up across the United States. While the story of the Zoomar's invention is revealing of the manner in which small firms and individual inventors were supported by the wartime needs of the U.S. Armed Forces, the innovation process which followed is also instructive of the way in which individual inventors interacted with larger firms—such as broadcasters—in order to widely distribute their products and fund further innovation. Therefore, in addition to illuminating a specific development in the history of television technology, this article adds evidence to the existing body of work focusing on relations between small firms and individual inventors, large corporations, and the U.S. government and military in the American mid-century.

Film history has for many years benefited from detailed studies of the interaction of filmmaking technology and the skills and working practices of inventors and users. Some key works include John Belton's history of widescreen projection, *Widescreen Cinema* (1992), Scott Higgins's *Harnessing the Technicolor Rainbow* (2007), and Patrick Keating's *Hollywood Lighting* (2010). These have emphasized the value of tracing the history and development of technology in addition to studying the style and meaning of films. In addition to entertainment industry case studies, recent accounts of technological development across the boundaries of the Second World War invite parallels that move beyond the production of motion pictures. As discussed later, the development of the Zoomar lens bolsters Eric Hintz's conclusions about "the continued viability of independent inventors as a source of innovations during the twentieth century," while providing another perspective on the interventions of the Signal Corps into wartime innovation.[6]

6. Eric S. Hintz. "Portable Power: Inventor Samuel Ruben and the Birth of Duracell," 55.

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The Zoom: A Brief History

A zoom lens enables a camera operator to alter focal length between a short (wide angle) and long (telephoto) position. When attached to a motion picture or television camera, the focal length of the lens can be varied while the camera runs. This creates a zooming-in or zooming-out effect, which is sometimes mistaken for physical movement of the camera. Alternatively, a zoom lens can be used as a substitute for multiple lenses of different focal lengths. In this case, the camera is stopped, the setting of the lens changed, and the camera restarted. Under these conditions, viewers will probably not be aware that a zoom lens has been used. Today nearly all consumer cameras are equipped with zoom lenses, and even cheap models which lack a variable focus lens often simulate a zoom function digitally. However, this ubiquity is a relatively recent development, and the technology remains less common on professional video and still-image cameras. This is partly because zoom lens systems usually consist of a greater number of glass or polymer "elements." This reduces light transmission and increases distortion, and therefore generally results in a lower image quality than equivalent fixed focal length, or "prime," lenses. As a result, while motion picture cameras designed for amateur use have featured zoom lenses since the late 1950s, many professional photographers and filmmakers have continued to prefer prime lenses.

Historical accounts disagree as to who first "invented" a zoom lens. There is no shortage of accounts of individual lenses which interpret incremental developments as radical ones, or even as "firsts." Such misinterpretations have been applied to lenses innovated in every decade from the 1930s to the 1960s, with European inventions often viewed in isolation from simultaneous developments in the United States, Japan, and other parts of the world. In fact, zooms emerged gradually, through diverse inventions, over a period of decades.[7] As early as 1890, optician Thomas Dallmeyer patented a variable focal length telescope, and an early zoom lens for motion pictures has been dated to 1901.[8] Most accounts, however, settle on the late 1920s as the point at which the earliest innovation of motion picture zoom lenses took place. In the United States, cinematographer Joseph B. Walker developed a zoom lens from 1922 on, filing a patent in 1929.[9] Technicians at Paramount in Hollywood also worked on a zoom

7. The best history of zoom lens technology is given by Rudolf Kingslake in *A History of the Photographic Lens*. The subject has also been discussed from the perspective of film history, especially by Salt in *Film Style and Technology*, by John Belton in "The Bionic Eye," and by Priska Morrissey in "Naissance et premiers usages du zoom."

8. Kingslake, *History of the Photographic Lens*, 155.

9. Joseph B. Walker and Juanita Walker, *The Light on Her Face*, 266–67; Walker, Joseph B. Camera. US Patent 1,898,471, filed 21 September 1929, and issued 21 February 1933.

lens during this period, filing their patent in 1927.[10] Meanwhile, in the United Kingdom the firm of Taylor Hobson developed, and exported to the United States, a zoom lens called the Varo. Each of these lenses was used to an extent in feature film production, though none became ubiquitous.[11]

Despite slow innovation, it would be a mistake to suggest that development on such lenses came to a standstill at any point during the twentieth century. Optical historian Rudolf Kingslake claims that "because of the great Depression that raged during the 1930s, no further development of zoom lenses was undertaken until after World War II."[12] However, the patent record demonstrates that in the United States zoom lens research took place on both coasts throughout the 1930s. Zoom lens designs were patented by the C-Lens Corporation of New York, and by Kodak—while in California researchers at Paramount continued to develop new forms of the technology.[13]

Zoom lens design poses a lot of challenges, many linked to the complexity of ensuring that the lens maintains a constant focal point across a range of focal lengths. During the 1920s and 1930s inventors experimented with different means of solving this problem, alternating between mechanical and optical image compensation, and between linear and nonlinear relations of movement between elements inside the lens system. The extent to which inventions described by patents during the 1930s were innovations is unclear. However, it is beyond doubt that by the beginning of the 1940s, American optical researchers were actively engaged in the development of zoom lenses. Research in this field had been altered, not halted, by economic depression and global conflict. Frank Back did not, as Kingslake's account erroneously implies, revive a field of research that had lain dormant for a decade.

"A Real Contribution to the War Effort"

Frank Back was born in Vienna, Austria, in 1902. Before emigrating to the United States, he undertook an education in mechanical engineering. He gained a bachelor's degree in mechanical and electrical engineering from the Technische Hochschule (Technical University) in Vienna, followed by a doctorate in technical science, while studying optics "as a side line."[14] After graduating, Back worked as a consulting engineer in Vienna

10. Flora, Rolla T. Photographic apparatus. US Patent 1,790,232, filed 21 March 1927, and issued 27 January 1931.

11. Salt, *Film Style and Technology*, 207.

12. Kingslake, *History of the Photographic Lens*, 156.

13. Holst, Lodewyk J. R., William Mayer, and Harry R. Menefee. Lens system. US Patent 2,130,347, filed 22 September 1934, and issued 20 September 1938.

14. Register of Frank Back Papers, in RFBP; Transcript, *Zoomar, Inc. v. Paillard Products, Inc.*, Box 8, Folder 5: 22, in IRKP.

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between 1929 and 1938. During this period he was employed by Georg Wolf, a manufacturer of endoscopes. He visited the United States in 1928, where he promoted an early form of endoscope—a device which *The New Yorker* later described as "a swallowable camera more popular with doctors than with patients."[15] During the early 1930s, he published several research papers relating to intragastric, intralaryngeal, and intranasal photography.[16] By 1938 Back, who was Jewish, had moved to Paris where he continued to work as a consulting engineer. In July 1939, he moved to the United States and until 1944 consulted in engineering for at least three firms in New York City or its vicinity: Gastro-Photor Laboratories, General Power Plant Corporation, and Helix Gage Works.[17]

Throughout this time, Back engaged in substantial research in the field of variable focal length optics. His research was not initially directed toward the development of a zoom lens for motion picture cameras, but his role in developing a viewfinder for motion picture cameras and the projector component of a torpedo-targeting trainer provided opportunities to experiment with variable focal length lens system design principles. Back's viewfinder, developed for the Signal Corps and designated PH-532/UF, was attached to Bell & Howell Eyemo cameras commonly used by battlefield camera operators.[18] It encapsulated the essential principles of a zoom lens, enabling the magnification of the image within the scope while maintaining the size of that image. This compared favorably with earlier viewfinders, which simulated different focal lengths either by mechanically altering the size of the field of view or by arrangements of lenses which performed a zoom-like operation but could not maintain steady image framing or size.[19] It differed from earlier variable focal length lenses—including Joseph B. Walker's design and the Taylor Hobson Varo—by virtue of its optical compensation. Whereas earlier zoom lenses had required mechanically complex nonlinear relationships between the movements of their internal elements, Back's design maintained focus throughout the range of focal lengths by means of a single slideable internal lens assembly positioned between fixed forward and rear lens elements. Changes in focal length could be achieved by moving this internal assembly forward and backward, while the system's point of focus remained approximately stable.

Back's other wartime innovation, a variable focal length projector contained within a device referred to as a Peritelengiscope, was a project of the Navy Department Bureau of Aeronautics Special Devices Depot.[20] The de-

15. Spencer Klaw and Brendan Gill, "The Talk of the Town."

16. Register of Frank Back Papers, in RFBP.

17. Resume, Dr Frank G. Back, 26 August 1980, Box 2, Folder 6, in FBP; see also "Personalia." Back left neither a diary nor an autobiography, and his precise activities and projects during this period are not recorded beyond the details given here.

18. Midge Mackenzie, "An Antiwar Message from the Army's Messenger."

19. Frank G. Back, "A Positive Vari-focal View-finder for Motion Picture Cameras."

20. The Special Devices Depot was established on 1 July 1943. Its location at 1 Park

vice was "designed to project the image of a target vessel on a curved cyclorama screen, and to make this projected image perform all the real and apparent motions of an actual battle ship, as seen from the cockpit of a maneuvering aircraft." Back's contribution was development of a lens system which could project an image on screens at different sizes "without impairing the optical quality of the image." Whereas the viewfinder altered the scale of its image contents while the overall image remained the same size, the projector varied the size of the image itself. Both made use of variable focal length lenses, but unlike the viewfinder, the projector's compensation mechanism was of the more traditional, mechanically compensated, variety.[21]

By October 1945, the Peritelengiscope had been used "for some time in various Navy Training Centers."[22] Back's work elicited warm letters of thanks from the two branches of the military for which he had worked. Following delivery of the Peritelengiscope, Lt. Cmdr. L. D. Wallick, head of the Special Devices Depot, wrote to Back:

> You may be interested to know that previous to entering into a contractual agreement with you on this project, a number of other sources had been considered, but upon presentation of the optical problem, the concurrence of opinion seemed to be that the problem was very nearly impossible of solution. The self-correcting optical system with a minimum number of moving parts, which you devised, has met with the exacting requirements of this problem. That you and your associations have handled this difficult problem so expeditiously, and that you met an early delivery date that hitherto had been regarded with skepticism, is sincerely appreciated. Your ingenuity and cooperation have been a real contribution to the war effort.[23]

The viewfinder project resulted in a similar letter of praise, which also emphasized Back's willingness to cooperate with clients during the design phase. Capt. Lloyd T. Goldsmith, Signal Corps director of pictorial engi-

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Avenue, New York City, "[provided] closer contact between engineering, procurement and distribution activities and manufacturing and engineering facilities located in the New York area." The Depot shared premises with the Training Aids Division of the Army Air Forces, and its primary aim was to produce "synthetic training aids"—including flight simulators, dummy radar displays, and bomb-targeting trainers. The Depot worked at a feverish rate: during 1943 alone it contracted with over 200 companies, spending $3 million per month on the advancement of 415 separate projects. Back's Peritelengiscope, code-named 14-L-1, was but one small aspect of the Depot's work, and is mentioned only briefly in monthly progress reports. A summary of the Depot's work and progress can be found within the Division Histories of the Bureau of Aeronautics, Entry 195, Box 16, in RBA.

21. Frank G. Back, "Nonintermittent Motion Picture Projector with Variable Magnification," 248–49.

22. Ibid., 253.

23. Letter, L. D. Wallick to Frank G. Back, 26 September 1944, Box 3, Folder 26, in FBP.

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neering and research, thanked Back for his "[prompt and wholehearted] cooperation in the matter of mechanical revisions necessary to conform with the requirements of field service."[24] These letters paint a picture of Back as a man who, by the end of the war, was not only a highly effective theoretician but also a well-connected inventor who possessed the skills needed to cooperate with clients in order to deliver workable devices. Importantly, Back had by this stage developed operative inventions based both on mechanically compensated prior art (the projector) and on a novel optically compensated design (the viewfinder). The novel optical principles of Back's viewfinder design were to form the basis of the Zoomar lens.

Developing the Zoomar

From around 1943, Back divided his time between military contracts and the development of what was to become the Zoomar lens. In a workshop at 381 Fourth Avenue, Back—with his assistant Herbert Lowen—spent "two or three years" developing the lens. The process was trial-and-error: they "computed lenses, . . . made models, . . . tested all these models, tried them out, and evaluated the results."[25] It is likely that, at this point, the development processes for the viewfinder and the Zoomar lens were one and the same, but because we lack notebooks or journals relating to this period, it is not possible to determine the point at which the Zoomar lens could be characterized as a different invention from the viewfinder. As Back's patent for the resulting device stated, the project presented significant mechanical challenges:

> it is virtually impossible to obtain an accurately focused image over the whole focal range. The spacing of the several component parts of these varifocal lenses is so critical that even a minute deviation throws the image entirely out of focus. Normal wear in the moving parts suffices to throw the system out of focus.[26]

A later account suggested that perfecting the image it produced was as challenging a task as the initial design of the lens, because

> the complicated optical system of the Zoomar was basically afflicted with many aberrations. Correction of these aberrations was one of the major tasks in designing the Zoomar. Ordinary correction methods of optical design broke down and [other] ways had to be devised.[27]

24. Letter, Lloyd T. Goldsmith to Dr F. G. Back, 22 May 1945, Box 3, Folder 26, in FBP.

25. Transcript, *Zoomar, Inc. v. Paillard Products, Inc.*, Box 8, Folder 5: 38, in IRKP.

26. Back, Frank G. Varifocal lens for cameras. US Patent 2,454,686, filed 30 July 1946, and granted 23 November 1948.

27. Back, "The Physical Properties and the Practical Application of the Zoomar Lens," 59–60.

This was not a trivial task, taking place during a period in which "all lenses were designed by hand using a desk calculator and a book of tables" in a process characterized by "eternal raytracing."[28] By adopting an optically compensated design, Back removed many of the problems associated with precision engineering nonlinear mechanisms. However, this created a more complex mathematical problem. For Back, this challenge was compounded by the location of his workshop, in which delicate assemblies of lenses were subject to disturbance from the vibrations of nearby trains.[29]

Despite the heavy burden of such calculations, and competition from other projects, Back's zoom lens development work reached beyond the laboratory. Toward the end of the process, he collaborated with working camera operators, who tested prototypes of the Zoomar lens. New York cameraman and film producer Raymond B. Gamble was provided with "an experimental lens . . . before it was put on the market," and "used it to see for myself the operation of the lens." For Gamble, the Zoomar was "very new in the industry, very revolutionary, something we had never had before."[30] He first used the lens to film dioramas at the Museum of Natural History, and later took it to the Bronx Zoo to film "a television show for Alexander Smith [Carpet Mill] entitled *The Magic Carpet*."[31] In addition to working alongside Gamble, Back collaborated with Hearst Metrotone *News of the Day* cameramen, and with the Long Island Optical Company.[32]

By July 1946, the lens was judged sufficiently advanced to be sold commercially. Back applied for a patent to protect the device's design, and a few months later applied for a trademark on the name "Zoomar."[33] Designed for use with film cameras, the lens offered a 3:1 zoom ratio ranging from a wide angle of 17mm to 53mm at its longest extension. The lens contained 22 glass elements, some of them positioned within an internal barrel (fig. 1). By manipulating a lever on the lens, the camera operator moved the internal barrel forward or back, thereby zooming in or out.[34] Over the following year, Zoomar lenses were sold, leased, or loaned to a range of industrial and commercial film organizations: first to the New York film company Hartley Productions, and later to Fox Movietone, the Medical Film Guild, and the Ford Motor Company in Detroit.[35]

Back's patent filing and trademark application coincided with a

28. Kingslake, "Lens Design by Desk Calculator (1920–1960)," 3.

29. Bill Pegler interview.

30. Transcript, *Zoomar, Inc. v. Paillard Products, Inc.*, Box 9, Folder 1: 312, in IRKP.

31. Ibid., 307, 309. *The Magic Carpet* was a television pilot produced by Gamble and broadcast by DuMont on 16 May 1947. See Vincent Terrace, *Encyclopedia of Television Pilots*, 177.

32. Back, "A Positive Vari-focal View-finder for Motion Picture Cameras," 468.

33. Back, Varifocal lens for cameras (see footnote 26); Zoomar. US Registered Trademark 432,534, 2 September 1947.

34. Rudolf Kingslake, *A History of the Photographic Lens*, 170.

35. Transcript, *Zoomar, Inc. v. Paillard Products, Inc.*, Box 9, Folder 1: 318, in IRKP; Brochure, Box 596, Folder 32, in NBCR.

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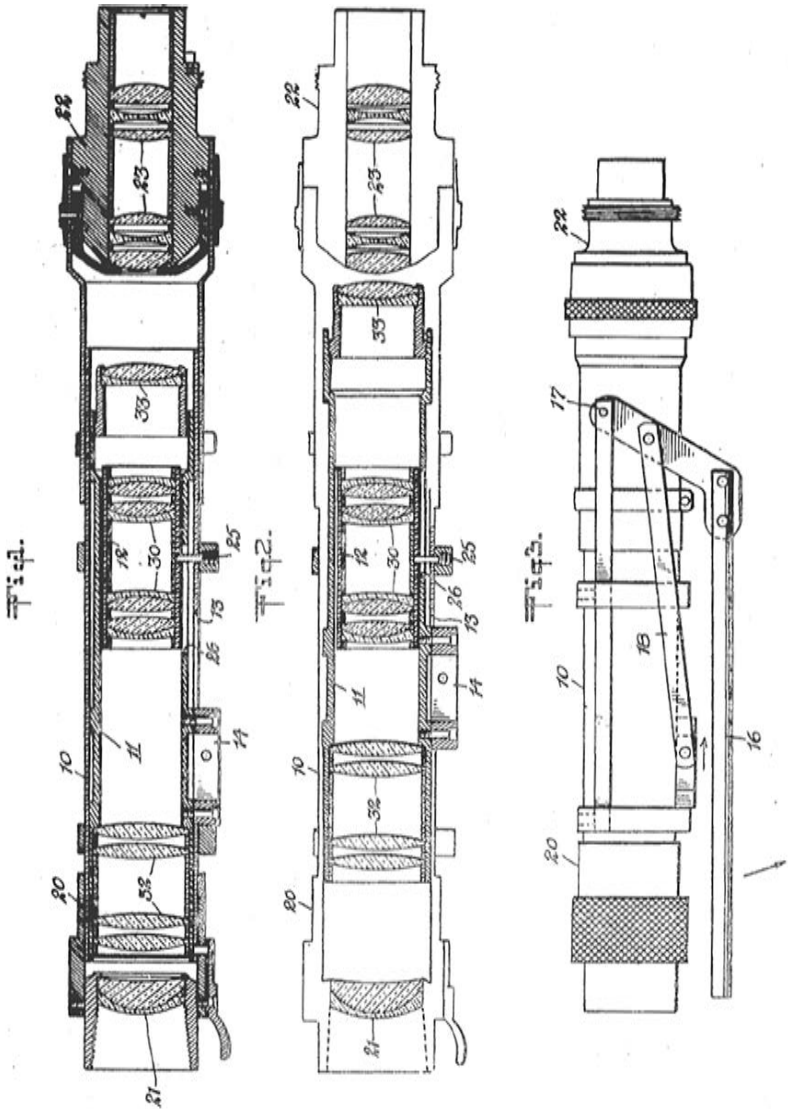

FIG. 1 Sketches from Frank Back's patent "Varifocal Lens For Cameras," showing the layout of lens elements inside the barrel, and the focal length adjustment lever. (Source: U.S. patent 2,454,686.)

marked shift in the marketing of the Zoomar lens. While developing the lens, Back had worked under at least two company names: Viewfinder Corporation, and Research and Development Laboratory. Both were based at 381 Fourth Avenue, where Gastro-Photor Laboratories (where Back did consulting work) had also leased an office since 1941.[36] After the prototyping phase, Back came to the attention of film producer Jerry Fairbanks and his publicist Jack Pegler, who invested in the new technology. Under the auspices of Fairbanks's industrial film production company, Jerry Fairbanks Productions, the trio pursued bigger customers.[37] Newsreel giant Paramount was the first major corporate customer to buy a Zoomar lens designed for film cameras, at a cost of $12,500, in October 1947.[38] The *New York Times* reported that the studio's newsreel division had purchased the lens, known as a Field Zoomar, in order to cover the baseball World Series between the New York Yankees and Brooklyn Dodgers. The newspaper reported Paramount's claim that the use of the Zoomar amounted to "history . . . being made," explaining that the lens:

> makes it possible to take close-ups of every play and player on the field with uninterrupted continuity. With a flick of the wrist the Paramount camera man, equipped with the Zoomar lens, follows the ball from pitcher to batter and from the batter to the depths of any part of the field, keeping the entire action in perfect focus.[39]

Back worked closely with Paramount to ensure that the Zoomar lens performed as well as possible, later recalling that he had been present when the company conducted its first field tests, overseeing "almost every take because I was helping the newsreel men with that lens."[40]

Footage made with the Zoomar was included for the first time in a Paramount newsreel dated 11 October 1947.[41] Spectators in movie theaters across the United States can have been left in no doubt of the significance of the new technology: the sequence was preceded with title cards stating: "*Paramount News* introduces the greatest innovation in newsreel coverage since the invention of sound—The Zoomar Close-up Lens!" This was followed by a series of shots showing the lens being operated by a camera-

36. Kingslake, *A History of the Photographic Lens*, 201; Back, "A Positive Vari-focal View-finder for Motion Picture Cameras," 466; "Business Firms Lease Downtown."

37. Two companies—Zoomar Incorporated and Television Zoomar Corporation—were subsequently established to manufacture and sell lenses. Jack Pegler remained employed by Jerry Fairbanks Productions until 1949 (see "Fairbanks Firm Shifts Sales Personnel"). In 1952, after the companies moved to new headquarters in Glen Cove, New York, Fairbanks sold his shares to Back and Pegler (see "Television Chatter," 19).

38. "Par Reel Tried Zoomar Lens on World Series."

39. A. H. Weiler, "Betty Smith Looks at the South."

40. Transcript, *Zoomar, Inc. v. Paillard Products, Inc.*, Box 8, Folder 5: 29, in IRKP.

41. See "'Zoomar' in Action." The newsreel in question is Vol. 7 No. 13 of 1947, Accession 2746, Motion Picture Collection, in PN.

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man, and a montage demonstrating the shots it could achieve, while narrator George Putnam explained:

> Through this lens the eyes of the world take on third dimension [*sic*] of movement. You in the audience are brought right in on the game as it progresses on the field. Actually a player's eye view as our camera zooms with the action, every play followed to completion. Now, watch the results as this revolutionary lens is used for the first time in newsreel coverage.

In the baseball highlights which followed, Zoomar shots were used on several occasions, and *Variety* reported that "[the] newsreel threw the house into a feverish parallel of the ballpark. Focus is so sharp players' expressions become public knowledge."[42]

Alongside Paramount's promotion of its new technology to the audience, the company also distributed publicity to theater managers emphasizing the positive reaction Zoomar coverage had provoked among audience members and reviewers in the press. The material quoted a company agent in New Orleans who remarked that "everything that has been said about Zoomar Lens is more than true. One exhibitor shook his head and said he didn't see how it was possible." Another, from Connecticut, said: "Our major accounts are advertising Zoomar in the newspapers, and featuring it in the lobby."[43] By the end of 1947, Hearst's *News of the Day* had joined Paramount in using a Zoomar lens to enhance its sports newsreel coverage.[44]

Television: Innovation, Diffusion, and Ubiquity

Paramount's enthusiastic adoption of the Zoomar supplied substantial capital with which to produce more lenses. This enabled Back, Pegler, and Fairbanks to invest in the newly reborn and fast-growing postwar television industry. Though initially designed for use with film cameras, a television version of the Zoomar lens had been planned by Back at the prototype stage, and a prototype had been demonstrated in April 1947 inside Studio 3H at NBC's Rockefeller Plaza headquarters.[45] Two image orthicon cameras—"one mounted on a moveable dolly, the other stationary"—captured a performance by "balladeer Tom Scott, ventriloquist Paul Winchell, and dancers Nelly Fisher and Jim Starbuck." Camera operators demonstrated the different means of moving closer to the action: while one phys-

42. "'Zoomar' Lens a Boon for Newsreels."

43. Promotional Materials, undated, Box 596, Folder 32, in NBCR.

44. Evidence of Zoomar lenses in use in Hearst newsreels can be seen, for example, in the 15 December 1947 edition of *News of the Day*, VA12490M, in HMNC.

45. The potential application to television cameras is mentioned in Back's patent (see footnote 26).

ically moved the camera forward, the other varied the focal length of the Zoomar lens from a fixed position.[46] The trade press noted the Zoomar's array of advantages, the most striking of which was to be a 75 percent reduction in the cost of making "dolly" shots—tracking shots with the camera moving on a wheeled platform.[47] Whether in cramped studios or at remote broadcasts from sporting events, existing cameras relied on rotating turrets of three or four lenses of different focal lengths. The Zoomar lens promised to reduce the need for the sluggish rotation of these turrets, resulting in more responsive and fluid television coverage. In the optimistic publicity that followed, NBC vice president and chief engineer O. B. Hanson presciently remarked, "ultimately, the Fairbanks Zoomar lens will become standard equipment in all television cameras."[48]

The public demonstration was primarily a promotional exercise, rather than a rigorous technical test, and it formed one of the early stages of a lengthy process of negotiation between Jerry Fairbanks Productions and NBC. Jack Pegler led the discussions, while mid-level NBC executive Noran "Nick" Kersta represented NBC.[49] Telegrams and interoffice communications offer a valuable insight into the business relationship between Fairbanks and NBC. Attempts to convince NBC of the value of Zoomar lenses were met initially with skepticism: NBC tried to negotiate lower prices for the equipment, and even tried to engineer an alternative form of zoom lens to avoid having to make a purchase. Once NBC received the lenses, it played an active role in shaping the final form of the technology, insisting that the lenses be altered and fixed where problems arose. By robustly objecting to the device's shortcomings, but maintaining a positive approach to the overall venture, NBC's purchase of the Zoomar lens effectively became part of the device's prototyping and development process.

Pegler's initial aim was to lease lenses for a period of one year to each television network, but he quickly became frustrated by NBC's failure to agree to such a commitment. Whereas Pegler sought to tie NBC into a restrictive leasing deal, Kersta's priority was to quickly obtain a Zoomar lens so that NBC engineers could thoroughly test its capabilities and determine its potential value. In May 1947 Kersta wrote to a colleague that the only way to fix the value of the lens was to use it in "actual television operations in the field or on as many different types of shows as we can do within a one-month or two-month period." He resolved to "press [Pegler] for the free use of this lens for a one-month period," but tempered the urgency of the situation by pointing out that—should NBC's march be stolen by a competitor—"we will watch their results. We have had the

46. "New Tele Lens Gives Longshot or Closeup without Switching," 15.

47. "New Zoomar Tele Lens Expected to Cut Dolly Shot Costs about 75%."

48. "New Lens for Televising Simplifies Operation."

49. Kersta was at this time manager of NBC's New York television station WNBT-TV. See "Mullen to Head NBC's Tele Push."

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jump promotion-wise and publicity-wise anyway, and nobody can claim 'firsts.' The pillars of television will not crumble if we do not have one of these lenses."[50]

Discussions continued within NBC until July 1947, when a decision was finally made to lease a lens for testing. However, there was a delay in drawing up an agreement, and a fortnight later Pegler and Fairbanks resumed their marketing efforts toward NBC. Pegler sent clippings from *Popular Science* magazine and *Variety*, and emphasized that the latter included a quote from O. B. Hanson—Kersta's superior—declaring that the Zoomar lens was "the best thing that's happened to television sports since the invention of the RCA image orthicon tube."[51] Pegler also appears to have targeted NBC offices in other cities, since at the same time, NBC executive George H. Sandefer, based in Washington, D.C., sent a memo to Kersta, remarking: "We have heard a great deal about the Zoomar Lens and would like to know if you plan a demonstration or program using it in the near future."[52]

Having recaptured NBC's attention, Fairbanks abandoned his plan to lease Zoomar lenses, instead opting for outright sales. He communicated the news to NBC executive Sydney Strotz at a meeting in Los Angeles in early August. According to the report Strotz made to Kersta, "because of extremely high cost of tooling up large scale production," Fairbanks had offered to sell NBC sixteen lenses, over the course of two years, at $5,000 each, or individual lenses at $10,000 each. "He states this is best he can do."[53] This was aggressive negotiating: only a few weeks earlier, Kersta had struggled to muster support for the purchase of a single test lens. In the weeks that followed, with Fairbanks demanding a bulk order to secure the agreed price, NBC technicians investigated alternatives. Kersta ordered a study of "a zoom effect by all-electronic means in the television camera." NBC engineers had already explored this principle, but carried out further laboratory tests. The results fell heavily in Zoomar's favor. Engineers reported significant problems with electronic zooming, including unwanted image persistence and "serious geometric distortion." They concluded that it would take at least six to eight engineer-weeks of effort to prepare a demonstration, which would in any case "probably be somewhat inferior to results now being shown by use of the Zoomar lens."[54]

50. Memo, Noran E. Kersta to John F. Royal, 15 May 1947, Box 596, Folder 32, in NBCR.

51. See "Zoomar Zooms Tele Along," enclosed with Letter, Jack A. Pegler to Noran E. Kersta, 25 July 1947, Box 596, Folder 32, in NBCR.

52. Memo, George H. Sandefer to Noran E. Kersta, 24 July 1947, Box 596, Folder 32, in NBCR.

53. Cable, Sidney N. Strotz to Noran E. Kersta, 5 August 1947, Box 596, Folder 32, in NBCR.

54. Letter, R. E. Shelby to O. B. Hanson, 7 August 1947, Box 596, Folder 32, in NBCR.

With NBC's tests unpromising, price negotiations with Fairbanks and Pegler moved to their final stage. After taking up negotiations with Pegler over the revised $10,000 asking price, the two sides met halfway. Kersta issued a purchase requisition for two Zoomar lenses at the compromise price of $7,500 each.[55] In light of the compromise, Kersta stipulated that NBC was making "an outright purchase" with "no restriction on the use to which we put these Zoomar Lenses." In addition, he wanted to use the "pilot model" until delivery of the first lens, as he was "especially interested in getting the use of this pilot for possible use at the World Series and our football games."[56]

On 3 October, Pegler signed a sales agreement promising the delivery of two Zoomar lenses within eight weeks. The agreement bound Jerry Fairbanks Productions to "make every reasonable effort" to deliver a working lens to NBC in time for the 1947 World Series "and as many of the early football games as possible." It further stated NBC's understanding that a zoom lens with a longer range was in development, and that when perfected two copies of the newer lens would be purchased by NBC at a price of $7,500 each.[57] Jerry Fairbanks Productions immediately added the NBC purchase to its promotion of the Zoomar lens, and an article in the 8 October edition of *Radio Daily*—copied to NBC as part of Zoomar's marketing efforts—noted that CBS and three local stations had also bought versions of the lens. Modified for television image orthicon cameras, the Studio Zoomar lenses offered a choice of focal lengths, from 3 to 9 inches and from 4 to 13.5 inches. Because the design of television cameras was different from film cameras, the focal length of the lens was adjusted by a push-rod which extended through the body of the camera and along the length of the lens body.

Because of the rush to deliver lenses in time for NBC's coverage of baseball and football, and because of the challenges inherent in the manufacture of zoom lenses of a standard suitable for film and television production, the equipment delivered to NBC in late November 1947 was far from perfect. Engineer Noel Jordan noted that his colleagues observed a "lack of resolution"—fuzziness—in one lens. The faulty lens was immediately replaced, yet over a longer course of testing, further problems became apparent. Technicians observed that the lenses appeared to be "slower" than promised—rating f/6.3 as opposed to the claimed f/4.5. In photography, the f-number is the ratio of the focal length of a lens to the diameter of its aperture. It is an expression of the amount of light which can enter a lens.[58] This

55. Purchase Requisition, Noran E. Kersta, 13 August 1947, Box 596, Folder 32, in NBCR.

56. Letter, Noran E. Kersta to Jack A. Pegler, 13 August 1947, Box 596, Folder 32, in NBCR.

57. Letter of Agreement, 3 October 1947, Box 596, Folder 32, in NBCR.

58. For a more detailed explanation, see Warren J. Smith, *Modern Optical Engineering*, 152.

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rating was particularly important because a lower *f*-number permits the use of a lens in lower ambient light conditions (such as a remote broadcast on a cloudy day) or with a recording medium (such as an early television camera iconoscope tube) which requires greater illumination in order to function satisfactorily. Furthermore, a technician noted that

> when opened all the way, it is fuzzy around the edges and tends to blur at both maximum and minimum angles. . . . Shortly after the game was underway, we became increasingly aware that the Zoomar picture was considerably below the standard of our regular lens.

The problems were so serious that engineers removed the lens after the first quarter of the game. Noting that the Zoomar's performance improved markedly when used set to a smaller aperture, they concluded that the device was better suited for use in bright sunshine. Picture problems aside, Jordan noted that substantial challenges lay in the unfamiliar nature of the lens: "We have much to learn about the technique of using the Zoomar. I think skillful use can only come with experience, but assuming we can get a good picture and get our cameramen and directors used to it, I feel it can add tremendously to our coverage on field pick-ups."[59]

News of NBC's dissatisfaction quickly reached Jerry Fairbanks, who cabled Jack Pegler the following day to ask: "Are you sure these lenses were properly assembled and tested before delivery? A little of this kind of publicity can do the Zoomar alot [*sic*] of harm."[60] In turn Pegler reassured NBC that "if there is anything wrong with the lenses we are most anxious to make necessary adjustments," and Zoomar engineers worked with NBC over the following three weeks. NBC withheld payment until mid-December, paying only after Zoomar promised to make alterations to the lenses delivered to NBC, and to incorporate the same changes into future models of the lens.[61] Despite these modifications, NBC engineers remained dissatisfied. In mid-December, television field supervisor F. C. Wilbur noted that:

> during operation, the lens elements seem to shift around and become out of line so that when the lens is restored to a wide angle position, it becomes out of focus. Also, during a zoom, the lenses go in and out of focus. During mechanical operation, it is pretty hard to pan the camera and zoom smoothly at the same time and also focus at times.[62]

59. Memo, Noel Jordan to Warren Wade, 24 November 1947, Box 596, Folder 32, in NBCR.

60. Letter, Jack A. Pegler to Noran E. Kersta, 25 November 1947, Box 596, Folder 32, in NBCR.

61. Cable, R. E. Shelby to S. N. Strotz, 19 December 1947, and Memo, R. E. Shelby to N. E. Kersta, 9 January 1948, Box 596, Folder 32, in NBCR.

62. Letter, F. C. Wilbur to R. E. Shelby, 19 December 1947, Box 596, Folder 32, in NBCR.

Despite the string of technical problems which bedeviled the Zoomar lens in its earliest days at NBC, the company maintained the critical but constructive approach that characterized its relationship with Zoomar. Wilbur tempered his list of complaints about the lens's technical shortcomings with the observation that: "So far, the best use of the Zoomar lens was made on the Macy's Thanksgiving Day programs where the coverage was from ten blocks away to two blocks away. I believe the lens has great possibilities and can be improved upon."[63]

As they began to market the Zoomar lens to the numerous other television stations being established across the United States in the late 1940s and early 1950s, Back, Pegler, and Fairbanks continued their tripartite sales and marketing strategy. In the autumn of 1947, while Pegler negotiated with NBC over Zoomar specifications and delivery schedules, Fairbanks embarked on a "two-week tour of Eastern and Midwestern television stations, during which he supervised the installation of Zoomar television lenses in several video stations," while Back traveled to California to meet prospective customers there.[64] This was the beginning of a personal sales and promotion effort which lasted several years and included visits to new television stations from coast to coast. Plans to lease lenses to local stations were abandoned in favor of outright sales.[65] Business was brisk: by November 1947, Jerry Fairbanks Productions reported that orders had been received for Zoomar lenses from seven stations in Los Angeles, New York, Philadelphia, Washington, D.C., Chicago, and Baltimore.[66] By now Fairbanks was struggling to fill orders on time: delays in the manufacturing process meant that the company was forced to rush a demonstration lens to KTLA in Los Angeles in order for it to be used on coverage of that year's Rose Bowl football game.[67] Nonetheless, by the end of the decade, with production capacity increased, at least 31 television stations—about one-third of the approximately 100 stations in operation at this point—had purchased Zoomar lenses.[68]

Zoomar's marketing strategy toward local television stations was more informal than the approach to NBC. Unlike the protracted negotiations and multiple tests demanded by NBC, sales discussions took place relatively quickly at the level of local stations. Visits there involved a meal, meetings with key personnel, and a hands-on demonstration of the technology. Jack Pegler's son Westbrook "Bill" Pegler II, who started work for the Television Zoomar Corporation in the 1950s and later became a shareholder, understood that:

63. Ibid.
64. "Jerry Fairbanks Group Returns from Hawaii"; "Technical."
65. "Zoomar Production Zoomed by Fairbanks."
66. "Songwriter to Make 16mm for Nontheatrical Use."
67. "Zoomar in Rose Bowl."
68. "Zoomar Lens—Six More TV Outlets Buy." For figures on television stations in operation by 1949, see J. Fred MacDonald, *One Nation under Television*, 43.

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> New tv station[s] were opening up like popcorn—Pegler and Back would show up for the openings and bring the zoom lens. Many of the new stations were wealthy radio stations and their staff couldn't barely "spell television"—so when word got out that Back/Pegler actually [knew] how to set up a tv camera—they became very popular. However, finesse was needed—didn't want to make the radio engineers look like "dummies"—so—they would arrive in the AM—put the lens on a camera—then it would be lunch time—so Pegler invited everyone to a fancy lunch—and just after the soup, Back excused himself—[drove] back to the station—and set up the electronics for the big demo after lunch. As there was no interconnect—each station had to program everything. The easiest/cheapest activity of interest was sports—which made a pretty boring show without a zoom lens.[69]

Robert J. Roth, who worked as a camera operator for WAVE-TV in Kentucky in the late 1940s, was present during Frank Back's 1949 visit to Louisville to set up the station's zoom lens, which was to be loaned for coverage of the Kentucky Derby. Roth recalled:

> It was very stressful, because we practiced all afternoon before the Derby, and the Zoomar lens had a rod [coming] out from the center of it that you pulled to zoom it. And you had, with your one hand keep [*sic*] the camera trained at the proper spot, and then you would zoom in and zoom out to get the picture that you wanted. It worked well, [but] we couldn't use the full close-up position because the picture would get fuzzy on the edges, so [Back] put a stop on the rod so that you could only zoom to a certain point.[70]

Not long after the Derby, WAVE-TV acquired a Zoomar lens of its own, which was frequently loaned to neighboring stations owned by the same company.[71]

WAVE-TV's adoption of the Zoomar lens mirrors the device's innovation across the American television industry. The biggest selling point of the lens was its ability to improve the visual appeal of sporting television coverage, and the same ability to capture unpredictable action proved advantageous to news camera operators—notably to those working at the Democratic and Republican National Conventions in 1952.[72] Its sporting applications were broad: in addition to baseball, football, and horseracing, Zoomar lenses were used in the televising of boxing, golf, and boat-racing. Aside from sports coverage, Zoomar lenses provided close-up views of

69. Bill Pegler email.
70. Robert J. Roth interview.
71. Norman Preston interview.
72. See Sam Chase and Jerry Franken, "Louis-Walcott Fight"; "WPTZ at US Open"; "WXYZ-TV Sells 5-Hour Boat Race to Chevvy."

FIG. 2 Frank Back (r) and Burr Tillstrom (l) examine a Studio Zoomar lens mounted on a WBKB camera on the set of the children's entertainment show *Kukla, Fran and Ollie*. (Source: *American Cinematographer* 50, no. 6 [June 1949]: 202. Image reprinted courtesy of *American Cinematographer* magazine.)

events like Gen. Douglas MacArthur's return from Japan, and the inauguration of President Eisenhower, but were also used in the production of more mundane televisual attractions—one of the earliest of which was the live broadcast, in November 1948, of the first lowering of Chicago's new State Street Bridge.[73] Meanwhile, inside television studios, Zoomar lenses shaped routine productions. Episodes of the NBC network show *Kukla, Fran and Ollie*, which originated from WBKB in Chicago, were shot almost exclusively via the Zoomar lens, partly because of cramped studio conditions and partly because mismatched image orthicon scanning tubes meant that switching between cameras could be a visually jarring affair[74] (fig. 2). The wide-ranging impact of the Zoomar lens was thus cemented by the early 1950s. During that decade, the Zoomar Corporation produced several improved versions of the lens, and by 1957 the company had sold lenses to more than half of the television stations then operating in the United States.[75]

73. See Bundy, "Industry Hits All Time High on Tough MacArthur Assignment," 3; Bert Briller, "Iconoscopes Invade Ike Inaugural"; "Simple TV Remote."

74. Victor Ford, "How Zoomar Aids TV Photography," 214.

75. Jack Pegler testified under oath in mid-1957 that the company had by then sold

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Conclusions

The story of the Zoomar lens reveals important insights into the way in which a technological innovation emerged out of wartime research, its conversion to peacetime applications supported by interaction with large-firm customers. This is particularly evident in the interaction of Jerry Fairbanks Productions and NBC. Though much smaller than NBC, Fairbanks was able to engage with its customer by adopting the larger company's management structure of executive, middle-management, and research and development divisions. This mimicry of a large-corporate structure provided compatible systems through which the two were able to communicate. Following an introductory meeting attended by Jerry Fairbanks, the majority of dialogue and negotiation was carried out by Jack Pegler, who communicated directly with Noran Kersta. Fairbanks, it can be surmised, was located for most of this time in Hollywood. Despite his geographical distance, he remained in the background as a senior figure able to accept or deny deals negotiated between Kersta and Pegler, while O. B. Hanson embodied a similar role at NBC. As the inventor responsible for the technology, Frank Back remained in the background, and appears to have played no direct role in negotiations with NBC. However, when it was time for the company to physically test the lens, Back became closely involved, personally supervising the experiment and showing engineers how best to use it. Moreover, despite his disconnection from the sales effort, Back was prominently featured in publicity material, as both the "genius" behind the Zoomar lens and as the artisan responsible for building by hand the first batch of models.[76]

While Jerry Fairbanks Productions nimbly imitated large company structures in order to gain access to NBC, that company's television division took a substantial risk in order to support the development of the zoom lens. The zoom has often been described as a cost-saving technology, because it can remove some of the expense associated with moving camera equipment around a set. However, Fairbanks, Pegler, and Back demanded a high price for Zoomar lenses in 1947, even though the device was largely untested and there were few people in the television or film industry familiar with it. An investment in zoom lens technology would by no means have been certain to deliver a return—Paramount had not yet demonstrated its lens publicly—and the documents discussed above confirm that NBC television executives were aware of the risk.

However, the company's priorities appear to have been split. On the one hand, their executives negotiated to obtain the technology for as little

"over 257" lenses. 485 television stations were in operation in the United States by the end of 1958: see MacDonald, 63.

76. "Fairbanks in Production for Zoomar Tele Lens," *Radio Daily*, 8 October 1947, among Promotional Materials, undated, Box 596, Folder 32, in NBCR.

money, and with as few restrictions, as possible. They investigated in-house alternatives to the Zoomar lens, and were cool-headed in the face of some of Fairbanks's tougher negotiating positions. NBC successfully negotiated lower prices, and once agreement had been reached it placed pressure on Fairbanks to make quick deliveries. On this evidence, the relationship between NBC and Zoomar appears adversarial. However, NBC's position was nuanced. Kersta was keen to adopt the new technology, and the autumn and winter sporting calendar imposed an urgent deadline. The rush to provide lenses to NBC explains why NBC engineers treated the lens more as a test model or prototype. This attitude both defended NBC's interests and budget while also engaging Zoomar in refinements. As a result, the negotiation is best understood in the context of a constructive relationship which helped Zoomar to complete the prototyping and testing of the new lens. It may be seen not only as the first innovation of the Zoomar lens in television, but also as a further stage of development and testing early in the life cycle of the invention.

The Zoomar story, along with other lens developments discussed above, also emphasizes the extent to which zoom lens technology developed continuously and incrementally throughout the twentieth century, and how technologies designed for television inspired those designed for motion picture filming. Although it consisted of minor modifications and improvements to existing technologies, as a package the Zoomar lens was a radical development that substantially enhanced the reach and flexibility of early postwar television production technology. However, while zoom shots quickly became ubiquitous in American television, it was not until the mid-1960s that a 10:1 zoom lens manufactured by the French firm Angénieux saw widespread adoption in the American motion picture industry.[77] Zoomar's key contribution was therefore subtle. It gradually made "zooming" a more desirable, acceptable, and practical technique, in turn spurring demand for zoom lenses suitable for feature film use—that is, with higher optical quality and greater zoom ranges.

Indeed, by the mid-1950s, Frank Back was fighting a patent battle with a new market entrant, the American subsidiary of the Swiss camera manufacturer Paillard-Bolex. Paillard Products, Inc., had been importing French zoom lenses which were better designed than Zoomar's for motion picture filming. The New York Southern District Court ruled that Back's patent overreached by appearing to cover all zoom lenses of any design. This ruling opened the American market to foreign zoom lenses.[78] After a

77. Kingslake, *A History of the Photographic Lens*; Salt, *Film Style and Technology*; Belton, "The Bionic Eye"; and Priska Morrissey, "Naissance et premiers usages du zoom."

78. For the full judgment, see Zoomar, Inc. v. Paillard Products, Inc. 152 F. Supp. 328, 5 June 1957. See Joseph E. Gortych, "Lens Design Patents," for an elegant summary of the judgment within the broader context of patent cases relating to optical technologies. The effect of the judgment on the market was immediately recognized: see "Zoom Lens Rights Are Held Invalid."

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few years Zoomar ceased research and development on new lenses, and instead focused on the distribution of foreign-made equipment, becoming one of the leading distributors of the Angénieux 10:1 lenses which in 1963 heralded the beginning of a "zoom boom" in the American film industry. The link between the zoom lens in early postwar television, and in cinema in the 1960s and 1970s, is therefore much deeper than simple technological availability or stylistic preference: Frank Back and Jerry Fairbanks Productions disrupted the market, creating a new standard on which competitors could improve.

Frank Back was described, in his lifetime, as the "'father' of the modern zoom lens."[79] Yet despite his evident skill in optical theory and engineering, the circumstances of his life offer a sobering corrective to such a simplistic assessment. Back was born in Austria at a time when that country's academic institutions in the fields of physics and engineering were strong. He had the good fortune, as an Austrian Jew, to escape his country in 1938, and to leave Europe altogether before the outbreak of the Second World War. However, it must also be noted that Back's move from Europe to the United States was part of a broader transition of optical skills and labor. Back recalled in 1950 that:

> Oddly enough, these great strides in lens-making progress have come about simultaneously with a shift of the photographic center of the world from the eastern to the western hemisphere. America today leads the world in the production of high quality lenses. Before World War I, most good lenses were made in Europe. But gradually—thanks to scientists here and many who came here from abroad—this country has taken the lead in high quality lens production.[80]

In this context, attention must also be paid to similarities between the innovation of the Zoomar lens and the inventive activities of a number of other wartime innovators and industries—especially in their interactions with military-industrial institutions which sponsored and encouraged them during and after the Second World War. There are particularly strong parallels to Eric Hintz's case study of the development, by Samuel Ruben and Duracell, of portable batteries; with Richard J. Thompson's research into the Signal Corps' intervention in the development of crystal frequency control; and especially with Giles Taylor's account of the Waller Flexible Gunnery Trainer, which later became the Cinerama motion picture exhibition system. In Back's work we see further evidence to bolster Hintz's conclusions about the viability of the small-scale inventor in the mid-twentieth century.

Frank Back and Samuel Ruben followed similar paths: both were individual, independent inventors who carried out their work outside the aus-

79. "Industry News," 646.
80. Frank G. Back, "Optical Lens Development," 62.

pices of large-firm research and development departments. They were polymaths: Ruben, like Back, "worked on a fascinating assortment of defense-related ideas."[81] Both men converted their technologies to suit postwar needs, and both saw their technologies flourish in the commercial market once combined with other new technologies. For Ruben, miniature batteries awaited transistors, while for Back, the Zoomar lens did not reach its full potential until the advent of postwar television. Even then, the lens did not "sell itself": it required energetic promotion within the newsreel and television industries. The success of the Zoomar was as much a result of the efforts of Back, Pegler, and Fairbanks to persuade skeptical camera operators, television directors, and station owners of the benefits of an expensive and unfamiliar new piece of equipment as of the technology itself.

The present case study therefore sheds light on strategies adopted by inventors when interacting with commercial customers in peacetime, and—in this case—when negotiating film and television's peculiar mix of social and stylistic norms and preferences. Furthermore, for Back and Ruben alike, research and development work was supported in part by contracts with Signal Corps Engineering Laboratories (SCEL). SCEL's proactive approach to innovation—reaching out to potential inventors to solve specific problems—has been shown by Thompson to have been a significant aspect of the way in which the Corps solved the problem of crystal frequency control.[82] In the case of Zoomar we see similar proactivity in a different division of the Signal Corps; however, we find that, far from consolidating and influencing an existing market consisting of tens of competent manufacturers, Back was a last resort to whom the Corps turned after invitations to other firms and inventors had been rejected as infeasible.

By far the most valuable parallel is to be found between Fred Waller and Frank Back. Waller's Flexible Gunnery Trainer was a synthetic aid used in training antiaircraft gunners. It had evolved from a spectacular multiple-projector motion picture exhibition system developed for the 1939 World's Fair in New York; after the war, the technology was reapplied to civilian use in the form of Cinerama.[83] Waller and Back shared similar backgrounds and attended similar events, and the men shared a session at a Society of Motion Picture Engineers meeting in 1945. It is also likely that Waller, like Back, received research contracts from the Special Devices Depot. Yet while the circumstantial similarities between Back and Ruben, and between zoom lens technology and crystal frequency control, are reflective only of broad research policy, the links between Back and Waller are more intriguing. They indicate that in addition to supporting individual inventors through contracted research projects, military institutions

81. Hintz, "Portable Power," 31.

82. Richard J. Thompson, *Crystal Clear*, 33.

83. For a detailed history of the Waller Flexible Gunnery Trainer, see Giles Taylor, "A Military Use for Widescreen Cinema."

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such as the Signal Corps and the Special Devices Depot also indirectly fostered links and social connections between engineers and inventors with similar interests. This may help to account for how Back became such a well-connected and influential figure so soon after his emigration to the United States. The many links between military technologies and cinema and broadcast media are well known, but detailed case studies can render a deeper understanding of how these relationships functioned in particular contexts and at specific historical moments.[84] In this instance, further research, especially into the work of the Special Devices Depot, might begin to uncover the social geography of the many independent inventors who worked in the greater New York area during the war years, and in turn further reveal the depth of the Depot's influence on the postwar television and motion picture industries.

In a few short years the Zoomar lens disrupted the market for American television camera lenses and began the process by which zoom lenses became ubiquitous within the industry. Parallels between Back's innovation of the Zoomar and other analogous innovations suggest that his success was due partly to the efficiency with which the mobilizing, wartime, and postwar United States enabled skilled personnel to contribute their expertise to the war effort, and thereafter enabled them to commercialize elements of their inventions. Though Back may not have envisaged it when he emigrated, the innovation and commercial policies of the United States were calibrated to encourage him to invent something of use to the war effort, and then to build—with the help of investors such as Jerry Fairbanks Productions—a profitable business around that invention. This he did, in common with numerous other firms and inventors. What could not have been planned or foreseen was the profound and permanent effect the Zoomar lens and its successors would have on television and film industries the world over.

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84. Paul Virilio, for example, offers a valuable overview of industrial and philosophical links between battlefield surveillance and commercial filmmaking through the twentieth century. See *War and Cinema*, 15–39.

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