Dage Film Chain Technology

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Moving Image and Sound: Basic Issues and Training

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The Dage Color Vision Film Camera System

The genesis of the broadcast Television industry was fraught with the prerequisite of sourcing content to be transmitted into homes. Thus was borne the need for a film to analog signal converter. Gargantuan multi-gauge cameras within projectors were designed, alongside a sophisticated prism system to convert photochemical images into a televised signal.

Somewhat of leader in technological advancements, Dage Television Division[1], headquartered in the sleepy town of Michigan City, Indiana, quickly jumped on the incipient broadcasting bandwagon. Dage Television Division was at the forefront of a trend towards color film chain systems and was an active developer of technology to fully support color television transmission. George Fathauer, Chief Development Engineer for Dage focused on television station equipment aimed at smaller cities, his manufacturing zeal was ignited by television's recent commercial value.

[1] Dage later merged with MTI (Maryland Telecommunications) in 2003 and as per their website, they remain the oldest video camera manufacturer in the United States, subsequently evident through their head-to-head participation in the development of video equipment

After World War II, Fathauer branched out with three other former RCA engineers to form an independent consulting business. When the freelance jobs where insufficient, he took a temporary job with the RCA plant in Indianapolis. There he was assigned to test equipment for use in production testing. According to Fathauer's autobiography[2] written in 1995:

> "At this point in time, television was just becoming a significant consumer item, and television-transmitting stations were being constructed in the major cities of the U.S. Because of limited coverage of the transmitters and relatively poor sensitivity of television receivers, there were large fringe areas where reception was very poor. (I was) able to develop a device which could be connected between the television antennae and the receiver and significantly boost the signal and make TV reception satisfactory in fringe areas. This appeared to be a marketable device, and it was decided to... Manufacture it under the name of Regency. This quickly became very successful, and Regency ended up as a fairly substantial manufacturing operation, producing over 400 TV boosters per day..." (Fathauer 1995)

Fathauer's success with television boosters paved the way for developing and selling additional technologies adapted for television broadcast. Fathauer decided to join forces with one of his contacts from Regency in the inexpensive manufacture of coaxial

[2] Steve McVoy, from the Early Television Museum in Ohio, sent George Fathauer's self-published autobiography; *My Career* to the author.

cable connectors and in 1952; the partners formed the Dage Electric Company. According to his autobiography-- Fathauer's recognition of RCA's newly developed vidicon tube and his newfound interest in closed-circuit television[3] led him to form the Dage Electronics Corporation to develop and manufacture television cameras and related equipment aimed at the industrial market.

> "I became quite interested in the technical challenge and potential of closed-circuit television, utilizing recently developed camera tubes known as vidicons produced by RCA....(I) formed a company called Dage Electronics Corporation to develop and manufacture television cameras and related equipment aimed at the industrial market.[4]" (Fathauer 1995)

Although small in size, Dage Television and Dage Electronics Corporation tried their hand at many technological endeavors, including anything from Police Car, FM and emergency signal scanners to mechanized seed counters (Fathauer 1995). An Indianapolis Star writeup of the company, in May 1952 remarked: "This quick footed little company is not complaining. It has orders piled up from the best paying costumer in the world, an uncle of yours, named Sam".

[3] Closed-circuit television will have an undeniable impact in history. Evident in the proliferation of institutionalized surveillance; its ramifications extending to cold war counterintelligence to the Orwellian scrutiny of NSA-type organizations on US civilians. Closed-circuit television technology was also appropriated within the early video art world, a notable example being Nam June Paik's TV *Chair* (1968), *TV Buddha* (1974) and Bruce Nauman's *Live-Tape Video Corridor* (1970).

Armed Forces Radio and Television Division

Widely used during post- Second World War military communications, Dage's version of film chain models entered the market swiftly with the support of the Department of Defense. A decade earlier, Fathauer had joined the Navy and had trained in radar technology, where he refined his engineering skills. During his two-year military deferment, he worked fleetingly at RCA's facilities in Indianapolis. There he developed a circuit technique for use with motion picture sound amplifiers and in all likelihood set the basis that would form the Dage Electric Co., his service in the navy as a radar technician provided him with the technical know-how that would advance his career.

The first mobile television units used by the United States army were furnished with Dage equipment, ostensibly because of their low cost. An anonymous technician that ran a military television station in Kodiak, Alaska relates the following general setup:

> "TV was Dage equipment, two studio Vidicon cameras and a third identical camera one minus the viewfinder on the film chain. All equipment except the Dage sync gen was [a] discrete transistor. Audio was a Gates 'Yard' console. The TV transmitter was a Gates 100W with a 4X250 in the visual final and I think a 5894 in the aural 50W final. The antennas were on a tall wood pole and were

separate for the picture and sound. (Most TV stations use a diplexer and one antenna.)"[5]

During the 1960's, Dage film chain equipment was also used in the Armed Forces Radio and Television Naval Base in Guantánamo Bay, Cuba. The reasoning behind using film chain equipment in an Armed Forces setting, was the speedy transmission of images (i.e. intelligence) shot from a remote location to another. An Armed Forces Radio and Television Broadcasting Guide published in 1951, 1953 and 1961, covering bases all over the world (Turkey, Morocco, Saudi Arabia, Philippines, Cuba, Iceland, Puerto Rico, Germany, Taiwan and Iran to name a select few) demarcates the setup used in stations of the time. In the booklet's dedication, the feat of this burgeoning technology was explicitly stated, given a political agenda and manipulated.

"Radio and Television are potent instruments for keeping the United States military personnel the best informed in the world. (…) AFRTS implement this information responsibility to the utmost in this great struggle of our time—The clashing concepts of Democracy and Communism." [6]

In addition, the television stations functioned as sourced entertainment for troops or units. A station would receive shortwave transmissions of news and sports programs,

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[5] Kodiak Alaska History is one of many websites dedicated to record the history of military and civilian television technicians and the forefront of new technologies. Most are kept by aficionados or former technicians and are a supply of an invaluable wealth of knowledge. See bibliography. (http://www.kadiak.org/misc.html)

[6] United States Department of Defense, *Armed Forces Radio and Television Broadcasting Guide,* 1961, page xi

featured programs of the interest of servicemen and televised film programs. The "Television Film" service was composed of Cartoons, Religious Films, Motion Picture Features and Industrial and Public Service Programs. According to the guide[7], a Class A Television station was one that was equipped with two or more studio cameras as well as a *telecine* camera (film chain camera),[8] and equipment, which was divided into six major categories:

1. Video equipment
2. Transmitter and antenna equipment
3. Film Equipment
4. Studio lighting equipment
5. Test and maintenance equipment
6. Audio equipment

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[7] United States Department of Defense, *Armed Forces Radio and Television Broadcast Guide*, page 23.

[8] This is one of the few instances in my research where I've seen film chains referred to as *telecine* cameras. It would be fascinating to trace where one term is adopted colloquially and the other one is left off as a distant, often confusing memory. The term "film chain" may denote a device that connects a telecine projector with one or more slide projectors, typically used for titles. "Film Chain" refers to the whole system setup used to switch between source images for broadcast through a multiplexer or telecine camera. Conversely, "Telecine" refers to the process or the equipment used to transfer film into video.

Below a sample of the basic video equipment list employed by the station that appears on the Armed Forces Radio and Television Guide[9]:

BILL OF MATERIALS

VIDEO EQUIPMENT

QUANTITY	DESCRIPTION
1 each	Synchronizing generator, complete with tubes
1 "	Sync switcher panel
1 "	Video distribution amplifier, 5 channel, complete with tubes and power supply
1 "	Video patch system
2 "	Camera, vidicon, complete
3 "	Camera, control unit, complete
1 "	Switching and fading unit
1 "	Studio line monitor
1 "	Program monitor, 21" receiver, modified for separate video and sound
1 "	Master monitor, with "A" scope
1 set	Console end sections
2 each	Camera tripod, with friction head on dollies
1 "	Camera lens ½" F/1.5
2 "	Camera lens 1" F/1.5
2 "	Camera lens 2" F/1.9
2 "	Camera lens 3" F/2.5
2 "	Film projectors, 16mm, with dousers
1 "	Film camera mounting pedestal
1 "	Slide projector, automatic
1 "	Pedestal, slide projector
1 "	Multiplexer, complete with stand
5 "	Headset, intercommunicating system
1 "	Case, filing, for 35mm bound slides
1 "	Slide tray, interchangeable
1 "	Tele-cine Camera (Film chain camera)
1 "	Intercommunications system, electronic, complete with master and two (2) sub-stations, with cables
3 "	Clock, electric 14"
2 "	Max Factor Theatrical make-up kit
3 pcs.	Camera cable, 50'
1 each	Kit, interconnecting cables
1000 feet	Cable, coaxial JAN RH-59/U
1 each	Polarizing filter for use with 3" lens on TV camera, when used for film pickup
30 "	UG 273/U connector for making up video patch cord

[9] United States Department of Defense, *Armed Forces Radio and Television Guide,* page 24.

Available space was a crucial consideration when setting up these stations. As one can tell, an array of gear was needed to broadcast and early film chain models in particular were gargantuan in size. Subsequent models of telecines and film chains would be promoted highlighting their compactness. The April-June edition of *Broadcasting Telecasting*[10] reported on habitual use of packaged television stations made by Dage Products on Base Stations. Noting that civilians that ran overseas stations were operating kinescopes of stateside shows. "He says he does not have any live programs at the present time but plans to begin local news and sports shows in the near future." The luxury of setting up a television broadcast station without a production plan, relying on material that had already been shot was a benefit for small-scale, lower budget stations that might have not been able to exist without economical film chain systems like the one being sold and developed by the Dage Electronics Corporation.

16mm film Chain in a Military Television Station in Alaska.

[10] *$50,000 TV Station offered by Dage TV*, Broadcasting-Telecasting, 1955. http://www.smecc.org/azores_thompson-dage_usaf_1955.htm

Color Film Chain Systems:

A *Decantur Review*, June 25 1954 (Fellows, 1954) newspaper article announces in a sensationalist heading: "Color Television Closer Than You Think" and praises George Fathauer as an engineering contributor to color television. [11] In the article, Fathauer demonstrates how a dichroic lens in a camera picks up three primary colors (Red, Green and Blue), which are then separated by the lens and diverted into three differing color tubes that are manipulated through a control console. The camera sold for $12,000.00; the part advertisement-part news piece promoted. Fathauer's enthusiasm is evident through the piece. His endless tinkering and prodding would pay off and a few months later; Fathauer showcased his Dage Color Vision System at a prominent Television Broadcasting Conference.

George Fathauer demonstrates actual telecasting in color at the Dage Electronics laboratory, 1454 E. North St. The small, "lunch pail" sized camera picks up a color image from the magazine picture. This image is transmitted through the color control console, center, and shown on the color monitor's screen.

Color Television Closer Than You Think

[11] Fathauer is a prolific engineer; he holds over 76 patents extending from a seed counter, police radar systems to a miniature camera that sent the first TV signal onto space. (http://herald-review.com/lifestyles/decatur-native-and-father-of-bearcat-scanner-a-prolific-inventor/article_26ffe572-c25d-11e2-9b85-001a4bcf887a.html)

In a promotional flyer found at LabGuy's World website (Dage Television Division / Thompson Products, Inc. Advertising Flyers, 2005), Dage announces the unveiling of their system at the NARTB (National Association of Radio and Television Broadcasters) Convention in the Heavy Equipment Section. The year was 1955 and *The Color Vision Film Chain* was being marketed as a means of protecting ones investment of black and white cameras. Compatible with 16mm and 35mm color or black and white film, the manufacturer proclaimed that the film chain could relay monochrome film into a color signal. Converting a "basic" vidicon chain into a colorized chain. A monochrome camera and multiplexer (series of mirrors or prisms that direct the images from the projectors to the camera) serve as the green channel, two additional color channels would be fed through a supplementary color camera-multiplexer combo equipped with a removable Dichroic mirror[12] that would be mounted onto a plate. A Vidicon tube could replace the dichroic mirror, which with a color separation optical system could reassemble the RGB image through a color camera control unit.

The "Color Package" consisted of:

1. 360-a Color Film Camera (with self contained multiplexer)
2. 650-A Color Monitor
3. 660-A Color Video Monitor
4. Color Slide Projector

[12] Dichroic glass is a type of thin filter that can selectively pass colored light while reflecting other colors.

5. A standard rack for color (Sync generator, Subcarrier generator and divider, Color keyer, Color matrixer and encoder)
6. 16mm Holmes Color Film Projector
7. 360 ABW B/W Vidicon Film Camera
8. Color Conversion Package: 1 750-A Color Camera Control Console, 2 Yoke assemblies, Dichroic Optical Assembly and a Field engineer.

The picture viewed through the camera control panel combines red, green and blue pictures and was compatible with black and white television monitors. The Vidicon tube was a recent video camera design improvement developed by RCA that relied on a photoconductive surface that created an electrical charge that produced an image. The newfound popularity of the Vidicon tube is integrated into Dage's Film Chain system design; it also demonstrates the company's concern with keeping up with new trends in imaging technology, but alas a leader was already established. Dage's top competitors in the film chain business were RCA and General Electric and during the pivotal early 1950's where television was becoming increasingly accessible, a new frontier was established with color television.

Following World War II, RCA introduced image orthicon cameras for studio and remote pickup use, but still used pre-war iconoscope for their film chain. This soon changed when the manufacturer became a leader in advancing new image dissector tubes.

RCA also launched a film chain system in 1954, model TK-21[13], shunning away from Dage's packaged model. RCA claimed their model was compact, produced 600 horizontal lines, like the Dage model but in addition it would not require shading controls and could be operated unattended. Just mount directly to a projector or a multiplexer[14].

The introduction of RCA's TK-21model was furiously pushing towards the replacement of ionoscope cameras into their newly ushered vidicon cameras. As stated by the TK-21 promotional flyers:

> "The TK-21 is the only film system with enough signal output to use aperture correction to bring picture detail up to maximum sharpness (detail resolution %100 at 350 lines) with high signal to noise ratio." (Southwest Museum of Engineering, Communications and Computation)

A later model, the TK-41 almost doubled the price point of Dage's version, a color camera chain console cost around $49,000.00. As per their promotional material:

> "The ultimate goal in film programming today is to achieve a picture quality which will make it impossible for a television viewer to know whether the program coming into his home is "live" or "on film". Film programs have become direct competition to live presentations." (Southwest Museum of Engineering, Communications and Computation)

[13] RCA's model TK-21 can be viewed on the following link: http://www.smecc.org/rca_tk-21_film_chain_%26_camera.htm

[14] Multiplexers are devices designed to input several analog or digital signals and forward the selected input signals into a single channel.

RCA developed the type 6326 Vidicon (the same tube utilized by Dage) tube working with a photoconductor surface where an image would be reproduced, scanned and dissipate after the scanning. RCA's engineering sophistication and the fact that they had advanced both the orthicon and vidicon television tubes in house made for a market control on their part. In 1955, just a year later, Dage Television Division was offering in popular broadcasting periodicals, $50,000.00 worth of equipment to low-powered television stations in cities with a population of less than 50,000 people. [15] After gaining experience, building stations for the Air Force in the Azores and Iceland, Dage aggressively advertised their packaged stations. $34,904 would allow transmission of film and network programs exclusively**;** upper scale ones would go for $45,000 to $51,000 and would include one or two live Vidicon cameras. It is apparent that a component of Dage's business model at the time was to genuinely bring television to inaccessible pockets of America or in less ideal terms, to tackle the low-end consumer and broadcast market.

Pulsed Light System & Incandescent Lamp Projection

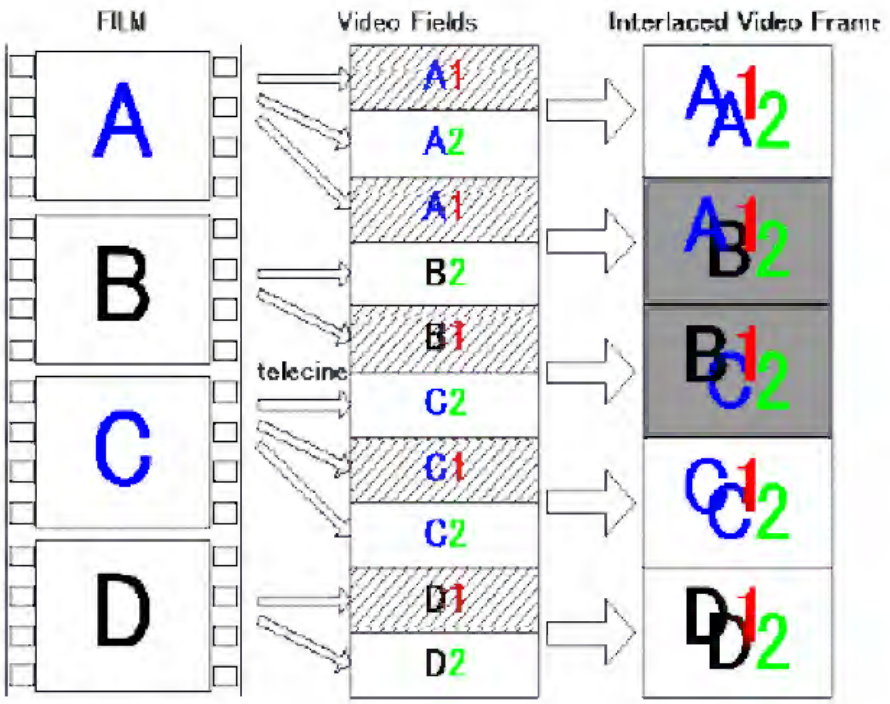
As much competition and demand that film chain systems possessed in the early 1950's, it was not without inconveniences. The most entangled constituent in the film chain system is the synchronization of film's established 24 frames per second to television's 30 frames to obtain perfect registration and capture. Thus, converting the 24 frames per second of film to 30 frames that is necessary for television broadcast.

[15] *Broadcasting Telecasting* April-June 1955, page 104.

Motion incompatibility was addressed by changing the phase of the alternate pull-down actions. The method used to synchronize in most film chain systems was a pulsed light system named Synchrolite. The Synchrolite lantern is a gas filled- discharge lamp that is automatically ignited by a pulse from the synchronizing generator which trips a high voltage circuit and flashes the lamp at intervals of one-sixtieth of a second[16]. With the introduction of the Synchrolite, film was moved past the lens or picture plane engaged in intermittent movement by a claw that would engage the perforations at the edges of the film. The action would pull down a frame into a plane one at a time. Simple and basic enough, the actual conversion of the frames is materialized by exposing one frame twice and the next one three times. When frame #2 is at the gate there are two flashes coming from the light source; two film frames are exposed 5 times, equivalent to the 5 video fields.

Another type of scanning can be accomplished with an incandescent light projector equipped with a mechanical shutter. The shutter consists of an 18-inch disc with a small opening cut in the circumference; the shutter is rotated at 3600 revolutions per minute, flashing light every 60^{th} of a second. The resulting outcome is illustrated in the images below.

[16] *Movies for TV*, John H. Battison, page 101.



Film to video conversion, featuring 3-2 pull-down.[17]

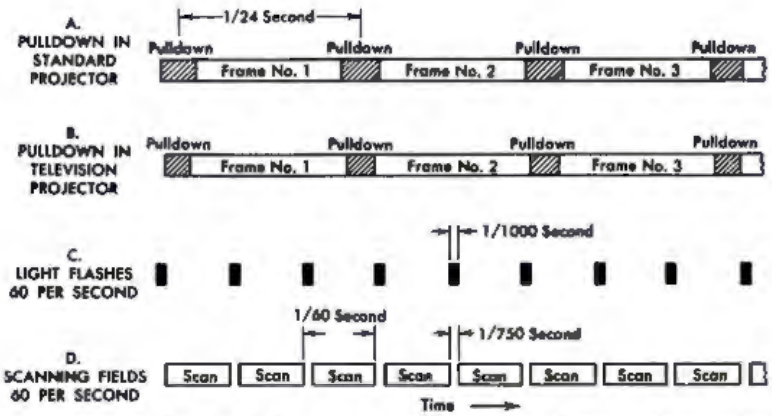


Fig. 4-8. RCA synchronizing cycle for 16 mm projector using incandescent light.[18]

16mm synchronizing using incandescent light

[17] Image taken from Dana M. Lee's website; Television Technical Theory Unplugged (http://www.danalee.ca/ttt/film_for_television.htm)
[18] Movies for TV, John H. Battison, page 104

Optics of a Film Chain

If that wasn't enough, a consequence of exposing a frame multiple times, through a distance and of varying gauge can result in unfocused, cropped images. Differences in curves between photographic processes and television broadcast can cause unevenness in terms of acquiring a well-exposed, defined picture. Standard home movie 16mm projectors often use lower quality lenses, since they are intended to illuminate small areas. In the technique referred as Uniplex Operation[19], projecting directly into the face of the Vidicon tube resolves this hassle. Since the face of the Vidicon tube is only slightly larger that the image area of 16mm film (low magnification), an adequate distance between projector and camera must be estimated and one should look out for a shaky picture due to vibration in the projection system.

An additional method for constructing a film chain is through the Relay System in which the projection lens forms an intermediate image and a second lens of the Vidicon camera relays the image to the photosensitive plane of the television tube. This system requires the use of a diffusing material to guide the cone of light emitted into a directed path. The use of ground glass as a diffusing material can lead to an image with reduced brightness in the center. In its place field lenses can be inserted. It is advised to use field lenses with long focal lengths to reduce spherical aberrations. When choosing a system, it is advised to take close consideration of the centering of the image, exposure, optics and focal length.[20]

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[19] Basic Optics of a Television Film Chain, D.F. Lyman and A.E. Neumer, page 6.
[20] Basic Optics of a Television Film Chain, D.F. Lyman and A.E. Neumer, page 9.

AD: After Dage

The dust had settled in 1975, when Dage Television and Maryland Telecommunications, Inc. (MTI) were incorporated to form Dage-MTI. Dage's early investigations and close work on closed circuit and infrared cameras for government intelligence purposes commenced a trend towards the manufacture of high-end security camera. Currently the company also has Science and Medical partition intended for the biomedical market. Quickly shifting commercial strategies has been instrumental in staying in business. Today, the company has expanded its products from the traditional analog cameras and monitors to also include digital to high-resolution microscopic cameras.

George Fathauer went on to retire in Arizona, though he still maintains an active "working" life. He purchased and resold a series of electronic supply stores in Arizona, including the still erect *Antique Electronic Supply*, which he dutifully managed with his son. The store sells vacuum tubes, amplifiers, audio components and D.I.Y. kits. When he was interviewed for the Herald Review and asked about modern day technology, he reprised without a shred of irony: "I can't keep up with it."

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15***."RCA: Broadcast Equipment for Monochrome and Color Television***." *Ogleetree Productions.* 1954, accesed 2014.
http://www.ogletreeproductions.com/images/TK-41.pdf
RCA's competing film chain systems, with price points and a scan of a promotional booklet.

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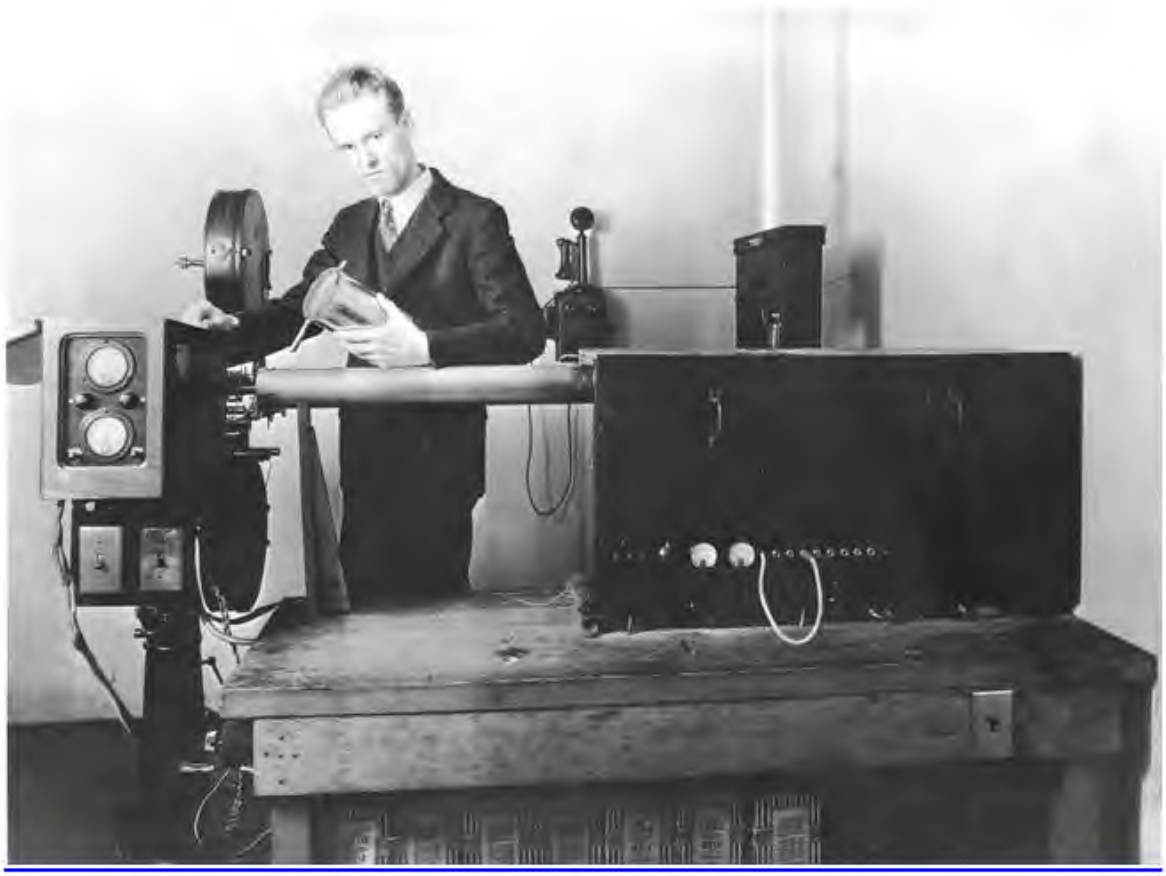
RCA vidicon film chain advertising, detailing film to vidicon conversion and its recent improvements.



Philo Farnsworth, early television pioneer with a proto example of a television film chain.

ADDENDUM

Scattered oral histories of people working with telecine/film chains, sourced from the Telecine Interactive Group and the tech-notes.tv website[21] are reproduced below.

From: **Jeff Kreines**

> I am staring at a book called "Movies for TV" (MacMillan, 1950) which includes pictures of a GE Film Camera (a roll-around film chain camera, that you placed in front of the projector -- focusing right on the face of the Iconoscope. Also discusses the Synchrolite, a flashtube that pulsed at 60 HZ (these were monochrome days!) and provided 3:2 pull down with a projector that used a claw. I guess the 5-bladed shutter came a bit later.
>
> The oldest film chain I ever used was an RCA TP6 projector with an RCA monochrome vidicon camera (in a multiplexer)... still in service in 1975 at an Alabama TV station that had yet to go color.
>
> The weirdest one I ever used was in 1966, in junior high school -- the school had an early CCTV setup and ran what little film we got (a 1/2 hour monthly newsreel, mostly) on a B&H 379 projector that had the shutter REMOVED! This went into a hideous rear-projection screen (sort of taut latex, in front of an angled mirror, actually made into a big rollaround device by some manufacturer of AV equipment. We'd aim the old Sylvania (or latter, the better Ampex CC323) vidicon camera at the screen. Ugh! (Best part was the video switcher -- it used relays, and hard-switched video mechanically. Talk about jumpy cuts... but at least each one was flagged by the actual click of the relay itself, since the "switcher" was near the ceiling-mounted (on goosenecks!) Shure Unidyne IIIs.)
>
> Stranger still, Dick Dienhart, now the man to see to buy a Spirit if you're on the East coast, was studying TV/Film at Northwestern U, and was interning in this very facility... I'm sure he'll be delighted I mentioned it! (Hi, Dick!)
>
> But I digress. I'd love to know more about early Flying spot gear, and other early telecines. We all probably remember TP66s and TK27s and 29s... it's the old stuff that interests me.

[21] http://www.tech-notes.tv/History&Trivia/Telecine/telecine.htm

John Strung:

I remember hearing about a system that was used during WWII. A film camera in a C-47 shot footage of the enemy from the air. On the plane, it was developed and telecined straight out of the camera, and transmitted to England, where the signal was recorded back to film again. Perhaps someone knows better details and can verify what I was told.

Dick Hobbs answers:

Yes, that certainly happened. It was a derivation of one of the earliest television techniques. Here in Britain we still believe that television was invented by the mad Scottish inventor John Logie Baird. Only a couple of days ago I was at the wonderful Museum of Film, Photography and Television in Bradford, which has a good collection of Baird's equipment.

Baird cracked most of the problems of television - display and transmission, not to mention recording. He built a high definition colour television disk player in the 1930s. But he could not think of a way to make a camera. He came up with three completely impractical ideas, but two of them use a technique, which is very familiar to most of us.

He hit on the flying spot scanning system very quickly, and built something that was essentially no different to a C-Reality. Indeed, the Baird Television Company became the Cinema Television Company, which got shortened to Cintel.

As well as showing pre-recorded films, he used it for what we would now call near real-time broadcasting. This used a 35mm camera, with the film going down a light-proof tube straight into a processor, then into the telecine. Which would have been a reasonable system, were it not for three small problems.

First, to get the film through the bath quickly, it used a cyanide fixer.

Second, because the film could not be dried quickly without streaks, Baird put the telecine in the tank.

Third, because audio delay lines had not been invented, the sound was also recorded on the film. Air bubbles in the sprocket holes caused problems with the audio heads.

I just have this vision of the person employed in Baird's studio to stand next to a tank full of cyanide, containing 25kV electrical devices, kicking it regularly to get the air bubbles out of the film path. Wonder what his long-term career prospects were?

The live film chain took less than a minute from shooting to transmission, which was pretty remarkable. However, Baird recognized the need for real live transmission, so he invented the flying spot studio. This was essentially a black room with a scanning beam of light. Exactly the same as a flying spot telecine, but on a bigger scale. Unfortunately, at that point Baird's ingenuity ran out, so we will never know how the presenter managed to read the script.