

First Use of Magnetic Sound on Film

by Louis A. Lembach

.... The first lip-synch magnetic sound film was produced in three days.

MAGNETIC recording has now come of age and is taking its place as an industrial tool in America. Much credit for this magnetic recording era is due to Armour Research Foundation of Illinois Institute of Technology, Chicago, Illinois, and its youthful inventor, Marvin Camras, who introduced a wire recorder shortly before the start of World War II. As soon as specialized machines could be designed and built, they were adopted by all branches of the armed services. Several years later tape recording made its debut and is now found working in many types of commercial dictating, calculating, and scientific machines, in home recorders, and in radio stations the world over where the bulk of transcribed programs are recorded on tape.

In the last few years a new phase of magnetic recording has been presented to the public—*magnetic sound on film*. Hollywood's Cinema-Scope carries a four-channel magnetic soundtrack which encircles the audience with stereophonic sound. Also 16mm projection equipment is now available to the amateur and professional, making it possible for him to produce quality sound-on-film pictures.

Marvin Camras, now a senior physicist in Armour Research, was asked to read a paper before the 1946 annual meeting of the Acoustical Society of America on his, then, new development—"Magnetic Recording on 16mm Film." This paper in its final form provided a very dramatic presentation before a select group of scientists several years before industrial engineers were able to design and build equipment for mass production and sale. This new development sparked the imagination of the several young men who were responsible for it into a challenge of its use, that illustrates a pioneering spirit so valuable in industrial research. Ordinarily a research program is carried out in a systematic, dignified, and painstaking manner. But an occasional exception adds zest to an otherwise routine life. And I'm giving fair warning that the following true story was definitely an exception.

One morning Camras came into the lab and asked three of his co-workers if they would care to hear his talk for the

meeting. They stopped their work and gathered round to hear it through. In the discussion that followed, Arthur Appel gestured to the equipment he had been working on, saying, "This pile of stuff is giving you all the data you are using. Too bad it can't go along to share in the applause". Then Walter Carr remarked, "Why don't you put the paper on film, Camras? Then they will know that your ideas really work". "Impossible", he said. "That meeting is only three days off!!" There was a dead silence in the lab for almost a minute and then Camras exclaimed, "What are we waiting for ??!!" That was the beginning of one of the fastest motion pictures, with lip synchronized sound, that had ever been made.

It took only a few minutes of planning and each had his immediate job outlined. Camras' first task was to quickly re-write his speech into a "scenario" to be used as a soundtrack on the film. The commentary and the picture must complement and support each other. Next he read it aloud with a stop watch in his hand so that each section of this commentary be given the proper length of exposed film to carry it. These two tasks took well into the evening. The writer gathered up the rough pencil sketches of the circuit diagrams, frequency response curves and recording head plans, re-drew them preparatory to taking them home to be photographed that night with his Bolex camera. This camera was brought to the lab the following morning to photograph all remaining portions of the film.

The 16 mm projector which was used to record as well as reproduce the sound, needed much work to be done on it to bring it up to the peak of performance, and to adapt it again for recording from a microphone. Arthur Appel, who had been in charge of designing and building the electronic equipment for the projector, took over this task. Art had come into Armour Research several years before as a young scientist-engineer and had been in the department since the early days of wire recording. The projector had been used almost entirely to record tones from an oscillator, which would give information on its ability to record over



A view of the Magnetic Recording Laboratory in the Electricity and Magnetism Building at Armour Research Foundation in Chicago, 1946.

the entire audible range. A continuous tone helps the engineer to track down and eliminate "wow", to measure signal-to-noise ratio, harmonic distortion, etc. About the only time a microphone was used was when making adjustments in the mechanism. A small loop of film threaded into the projector, carrying a continuously changing record, would then play back the change the adjustment had made within a few seconds. In the past, about the only words the machine had spoken were something like this: "Testing, 1, 2, 3, 4, Hello test. hello, Hello, HELLO !!!"

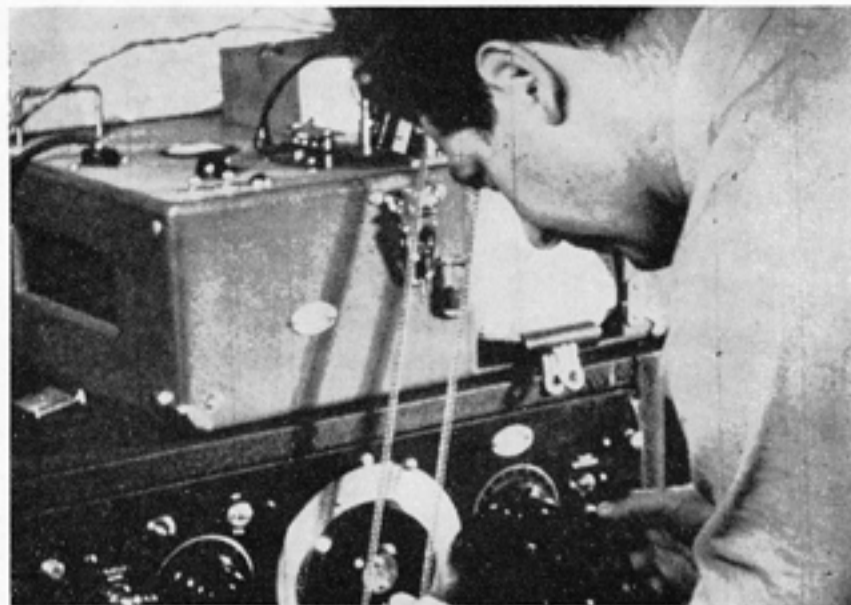
That first night the writer photographed several hundred feet of film showing all the drawings, circuit diagrams, and a number of photographs, and in the morning on the way to work, dropped them off at a processing plant for finishing. They were done by noon. Our lab by this time had completely changed from physics research to a movie studio. It was decided that the introductory paragraphs of the talk could best be shown by photographing Marvin Camras seated at his desk reading from the manuscript. Floodlights were commandeered from the Optics Dept. Unnecessary equipment was moved into the hall and the lab was prettied up a bit with a simplified background. A wire recorder was hidden under the desk to record the rate of talking, to assist in matching it to the lip movements on the film. (We wished later that efforts had been made to obtain a high quality wire recording. This would have saved us hours of work in the final recording.)

The four of us worked as a good team. There was a big staff employed in this building, but we soon found out that every researcher has a dozen ideas and we didn't have time to select the best one. *1/3 of our time was already gone!!*

The exposed film that came back from processing at noon now needed a sound-track, so Carr had many hours of very tedious work outlined for him. This sound-track is a narrow, very thin coating of a specially developed iron oxide in an adhesive binder, coated to one side of the moving picture film, between the sprocket holes and the edge. Walter Carr, the ace machinist who worked with Camras, had built this wierd piece of mechanism by learning from Camras what should be done, studying rough sketches, then using his own ideas. Walter is a very unusual machinist, completely unorthodox in his methods—and irreplaceable. When by conventional machinists' procedure, it would take weeks to build up a working model, Walter could have one running in a couple days. However, there would be much evidence of what some people would call junk, in his area of the machine shop.

The film coating apparatus which extended along fifteen feet of the wall of an adjoining room contained parts of an Electrolux sweeper to run it; a machinery fountain oiler to deposit the coating; an electric mixer to keep the coating solution agitated; a hair dryer to make it set quicker; and a queer assortment of pulleys to carry it back and forth from supply to take-up reels. It was quite a gadget—but it worked!! This film coater had been used primarily to coat short lengths of film and then selected sections could be used for testing. Here was a specific batch of film—It *all* had to be done *quickly* and it *must* be *good*. Optical recording, to which this was being compared, had reached a high state of perfection and this sound must have at least equal quality. This was to be shown to a very critical audience—The Acoustical Society of America—those men know bad sound when they hear it!!

Let's get back to the studio. It was 3:00 P.M. and we were ready to shoot. Where was our star? Under the desk, re-



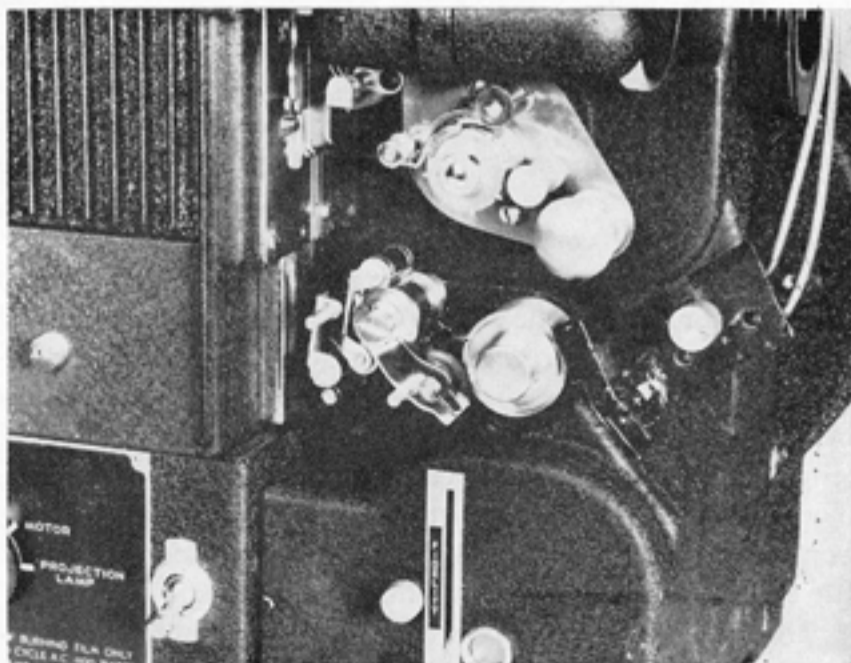
Arthur Appel making a frequency response curve on the magnetic stripe that had been experimentally applied to film.

threading the wire recorder. When he came out his disheveled appearance would make him just perfect for the part—if he were to portray a bum from Skid Row. But Marvin was way ahead of us. He'd brought along a clean shirt, tie, razor, and boundless energy.

Each paragraph of the paper was photographed twice; First, to be sure the exposure was correct under this unfamiliar lighting; next to provide against accidental damage to the film later. This was fortunate, for the coating machine went out of adjustment at one time and put a line down the middle of the picture. After photographs of Camras were taken we turned the camera on the projector and moving pictures of its recording mechanism were shot—so were we. It was much past bedtime.

The following morning our final film went out for processing immediately. We found the other reels all coated, ready for sound. Walter left work as we came in, but he was back again before the other film was returned from the processing lab and ready for him to apply the sound stripe.

Our photographic studio of yesterday now had to be reconverted into a recording laboratory. Our projector at that time has turned out to be in many ways a prototype to the ones being manufactured for both amateur and professional makers of 16 mm sound films. (Armour Research is a development laboratory and is not engaged in any manufacturing.) With this projector, as a film is shown, sound may



The magnetic sound head that both records and plays back was mounted on a standard optical projector and fed from external electronics.



Left: the sound stripe was placed between the sprocket holes and the edge of the film. Right: a frame from the picture showing Marvin Camras reading the paper before the Acoustical Society.

be recorded on the sound-track. It can then be played back immediately for it needs no additional processing. To record a new sound-track an erase head is automatically energized to eliminate the old one. This amazing little recording head was about the size of the eraser on the end of a lead pencil. This, under Camras' direction, was the writer's field of endeavor and he recalls that in one dimension it had to be correct within one half-thousandth of an inch. The head was small but it took much electronic equipment to feed it.

The carpenter shop was now ready to deliver a 4 x 4 x 6 ft. box with a large window in one side. This was our sound-proof room to keep the projector and nearby train noises away from the microphone. The projector was all threaded up. We were ready to begin recording. It was noon the second day. *2/3 of our time was gone.*

That afternoon and evening most of the text of the talk was put on film. The sections explaining the circuit diagrams and response curves were done first to gain experience. Marvin Camras was inside the little booth, and Arthur Appel manned the projector and recording equipment. After several trial starts this part of the film was recorded in its entirety. It was then replayed for the very critical "Camras' ear"—then redone. The third recording was acceptable.

The final voice recording was the lip-synchronized introductory paragraphs showing Mr. Camras at his desk. This was a real problem. The film was cut into paragraph lengths, then each length was made into a 30 to 50 foot loop by cementing the beginning to the trailing end. A loop of film was threaded into the projector, across the room to a pulley, and back to the top of the projector. Marvin, wearing headphones to hear the wire recording, looking at his manuscript, watching the projected film on the screen in front of him, was seated in the very warm little soundproof box trying to talk coherently into the microphone. Each flaw was ironed out as the voice was recorded, then heard back. These paragraph loops of film each averaged about fifteen recordings before words matched lip-movements throughout the entire length. There were many starts that were not heard back. The men would just let the machine run until it reached the beginning of the paragraph again. It was maddening to see the clock on the wall tick off the hours so fast.

The following morning we began to assemble the completed reels of recorded film. It wasn't until we were well along that another rude awakening came—one to show what amateurs, in a hurry, can do. The man assembling and edit-

ing the film had overlooked the fact that the sound-track precedes the picture by some eight inches. Therefore we had to dig in the wastebaskets for the opening words of several paragraphs. Short cuttings of film by the dozen were slowly dragged by hand over the recording-playback head mounted on the projector, to find these missing words.

We'd decided to finish up our demonstration film with around thirty seconds of music to illustrate its possibilities in that way. (These scientific papers are not allowed to run over an allotted time and we had used it all up.) While photographing drawings the first night the writer had finished up one of the rolls of film by shooting some wooden cut-out letters on his titling board, which read, *THE END*, and had animated the effect by having them fall from view in a spinning motion, one at a time. Arthur had selected some orchestral music on a phonograph record and was recording it on the end of the film. The final chords of the orchestra were almost synchronized to the dropping of the final letters. It was such a surprise that he had to record it again to get it just right. "Just right" took several recordings and it about drove the rest of us wild for, *OUR TIME HAD RUN OUT*. However Art's "ham" ending gave the film a fine professional flourish that later brought a rousing applause from the audience. Our completed film had to be all spliced together, the equipment packed, and a dash made for the Chicago loop where the morning sessions of the meeting were about over.

Camras had taken a big risk. Our equipment was completely "haywire" and could have failed us. The head men of Armour Research had been in New York all week and had returned only that morning and were going directly to the meeting. Such an unconventional presentation of a scientific paper before a national assembly should have been carefully checked with them. Someone suggested that moving pictures in the loop can be projected only by union labor. There wasn't a union man on earth that knew anything about this projector. Marvin may have to talk fast to keep Arthur at the controls. Oh well!!

Shortly after lunch, in the plush meeting room in the penthouse of the Stevens Hotel, Marvin Camras in acknowledging his introduction completed his remarks thus: "I think I'll take it easy this time and sit down in the audience with you and let a movie projector read my paper. It's nice to be lazy."

Do you suppose he really believed that?????