



A. P. DANK



A.P.  
End From Right



A.P. AND  
UNKNOWN  
WOMAN  
NEWSPAPER PHOTO

# RECORDER TO AID SAFE AIR TRAVEL

## New Device Could Handle Up to 28 Voices

Another "first" emerged yesterday from the laboratories of Cleveland's Brush Development Co. with the introduction of an ingenious safety device for recording all communications between pilots and airport control tower operators.

Exhibited to 50 aviation control experts throughout the nation at a luncheon conference in Hotel Statler, the unit records up to 28 voices on a single magnetic paper tape less than three quarters of an inch wide.

A play-back attachment then unscrambles any of the conversations desired and provides an exact, permanent log of what the tower tells the pilot, and more important, the flier's acknowledgement of receipt of the information.

### Crash Shows Need

Need for such a record of all transmissions in landing or take-off was underscored recently in the inquiry following the midair collision in Washington last Nov. 1 which took the lives of 55 persons.

The investigation showed contradiction and considerable confusion on what went out over the ground control radio and what the Bolivian pilot replied.

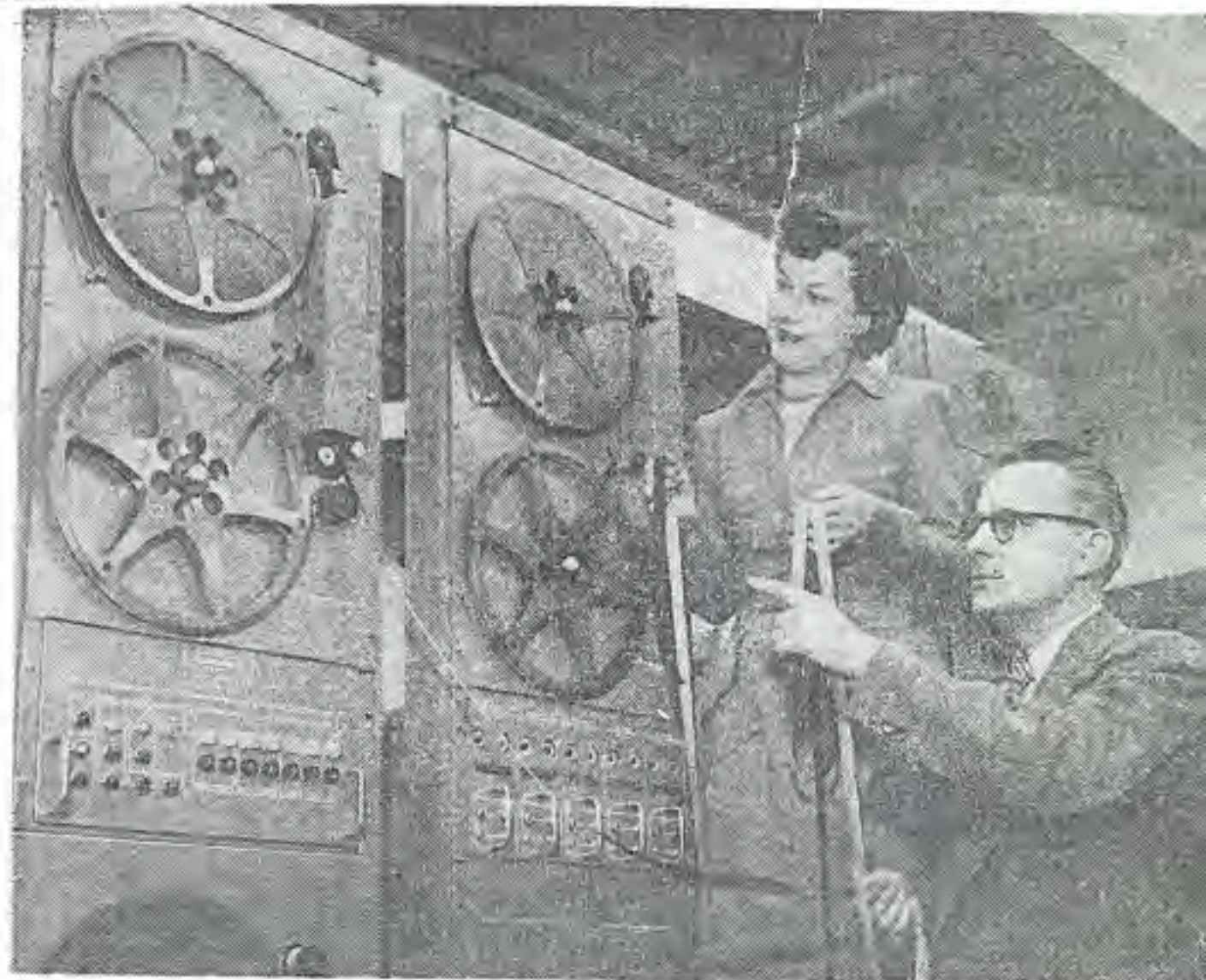
Previously, at some airports, records had been made only of the tower transmissions and at a considerable cost.

During an emergency it is obvious that the new recording method cannot prevent an accident. It can, however, be a major step toward determining cause. It will insure an investigation based on something more than hearsay.

Furthermore, it can help prevent recurrence of similar accidents and thus act as a true safety measure.

To illustrate how the multiple-recorder works, two Civil Aeronautics Administration traffic controllers from Cleveland Airport and four pilots from the 2240th Air Force Reserve Unit gave a live demonstration with a close duplication of actual flight conditions.

Virtually fool-proof in construction, the recorder will sell between \$12,000 and \$13,000. Three have already been ordered for installation at West Coast airports. The CAA has given strong endorsement to the device.



**INGENIOUS RECORDER**, engineered by the Brush Development Co. and introduced at a luncheon yesterday in Hotel Statler, is this multiple-action device capable of recording up to 28 voices simultaneously. Designed for use in airport control towers, it will log

accurately all communication. Pointing out features of the unit are Mrs. LaVerne Pope and A. Denk, employees at Brush.

CLEVELAND  
PLAIN DEALER  
JANUARY 27 1950

**INGENIOUS MACHINE FOR AIRCRAFT COMMUNICATIONS** records up to 28 voices on a single magnetic paper tape less than three-quarters of an inch wide.

Engineered by The Brush Development Co., Cleveland, Ohio, this unit is hailed as a great advance for aviation safety. For the first time, it makes possible a permanent record of all communications between pilots and control towers, thus permitting a detailed study of factors leading to air crashes.

This unit was introduced today at National Airways Communications Conference in Cleveland.

## BRUSH DEVELOPMENT CO.

3311 Perkins Ave.  
CLEVELAND, OHIO

P.S.

NAME Alfred Paul Dank  
 HOME ADDRESS 384 E. 131 St.  
 POSITION Electrical Engineer

Alfred P. Dank  
 Signature of Bearer

Brush Development Co. certifies that the bearer of this card has given the company satisfactory evidence of citizenship, that the bearer has been fingerprinted and charts forwarded to P.S.I. His personal background has been carefully investigated and it has been determined that he is unquestionably loyal to the United States.

COUNTERSIGNED

H.C. Frost  
 Capt., Cav.

SIGNED

[Signature]  
 TITLE Per. Dir.

5th Service Command

## AAF TACTICAL CENTER

EXPIRATION  
DATE8 May  
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Org: Brush Development Co.  
 Location: Cleveland, Ohio

NO.

Alfred P. Dank - Civ.

is authorized to visit the classified installations listed on reverse side for purposes indicated.

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ALIEN REGISTRATION

THE BRUSH DEVELOPMENT COMPANY  
 CLEVELAND 14, OHIO

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ISSUED TO:

NAME Mr. Alfred P. Dank  
 POSITION Dept. Head, Recording Engrng.  
 CLEARED FOR Secret

SIGNATURE

ISSUED BY

No. 417

TREASURER

CLEVITE RESEARCH CENTER  
 CLEVELAND 8, OHIO

ALFRED P. DANK  
 NAME

CLEVITE-BRUSH DEVELOPMENT  
 DIVISION

SIG. OF EMPLOYEE

VALIDATING OFFICER

A.P. Dank

E.J. Gilmore

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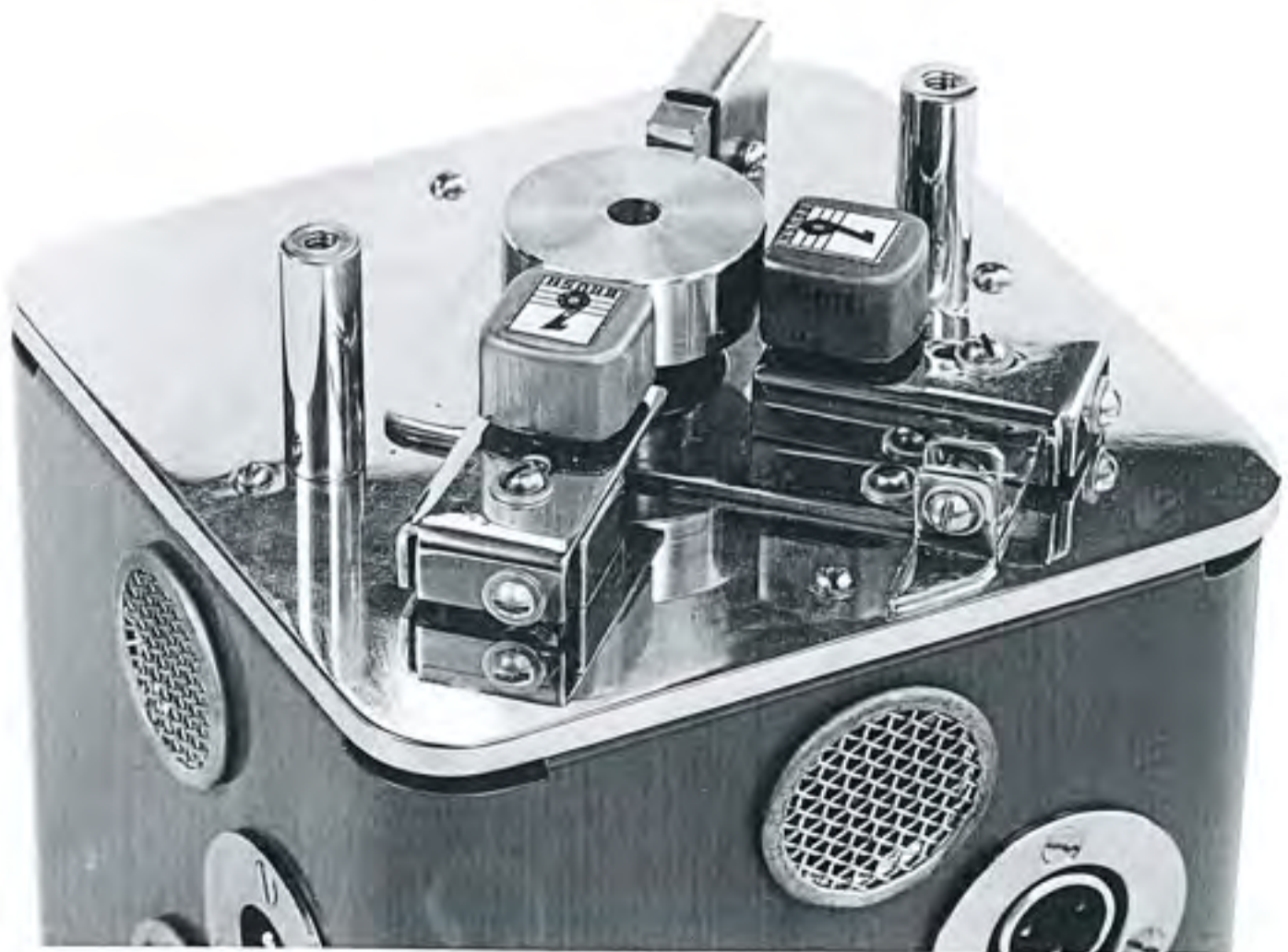
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March 31, 1955  
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## DEVELOPMENT CO.

A.P.DANK

The Brush Development Co. was established in the early 1930's as an offshoot of The Brush Laboratories to develop products employing the piezo-electric properties of Rochelle Salt. These products included microphones, headphones, phonograph pickups, loud speakers, and high speed pen recorders. After graduating from high school in 1931 I joined the company as a laboratory assistant. My duties consisted of building and testing prototype models of the various products. In the early days the emphasis was on microphones. In 1933 we received the contract to supply all the microphones for the public address systems at the Chicago World's fair. This was a large order for a company of our size.

Later on in the thirties we developed two light weight phonograph pickups, the PL-20 and the PL-30 having stylus forces of 20 and 30 grams respectively. This was a radical step forward in those days since most phono pickups required 3 to 4 ounces of stylus force.

In November of 1938 Dr. S.J. Begun, a leader in the field of magnetic recording, joined Brush. He had designed and built a magnetic recorder which he named the "SOUND MIRROR". The recorder was designed to provide pre-recorded messages at unattended exhibits in such places as museums or conventions. To accomplish continuous playback of the message an endless steel tape was employed as the recording medium. Recordings were easily changed by switching the unit to the record mode and recording the new text. The message length was in the order of one minute.

A number of these recorders were built at Brush. They were used extensively at the New York World's Fair in 1939. Another interesting application was on the George Washington bridge in New York. Traffic conditions were periodically recorded and broadcast on A M so that motorists could be advised as to tie-ups on the bridge. This was the first time that radio was used for traffic control. Fig. \_\_ is a photograph of this unit.

Another instrument that we designed was a transient recorder to capture transients that occur on power lines. This device also used an endless magnetic steel tape of short duration (two or three seconds). It recorded continuously until a transient occurred. The transient was recorded and the unit shut down automatically. This device was never produced in quantities. Only a prototype was built.

We also designed and built a prototype artificial reverberation unit using an endless steel tape. Again only a prototype was built.

2 Research and development on magnetic recording was accelerated during World War II. The military had many requirements for it's use. The Bell Telephone Laboratories had a Navy project that required a magnetic recorder as part of the overall system and they wanted us to design and build this part of the system. Mr. L. Vieth of Bell Labs was in charge of this project.

The recorder-reproducer was to be a reel to reel type using .006" diameter stainless steel wire. The record time was



30 minutes. Frequency range was 100 Hz to 5000 Hz. The equipment had to withstand the rugged environment of shipboard usage.

The recorder-reproducer consisted of two units: a base unit containing the record-reproduce amplifiers and the motor to drive the wire and a magazine containing the erase, record, and playback heads and the reels and wire. The magazine was a plug-in device where both electrical and mechanical connections were made simultaneously. Fig. \_\_ shows the magazine with the cover removed. Fig. \_\_ is a photograph of the prototype unit with the magazine installed in place.

The first prototype was designed, built, and tested in approximately six weeks. During this period Mr. Wm. Hoyt and Mr. J.R. Power of Bell Labs visited us a number of times to monitor our progress and help us in the design.

The design of the electronic section was supervised by Mr. Cary B. ("Casey") Jones of Brush.

The prototype was hand carried to the Bell Lab facility in Summit N.J. where it was successfully demonstrated to the interested people. As a result of this demonstration we received a contract to produce a quantity of these units.

The production phase proceeded relatively smoothly and the units were shipped to the customer. At this point in time it was discovered that the braking system for maintaining wire tension was subject to failure, permitting wire spillage. The braking system was completely redesigned as shown in Fig. \_\_.

The redesigned brake consisted of a thin metal band with felt cemented to it, spring loaded against the reel flange. This solved the problem.

During World War II we also designed and produced wire recorders for the Army Air Force. This project was brought to us from Wright Field. Mr. Harry Schechter was the project manager from Wright Field and his assistant was Mr. Victor Herter.

The project required the design and production of two units; an airborne unit capable of recording only, and a ground unit capable of recording and playback. The airborne unit operated from the 28V D.C. system in the aircraft and the ground unit operated from 120V 60 Hz.

Here again the plug-in magazine concept was used for transporting the wire. The unit employed .006" diameter wire and the record time was 30 minutes. Voice quality recording was required.

Mr. C. B. Jones was in charge of the electronic design and Mr. George Pepple was responsible for the design of the mechanical section.

This was the first time that a "black box" was installed in an aircraft to record the pilots' conversation.

Both the airborne and ground units were approved by the military and we received a production contract.

Fig. \_\_\_ is a photograph of the airborne recorder employing two magazines for continuous recording.

In parallel with this program we designed and produced a recorder-reproducer for the Navy for shipboard use. It was essentially the same as the ground unit that we supplied to the Air Force with one exception; the Navy insisted on using .004" diameter wire instead of the .005" wire used on the Air Force units. Since this enabled us to get the required amount of wire on a narrower reel we reduced the depth of the magazine accordingly.

We were in full production of this equipment in August of 1945 when World War II ended and terminated the contract.

One of the Government agencies contacted us with a request for a small hand-held magnetic recorder. We received a contract to design and build a prototype. The device consisted of a plug-in magazine containing the wire, the reels and the record-playback head. The magazine plugged into the drive mechanism which also contained the electronics for recording and reproducing. The drive mechanism was powered by a spring motor of the type that was used on home movie cameras at that time. The electronics was powered by self contained batteries. Figs. \_\_\_ and \_\_\_ are photographs of the magazine with and without the cover and Fig. \_\_\_ is a photograph of the drive unit with the cover removed.

This recorder did not get beyond the prototype stage due to the end of the war.

When World War II ended we immediately started designing magnetic recording equipment for civilian use. A new recording medium had been developed at Brush by a group under the direction of Otto Kornei. It consisted of a paper base coated with iron oxide. It was used in the form of a tape 1/4 inch wide.

The recorder-reproducer was a reel to reel type using 8 mm movie reels 7 inches in diameter and having a recording time of 30 minutes. Three motors were employed; one for the supply reel, one for the take-up reel and one for driving the capstan to obtain constant velocity of the tape regardless of the amount of tape on either reel. The tape speed was 7.5 inches per second.

The unit employed two magnetic heads; one for recording and reproducing and one for erasing the signal. The frequency range was 100 Hz to 5000 Hz and the dynamic range was in the order of 40 db. Fig. \_\_\_ is a photograph of the unit.

The mechanical design was supervised by Mr. George Pepple and the electronic design was supervised by Mr. Thomas E. Lynch.

In January of 1946 this recorder-reproducer was introduced to the public at the IRE convention at the Astor Hotel in New York city. It created considerable interest and as a result we received a number of orders for the unit.

This unit, Model BK-401, was the first commercially available magnetic tape recorder produced in the United States. It was in production for approximately

two years before a new model was designed.

At the same time that the BK-401 was being designed a group under the direction of John James was designing another magnetic recorder-reproducer known as the Mail-A-Voice. Fig. \_\_\_ is a photograph of this device. It employed a standard 33 1/3 RPM turntable. Instead of a phono cartridge a magnetic record-play head was mounted in the arm. The recording medium was the same material that we used for the tape recorder except that it was used in the form of a disk approximately 10 inches in diameter. Recording was accomplished by moving the record head across the rotating disk the same as a phonograph. The guide system for scanning the head consisted of the following: 1. A plastic disk with a spiral groove similar to a phonograph record was placed on the center of the turntable. 2. A phonograph stylus was attached to the arm that held the magnetic head. The stylus, riding in the groove, moved the magnetic head across the disk.

The purpose of this device was to provide a simple means of recording letters that would otherwise be hand written, providing a more personal touch.

It was manufactured and sold for approximately two years.

Fig. \_\_ is a photograph of a wire recorder-reproducer that was designed shortly after the end of World War II. The recording medium was brass wire electroplated with a nickel-cobalt alloy. This wire was developed by Otto Kornei of Brush. The signal to noise ratio was greatly improved over the stainless steel wire that we had been using.

The supply and take-up reels were supported by a common shaft. The supply reel drove the take-up reel through a friction arrangement. The wire was driven by a capstan to provide constant linear velocity regardless of the amount of wire on either reel.

The intended use for this unit was to supply two to three hours of continuous music on railroad trains during long trips. The device was always referred to as the railroad reproducer.

In 1949 we received a request for a proposal to design and build a magnetic recorder-reproducer to record the dialogue between airport traffic controllers and the airline pilots. The specifications required the capability of recording simultaneously fourteen channels of information.

Fig. \_\_ is a photograph of the equipment. It employed two tape transport mechanisms with automatic switching from one unit to the other when the tape supply was exhausted on the first unit. Each drive contained sufficient tape for four hours of recording, thus providing eight hours of uninterrupted recording. The tape speed was 3.75 inches per second to obtain adequate speech intelligibility. To accommodate fourteen channels of information on the tape the tape width was .75 inches.

This unit was the first multi-channel magnetic recorder designed and built in the United States.

This equipment was supplied to a number of airports around the world.

Another magnetic recorder-reproducer that we designed was a device for providing pre-recorded announcements. The information was recorded on a drum approximately 4 inches in diameter by 4 inches long. The magnetic record-play head was coupled to a lead screw which moved the head across the drum during record or playback. The lead screw was driven by the drum through gears. The maximum recording time was in the order of three minutes.

The original design specified the nickel-cobalt plating for the recording medium. During the life testing phase of the units it was discovered that intimate contact between record head air gap and the metal drum could not be maintained properly thus deteriorating the quality of the

recording. In order to maintain proper contact it is necessary for the recording medium to contact the head for a short distance on both sides of the air gap. This is not possible to accomplish with a metal drum.

This problem was solved by using a recording medium consisting of molded neoprene impregnated with iron oxide in the form of a sleeve which was stretched over the drum. This material was developed by the Bell Telephone Laboratories. Since we were building some of these units for Bell Labs they supplied us with all the necessary information to fabricate this material. The sleeve was approximately 1/8 inch thick and soft enough for the head to maintain intimate contact for reliable operation.

Fig. \_\_\_ is a photograph of the drum recorder.

In the early 1950's we received a contract to design and build a magnetic recorder-reproducer to be used by the oil exploration industry for recording the signals produced by their seismometers when they set off a dynamite charge in their efforts to find oil. The procedure at that time was to record these signals photographically with a multichannel oscillograph, and analyze them at a later date.

The required frequency range was from DC to 100Hz. The recording time was 5 seconds and the required dynamic range was 40 db.

Fig. \_\_\_ is a photograph of the recorder-reproducer. A drum 12 inches in diameter and 12 inches long contains two strips of recording material. On the right is the magnetic tape and the magnetic record-reproduce head. The multi-channel head contains 28 heads capable of simultaneously recording 28 channels of information. On the left is a pen recorder and paper to provide a visual recording of the information on any one of the 28 channels. The system operates in the following manner: the signals from the 28 seismometers are fed to each of the 28 magnetic heads and recorded on the tape. For this application we did not use the conventional direct recording system. Instead, the signal was in the form of a frequency modulated carrier. The carrier was in the order of 5000Hz. This enabled us to record down to DC. The magnetic recording was then converted to a visual recording using the pen recorder. The channels were transferred sequentially by indexing the pen recorder across the drum for each channel. Since the magnetic tape and the paper were both mounted on the drum the phase relationship between the channels was preserved during the transfer.

Fig. \_\_\_ is a photograph of the system. The cabinet on the left contains the recording equipment. The center

cabinet contains 28 FM modulators, one for each channel and the cabinet on the right contains the power supplies for the system. Since the channels were transferred sequentially to the pen recorder only one demodulator was required. This was mounted in the cabinet containing the drum.

Another magnetic recorder-reproducer that we designed was a device for storing large quantities of information for computers. This was usually accomplished by magnetically recording the information on a rotating drum with the magnetic heads spaced one or two thousandths of an inch from the drum.

Fig. \_\_\_ is a photograph showing the principle of operation of the Brush Tape Drum. A rotating drum, approximately ten inches in diameter by twelve inches long is employed. The magnetic heads are mounted in the drum and protrude slightly above the drum surface to provide contact with the magnetic tape. Approximately fifty heads were used allowing the simultaneous recording of fifty channels of information. To minimize the wear on both the heads and the tape the heads contacted the tape on the back surface of the tape. As shown in the photograph the tape was approximately nine inches wide. During recording and playback the tape is stationary and it is advanced when a fresh page is needed. Slip rings were provided to get the electrical signals in and out of the heads.

Fig. \_\_\_ shows the Tape Drum with a supply reel holding the tape. A similar take-up reel (not shown) is on the other side. This provided the means for selecting the pages on the tape.

Fig. \_\_\_ shows the Tape Drum in its cabinet. The slip rings can be seen at either end of the drum.