USAELRDL Technical Report 2324

REINFORCED PLASTIC MAGNETIC TAPES

A. Rusch

E. Beekman

C. P. Lascaro

January 1963

UNITED STATES ARMY
ELECTRONICS RESEARCH AND DEVELOPMENT LABORATORY
FORT MONMOUTH, N.J.

U. S. ARMY ELECTRONICS RESEARCH AND DEVELOPMENT LABORATORY
FORT MONMOUTH, NEW JERSEY

January 1963

USAELRDL Technical Report 2324 has been prepared under the supervision of the Director, Electronic Components Department, and is published for the information and guidance of all concerned. Suggestions or **criticisms** relative to the form, contents, purpose, or use of this publication should be referred to the Commanding Officer, U. S. Army Electronics Research and Development Laboratory, Fort Monmouth, New Jersey, Attn: Chief, Reliability and Electronic Parts Branch, Electronics Parts and Materials Division.

J. M. KIMBROUGH, JR.
Colonel, Signal Corps
Commanding

OFFICIAL:
HOWARD W. KILLAM
Major, SigC
Adjutant

DISTRIBUTION:
Special

REINFORCED PLASTIC MAGNETIC TAPES

A. Rusch

E. Beekman

C. P. Lascaro

DA Task No. 3A99-15-003-05

Abstract

Presently available magnetic recording tapes fail to provide the degree of dimensional stability required by high-speed military information sensing and data recording equipment. Tests on a recently developed experimental tape backing material, composed of ultra-thin glass fabric impregnated with polycarbonate resin, indicate the feasibility of developing a magnetic recording tape which will be free from excessive elongation, permanent set, and oxide film flaking. Steps in the development of the improved experimental tape backing material are described.

U. S. ARMY ELECTRONICS RESEARCH AND DEVELOPMENT LABORATORY
FORT MONMOUTH, NEW JERSEY

CONTENTS

FIGURES

REINFORCED PLASTIC MAGNETIC TAPES

INTRODUCTION

Background

1. *Deficiencies in Available Tapes*

Magnetic recording tapes currently used in high-speed information sensing and data processing equipment suffer from excessive elongation, permanent set, and magnetic oxide flaking. The flaking effect is increased under conditions of high humidity such as those which might be encountered during military operations in the field. Loss of magnetic oxide results in a loss of signal response. Figures 1 and 2 show the separation of magnetic oxide due to elongation and humidity, respectively.

In addition to the usual mechanical tests, the fact that magnetic tapes sometimes elongate and acquire a permanent set may also be demonstrated by the following apparatus and method. The apparatus consists of an audio magnetic tape recorder, an amplifier, an audio frequency microvolter, an audio oscillator, a cathode ray oscilloscope, and a frequency counter. The method consists of recording a signal of one thousand or more cycles per second on an unused reel of magnetic tape. The tape is then run through a high-speed analog magnetic tape recorder with the starting and stopping mechanisms in operation but with the recording and magnetic erasing systems disconnected. The tape is then removed from the analog recorder and played back on the audio magnetic tape recorder. Areas of permanent elongation are observed as fluctuations and changes of pattern on the screen of the oscilloscope. Electrical tests have indicated that efficient operation is adversely affected when magnetic tapes elongate over 6% and retain a permanent set greater than 0.75%. In order to overcome this deficiency, data processing machines are required to operate slower than their maximum speeds. In some cases, it is necessary to add bulky type mechanisms to decrease the tensile stress exerted on the magnetic tapes during high acceleration and braking. For miniaturized field-data-processing equipment, the additional weight and volume required for such extra mechanical systems of tape tensile control would be in contradiction to lightweight, mobility design objectives.

There are three types of plastic magnetic tape backing materials in current commercial use. These include regular and tensilized polyesters, and cellulose acetate type magnetic tapes. All are subject to various amounts of elongation and permanent set under tensile stress. Polyester magnetic tapes are stronger, have greater heat resistance and much less moisture absorption, and are less brittle than acetate type magnetic tapes. The tensilized polyester magnetic tapes, though the thinnest and strongest, have poor dimensional stability when subjected to elevated temperatures. (See Fig. 3). For these reasons, the Army Material Command currently uses regular polyester magnetic tapes exclusively for field digital magnetic tape transports, computer type, and for other electronic communication systems.

2. *Military Requirements*

Military electronic communications **now require** the operation of magnetic recording tapes under adverse field conditions. The steady and successful trend toward miniaturized, highly mobile equipments has placed these sets closer to frontline field operations and in more different types of field applications, taking over many functions automatically, where personnel formerly were required. High communication loads have also required higher tape transport speeds, faster stopping and starting, and greater information capacity. Coupled with a demand for increased reliability and efficiency, it is apparent that the physical and mechanical performances of the tapes have not kept pace with improvements of general electromagnetic responsiveness and information handling requirements of data-processing systems.

On the basis of the above-mentioned deficiencies in the physical and mechanical characteristics of magnetic recording tapes and the future planned military requirements, the following criteria for a satisfactory military grade have been established:

Thickness: 0.7 to 1.0 mil. (Complete assembly with magnetic coating).

Width tolerance: Tape edges shall be parallel so that the rate of change of width shall not exceed 0.002 inch/100 feet.

Stability: The tape shall maintain dimensional stability by not curling, crinkling, or cupping; not to exceed 1.5° from a flat plane when tested in conformance with Paragraph 4.4.6 of MIL-T-21029 and shrinking or extending not to exceed 1.1×10^{-5} inches/inch at relative humidity (RH) up to 100% at 75°F. Propagating tear strength shall be sufficient to resist 15 grams at 75°F, 35% RH when tested in accordance with ASTM D689 Plastics.

Tensile strength: 36 pounds ultimate strength longitudinal for one-inch-wide tape, 9 pounds ultimate strength longitudinal for 1/4-inch-wide tape, and 13 pounds per inch transverse. Elongation shall not exceed 6% at ultimate tensile stress, and permanent set shall not exceed 1% under peak load when tested at 25°C and 50% RH.

Shock tensile strength: At least 0.59 foot-lbs when tested at 70°F, 50% RH per 3.4.2 of MIL-T-21029.

Heat resistance: Operating conditions –25°F to +140°F. Storage conditions –80°F to +160°F for 240 hours.

Relative humidity: Up to 100% RH.

Initial reliability: Each reel of tape shall be tested for freedom from permanent errors. The error of dropout is a loss of read-signal amplitude in which the level falls below 25% of normal signal amplitude. This test shall be based on at least one full pass in each direction. The tape shall also be free of spurious noise output exceeding 10% of full signal level when magnetized to saturation in one direction.

Service life: Tape shall withstand at least 50,000 bidirectional passes (25,000 in each direction) in a standard wear test. The wear test requires that a 50-inch length of tape selected at any point in a full reel be cycled on a Digital Tape Unit Tester used in conjunction with an **RD-224( )/TYK Field** Digital Magnetic Tape Transport Computer Type. Speed of tape shall be 150 inches per second using NRZI recording and 300 bits/inch density. During the wear test, a continuous digital signal is recorded and reproduced. End of tape life shall be defined as the time when the signal error rate (signal falls below 25%) suddenly increases by several orders of magnitude or is greater than 1 part in 10^5. In a typical test, the error rate is zero with an occasional randon few errors until end of life occurs. End of life is primarily caused by surface breakdown of the coating and caked oxide on the heads.

Objective

It is the purpose of this task to develop a stronger magnetic tape having a minimum of elongation and permanent set, and improved dimensional stability for use in more compact, higher speed electronic data-processing and communication systems; a thinner magnetic tape to allow for more memory data per unit volume; and a magnetic tape backing material having greater adhesion to magnetic coatings in order to increase its efficiency, life, and reliability.

Work done at USAELRDL was concentrated on developing a tape backing film for the type of tape indicated above. In order to provide this type of tape, it was considered that the tape backing film should have the following properties:

1. The base film should not be more than 0.7 mil. in thickness (preferably less for the reason that thinner tapes allow for increased memory storage per unit reel volume).

2. The longitudinal tensile strength for a one-inch-wide tape should be at least 36 pounds and for a tape 1/4 inch in width, 9 pounds, with 13 pounds per inch cross-section transverse for both widths.

3. Elongation under maximum tensile stress of not more than 6% and a permanent set less than 1%.

4. It should have a maximum moisture absorption under 1%.

5. Be able to withstand an operating or storage temperature of 160°F.

6. In addition, the tape must provide improved adhesion capability to magnetic coatings.

7. Very smooth surface on the face to which the magnetic coating is applied.

8. Excellent flexibility at high and low temperatures.

9. Good tear resistance.

10. Freedom from curling, necking, crinkling, shrinking, and edge splitting and raveling.

Approach

In order to meet the above objectives, it was considered necessary to develop an ultra-thin reinforced plastic backing material to which the magnetic coating would adhere better than it does to conventional backing material. Because of the number and complexity of the problems involved, it was decided to approach the task by the six steps outlined in Fig. 4.

PROCEDURE

Magnetic Tape Evaluation

This evaluation was undertaken for the purpose of obtaining comparative test data on representative specimens of commercially available magnetic recording tapes in order to provide a point of reference in determining the amount of improvement necessary to meet military requirements in tapes.

1. *Tensile Strength*

Tensile strength, elongation, and permanent set measurements were made on an Instron machine, Model T.M:, located in a room maintained at 77°F and 50% RH. Both the crosshead speed and the recording chart speed were adjusted to twelve (12) inches per minute. The separation between jaws at the start of each test was four (4) inches. The specimens, all (6) inches long, were preconditioned at 77°F and 50% RH for twenty-four (24) hours immediately prior to testing.

In order to obtain a clearer view of the data, a chart (Fig. 5) was made showing the relationship between tensile stress, elongation, and permanent set on representative regular polyester, tensilized polyester, and acetate magnetic recording tapes.

It will be noted that all of these tapes have relatively high elongation when subjected to tensile stress over their elastic limit. This is particularly evident in the regular polyester magnetic tapes where the elongation under ultimate tensile stress is considerably over 100%.

2. To determine the effect of exposure to elevated temperature (160°F) which magnetic tapes are required to withstand in operation and/or storage, four domestic magnetic tape samples of the same type as those tested previously for tensile strength, elongation, etc, were exposed to a temperature of 160°F for 240 hours in an air-circulating dry-heat oven. The samples consisted of (A) a representative 1"-wide nominal one-mil-thick regular polyester magnetic tape; (B) a representative 1/4"-wide nominal one-mil-thick regular polyester magnetic tape having a lubricated back; (C) a 1/4"-wide tensilized polyester magnetic tape having a 0.5-0.7-mil-thick backing; and (D) a 1/4"-wide nominal one-mil thick cellulose acetate magnetic tape. The 1/4"-wide regular polyester magnetic tape sample (marked B), Fig. 3, was unaffected by exposure to heat (160°F) as it retained perfect dimensional stability. The 1"-wide regular polyester magnetic tape sample (A) showed slight longitudinal curling, probably due to the effect of heat on the magnetic coating; otherwise the sample retained good dimensional stability. The acetate magnetic tape sample (marked D) curled badly and the tensilized polyester magnetic tape sample (marked C) curled, shrunk and cupped. This test indicated that regular polyester magnetic tapes are the only commercially available ultra-thin plastic magnetic tapes which retain their dimensional stability under exposure to 160°F dry heat.

3. *Humidity Resistance*

Digital magnetic tape transports used in the field are required to operate under extremes of temperature and humidity. In order to simulate some of these conditions, magnetic tape transports were operated in environmental chambers at USAELRDL in conformance with MIL SPEC 170 – Title, "Military Moisture Resistant Test Cycle for Ground Signal Equipment." The complete test requires a total of five 48-hr. cycles. Near the end of each cycle, the magnetic tape transports were operated at a tape speed of 150 inches per second and a stopping rate of 3 milli-seconds for a period of from one to two hours at a temperature of 183°F and 95% relative humidity. The magnetic tape used in these tests consisted of a representative regular polyester magnetic tape one inch in width having a nominal one-mil-thick backing such as is regularly used for Field Digital Magnetic Tape Transports, Computer Type, RD-224( )/TYK. The extremes of temperature and the high humidity caused a breaking away in certain sections of the magnetic coating from the film base (See Fig. 2 – Items A and C).

4. *Oxide Adhesion*

During the tensile strength tests, particles of magnetic oxide were observed to fall off the tape onto the base of the testing machine and the amount appeared to be directly proportional to the amount of elongation. There appeared to be a smaller amount separating from the acetate types than from the polyester types.

In an attempt to determine the effectiveness of the adhesive, if any, in securing the magnetic oxide to the base material, several specimens, each of regular polyester, tensilized polyester and acetate tapes, were subjected to abrasion in a Wizenbeck Abrasion Tester. Again, the oxide appeared to adhere best to the acetate type, although the accuracy of this test is not of a very high order as all of the tapes were extremely sensitive to this kind of abrasion. Most of the information regarding the adhesion of magnetic coatings to magnetic tape backing materials was gained from a study of the behavior of magnetic tapes before, during, and after operations in such systems as Field Digital Magnetic tape transports, computer type, and satellite type recorders and transmitters. To study the effect of prolonged operation on magnetic tapes used for field applications, a test breadboard (Fig. 1) was made containing electronic parts similar to those found in some transmitting and recording equipment. A representative 1/4-inch-wide magnetic tape having a nominal one-mil-thick regular polyester backing was tested on this breadboard at a room temperature of 25°C and 50% relative humidity, by being given 14,000 pases through the recording and transmitting heads on the test breadboard at a speed of 30 inches per second. The effect of the continuous passage of the magnetic tape caused (1) flaking-off of the magnetic coating, and (2) distortion of the magnetic tape on the reel due to elongation.

The physical and mechanical responses of magnetic recording tape to humidity, heat, and tensile stress are primarily functions of the plastic film or base material. However, the adhesive coating which serves as the magnetic oxide carrier is considered to influence the referenced responses to some degree.

There are two possible types of adhesive coatings on magnetic tapes. One, the autogenous type, is a solution of a resin of the type found in the backing material. The other, the heterogenous type, contains a different resin because of the insolubility of the backing material in all usable solvents. Heterogenous adhesive coatings are used on polyester tapes and are subject to flaking because their physical properties are different from those of the backing material.

In order to rule out the effect of the coating of the physical and mechanical properties of the backing material, a varitey of plastic films without the coating were evaluated.

Film Evaluation

A study of commercially available organic films and film forming resins was made to determine those most suitable for the development of a reinforced plastic magnetic recording tape backing material. As a result of extensive evaluation work, the polyester (polyethylene terephthalate) films and the polycarbonate type films were found to have the best overall properties for this task. Both the polyester and polycarbonate films have similar physical properties, such as good heat resistance, low moisture absorption, and good flexibility under extremes of temperature, and neither of them contain plasticizers. Films without plasticizers are usually more stable over long periods of time.

1. *Tensile Strength*

Tensile tests were conducted on uncoated polyester, tensilized polyester, and acetate and polycarbonate films, as conducted on the magnetic tapes. Results of these tests are shown in Fig. 6. In order to obtain a clearer view of any deficiencies, graphs were made showing the relationships between tensile stress, elongation, and permanent set. Results of these tests are shown in Fig. 7, 8 and 9. The dotted lines in Fig. 7 show results of the same tests for comparison conducted on 1-inch-wide regular polyester magnetic tape.

2. *Heat Resistance*

Samples of uncoated regular polyester, tensilized polyester and polycarbonate films having a nominal thickness of one mil and a tensilized polyester film approximately 0.65 mil in thickness were exposed to a temperature of 160°F and 50% relative humidity for 240 hours. The regular polyester and polycarbonate films were unaffected, but the tensilized polyester film curled and the cellulose acetate type film curled and twisted. This indicated that tensilized polyester films and cellulose acetate type films have poor dimensional satbility under the above-referenced temperature and humidity conditions (see Fig. 10).

3. *Film Forming*

Polyester films are available in many thicknesses down to 1/4 mil but polycarbonate films in thicknesses below one mil are not readily available. Therefore polycarbonate films were cast at USAELRDL. These films were cast in thicknesses ranging from 1/10 mil to 1 mil. The films were cast on polished plate glass which had been previously treated with a suitable parting agent. Polycarbonate films were also cast by a continous film casting method using gravure-type steel rollers.

Reinforcing Yarn Selection

Previously described tests on available magnetic recording tapes indicated that significant improvement could be obtained only by using a reinforcement. Glass filaments are the strongest reinforcing material for plastics. They have good dielectric properties and are available in many forms such as chopped strands, rovings, yarns, woven fabrics, etc. Continuous mulitfilament yarns combined with a low twist produce the thinnest and strongest reinforcement. Therefore, the yarn selected was a continuous multifilament glass yarn which measured 180,000 yards to the pound, composed of 51 continuous filaments, with a twist of one turn per inch. A loss of strength may occur in glass reinforced polycarbonate magnetic tape backing materials due to continuous flexing of the magnetic tape during the high-speed operation of data processing systems. If glass fatigue should occur in these operations, it would probably be due to glass-on-glass rubbing. In order to overcome this problem, it was found advisable to use a softer, nonabrasive, organic yarn which could be woven in conjunction with glass yarns to serve as a cushion for the glass to prevent glass-to-glass friction. It was required that the organic yarn be as thin or thinner than the finest size glass yarns, that the tensile strength properties be as near as possible to that of glass yarns, that the elongation and permanent set under tensile stress be exceedingly low, and that the yarn be composed of multicontinuous filaments in order to give maximum strength properties.

All types of organic continuous multifilament yarns were studied and evaluated to determine the proper type of material to use for this purpose. Tensile, elongation, and permanent set tests were conducted on an Instron Tensile Testing Machine. Tests were conducted on viscose, polyamide, cellulose acetate, saponified acetate, acrylic, polyester and natural silk yarns. In addition, consideration was given to the effect that polycarbonate resins and solvents would exert on the yarns. As a result of these tests, it was found that saponified acetate yarns had the highest tensile strength combined with lowest elongation and permanent set.

Therefore, ultra-thin continuous multifilament saponified acetate yarns were made under USAELRDL direction by a commercial yarn manufacturer for experimental development work. Both 10- and 12- denier saponifield acetate yarns were produced for this task. Test results on ultra-thin saponified acetate yarns and on a fine size glass yarn are summarized in Fig. 11.

Other methods for protecting glass fibers against abrasion are also being studied. These include the treatment of the glass yarns with various types of chemical finishes, etc.

Fabric and Weave Development

A reinforcing fabric for this task should have a thickness of 0.7 mils or less to allow for an overlay film coating. It should have tensile strength of at least 40 lbs lengthwise for a 1-inch-wide material to allow for a safety factor of at least 4 lbs to meet the required 36-lb tensile strength requirements, a strength of at least 13 lbs per inch cross-section transverse, an elongation under 6%, and a permanent set under 1%. It is necessary for the material to have a very smooth surface in order to allow for a perfectly smooth laminated film overlay and thus to allow for the application of a smooth, polished magnetic coating. The reinforcing fabric material must be capable of being produced in lengths of at least 4000 feet splice free, and must be compatible with the laminating resin used and other chemicals required in the film forming technique.

As a preliminary step in the evaluation of reinforcment constructions for the development of Reinforced Plastic Magnetic Recording Tapes, sixty very-fine-size multicontinuous filament glass yarns, each one-yard long, were laid flat, evenly spaced and parallel within a width of one inch and an overall length of one yard. These threads were than laminated within a one-mil-thick polycarbonate film. This produced a unidirectional reinforced polycarbonate film having excellent tensile strength lengthwise but practically no lateral tensile strength. To give the construction greater lateral strength, many fine-size chopped glass strands, each approximately 3/4 inch in length, were inserted at random over and under the horizontal reinforcing threads which were then laminated with a one-mil-thick polycarbonate film. Both of the above methods proved unsuccessful for magnetic tape backing material construction owing to the relatively poor transverse tensile strength properties of the reinforced plastic film. In addition to the poor transverse tensile strength, the tape split readily lengthwise, was too thick, was not uniform in thickness, and had poor tear resistance. As a result of these experiments, it was found necessary to use woven fabric-type reinforcements in order to accurately control longitudinal and lateral tensile strength properties, to control widths and thicknesses within very close tolerances, and to produce a reinforced plastic material which would have the required tear resistance and maintain high dimensional stability and reliability under the fluctuating tensile stresses imposed by the operation of high-speed automatic digital magnetic tape transports.

High-strength glass reinforcing fabrics are available in many types of weaves and constructions but very few in thicknesses of one mil or less. It was, therefore, necessary to make a general survey of the market to determine the thinnest commercially available woven glass fabrics. As a result of this survey, a foreign glass fabric having a plain weave was procured which was composed of very-fine-size continuous multifilament glass yarns. The fabric had a thickness of approximately 0.8 mil but the looseness of the construction caused warp and filling slippage which rendered the fabric useless for a uniform reinforcement.

In the domestic market, a one-mil-thick glass fabric was procured. The fabric was composed of a warp having 60 ends of 900 1/0 continuous multifilament glass yarns and a filling having 52 picks of 1800 1/0 continuous multifilament glass yarns. The fabric was woven plain weave. This fabric did not have as smooth a surface as required, owing to its plain weave construction. It was also thicker than desired; its strength properties were only fair, but as it was the thinnest fabric commercially available containing the type of yarns required, this fabric was used for preliminary experimental polycarbonate film reinforcing techniques.

In order to produce a thinner reinforced plastic magnetic tape backing, it was necessary to have a reinforcing fabric less than one mil in thickness. To make a thinner fabric, it was necessary to use thinner yarns.

From a study of the strength and thickness requirements, an ideal theoretical fabric construction for this task was developed. It consisted of a woven fabric having at least 150 ends in the warp composed of No. 1800 multicontinuous filament glass yarns, having a very-low twist woven with a filling consisting of 84-88 picks of either 12-denier multicontinuous filament saponified acetate yarn, or a multicontinuous filament glass yarn of a finer size than the No. 1800. This fabric was to be woven with either a 5 shaft satin or a 4 shaft broken twill weave construction. A fabric made in this manner would have high tensile strength properties both laterally and longitudinally in excess of requirements. It would have a very smooth surface and its thickness under slight laminating pressure should range between 0.5 and 0.7 mil. It would have an elongation at maximum tensile stress less than 6% and a permanent set less than 1%. A comparison of the ideal fabric was made with commercially available fabrics in Fig. 12. Its assembly into a finished magnetic tape is illustrated in Fig. 13.

Designs for this type of fabric construction were submitted to textile manufacturers for a weaving quotation. But the manufacturers had not had experience in the weaving of glass yarn as fine as No.1800 in the warp. However, glass yarn of this size had currently been used in the filling for weaving ultra-thin glass fabrics such as that in the one-mil-thick glass fabric previously mentioned which had a warp composed of the heavier No. 900 glass yarn. Therefore, sample warps of No. 1800 glass yarns were made and were woven on power looms using the same same size glass yarn in the filling. However, it was found that a warp made of size No. 1800 glass yarns could not be woven successfully nor economically in modern high-speed looms. Glass yarns of even finer size than No. 1800 can be made by yarn manufacturers on special order and very-fine-size saponified acetate yarns have already been made. Therefore, if methods could be found to successfully weave these materials, a thinner and higher strength woven reinforcing fabric could be produced.

During the course of early work in the development of reinforced plastics at USAELRDL, flat sheets composed of fine-size glass yarns laminated and bonded with epoxy or polyester resins were constructed for the development of lightweight high impact resistant lead acid storage battery cases. This method is covered by a number of USAELRDL patents. This system was later modified to produce continuous length flat reinforcements and is capable of operating with the finest size yarns available. Its operation consists of utilizing any number of warp threads per inch, evenly spacing them under tension, and applying to them at right angles any number of transverse threads per inch evenly spaced and under tension. This apparatus is capable of making continuous length reinforcing fabrics, can be operated at high speed, and will operate with yarns too fine to be woven by modern power looms. It is anticipated that when this apparatus is fully developed, the saving in labor and operating expenses over conventional weaving methods will be considerable as the machine operates automatically. Utilizing this principle, a small experimental apparatus for making plastic magnetic tape backing material reinforcements was built at USAELRDL. Short-length experimental samples were made consisting of over 150 ends per inch of No. 1800 multicontinuous filament glass yarns in the warp and 60 picks or cross threads of 12-denier saponified acetate yarn in the filling. These experimental samples were made one inch wide and ten inches long.

Work is being continued to perfect this type of machine and also to develop suitable ultra-thin glass fabric constructions capable of being woven on modern high-speed power looms.

Reinforced Film Construction

Experiments were conducted to reinforce polycarbonate films by using as a reinforcement the one-mil-thick commercially available glass fabric described previously. The procedures were as follows: The fabric was first heat treated. It was then impregnated with a polycarbonate resin in suitable solvents. The impregnation of the fabric was accomplished by means of a pressurized rotating steel wire wrapped roller which laid onto the fabric a predetermined amount of resin solution. Great care was exercised to obtain the correct viscosity of the resin solution in order to assure thorough penetration of the glass yarns. Resin viscosity was measured by means of a Gardner Bubble Viscometer. After resin impregnation, the glass fabric was cold calendered to remove excess resin solution and subsequently passed through a heated drying oven to remove solvents. Following this treatment, it was hot calendered under pressure to obtain the proper thickness and surface smoothness.

Results of tests conducted on an Instron Tensile Testing Machine on a one-inch-wide glass fabric reinforced polycarbonate film ten inches long, made as described above, were as follows: The laminated film had a transverse tensile filling direction strength of approximately 13-15 pounds per inch. (Requirements call for 13 pounds per inch transverse). It had a longitudinal or lengthwise tensile strength (warp direction) of 30 to 40 pounds per inch (requirements call for 36 pounds ultimate tensile strength longitudinal for a one-inch-wide reinforced plastic magnetic tape backing material.) It had an elongation at ultimate tensile stress under 5%, a permanent set under 1%, and a thickness of 1.3 mils. It did not have, however, the required surface smoothness and it was too thick. (A thickness under one mil is required).

In order to make the material thinner and smoother, greater pressure was exerted during the laminating process, but it was found that extra pressure weakened the glass filaments. A very smooth surface is required on magnetic recording tape backing materials to enable the proper application of an efficient magnetic coating; therefore, new fabric and weave constructions are being designed to obtain a smoother face on the backing material.

Experiments were conducted to improve the surface smoothness of the above-described reinforced polycarbonate film by the following method: A 0.2 mil-thick red polycarbonate film was cast. The film color was accomplished by dissolving a small amount of rhodamine B dyestuff in the casting resin solution prior to casting. The colored film was then laminated under heat and pressure to the reinforced polycarbonate film, thus producing a red overlay on the reinforced film. This method improved surface smoothness but increased the thickness of the laminate by 0.2 mil. The color was added to the overlay laminated coating in order to indicate any nonuniformity of the coating. It was noted that the adhesion of the overlay film was excellent. Using this principle, magnetic coated samples of a reinforced polycarbonate film were made using the same method as that described with the colored polycarbonate overlay film except that instead of the addition of dyestuff to the overlay film, a dispersion of very-fine magnetic ferric oxide particles was used. This produced a magnetic film having a homogenous bond as is illustrated in Fig. 13.

The next experimental procedure for reinforcing polycarbonate films consisted of using a one-inch-wide, ten-inch-long sample of the ultra-thin reinforcing material previously described which was developed and produced at USAELRDL. This glass-fiber reinforcing material contained over 150 ends per inch of No. 1800 glass yarn in the warp and 60 lateral or filling threads per inch of 12-denier saponified acetate yarn and processed and laminated with a polycarbonate resin in the same manner as described above for laminating the commercial one-mil-thick glass fabric, with the exception that no colored polycarbonate overlay was subsequently laminated to this material. Results of tests conducted on an Instron Tensile Testing Machine on the reinforced polycarbonate film containing the USAELRDL developed reinforcing material were as follows: It had a longitudinal tensile strength at break of 62 pounds per inch and a transverse tensile strength per inch cross section of approximately 13-1/2 pounds. The material had an elongation under 5% and a permanent set of 1/2% at a 50-lb tensile stress; it had a thickness of 0.7 mil, and a very smooth face. (See Fig. 14 for comparison of physical properties with standard polyester magnetic tape.) This development sample of a magnetic tape backing material meets the technical objectives adequately, as indicated in Fig. 14 and 15, and proves that the achievement of a thin reinforced magnetic tape meeting the requirements set forth under the section on Military Requirements is feasible.

FUTURE MODIFICATIONS

While a short-length sample of reinforced backing material has been produced at USAELRDL, further work is required to produce continuous lengths of a composite magnetic tape with reproducible qualities. In the achievement of this objective, the following problems remain to be solved:

1. *Polycarbonate Resins*

Further work is required to improve polycarbonate resin formulations as follows: better impregnating, laminating and calendering techniques, thinner and stronger reinforcing materials, improved magnetic coating bonding systems, and the development of automatic machinery to produce continuous lengths of reinforced plastic magnetic recording tapes.

2. *Preventing Glass Abrasion*

Glass-on-glass abrasion in woven fabrics due to continued flexing must be prevented.

3. *Prevention of Edge Fraying*

The fraying of longitudinal glass threads along the sides of reinforced magnetic recording tape backing materials caused by the lengthwise slitting of wide width materials must be prevented.

4. *Improved Magnetic Coating Adhesive System*

As stated previously in this report, a great deal of trouble has been experienced in military grade magnetic recording tapes in the field due to the poor adhesion of the magnetic coating to the base film.

From experiments conducted at USAELRDL in the laminating of an overlay film (described under the section on Reinforced Film Construction), it was found that a laminated polycarbonate overlay film had tremendous adhesion to the reinforced polycarbonate base film as it was fastened by a homogenous bond. This technique should be further refined for achievement of an improved bond between the magnetic coating and the tape backing material.

CONCLUSIONS

An experimental tape backing material has been developed which shows promise of eliminating the physical and mechanical deficiencies of magnetic recording tape for military usage. This material has a thickness of 0.7 mil, a tensile strength of 62 lbs at break, total elongation under 5 percent, and a permanent set of 1/2 percent with a 50-lb tensile load. Its composition multifilament glass yarns in the warp and saponified acetate yarns transverse, the reinforcing fabric of which is laminated within an impregnating polycarbonate film. With certain improvements, the use of this backing material in magnetic tapes should more than meet the minimum requirements stated in the objective of this report.

To date, only short lengths of this material have been made on a laboratory scale. Preliminary techniques have been developed, however, which would allow for the continuous production of greater lengths.

With the feasibility of adapting reinforcing techniques to the development of a magnetic tape backing material, the basis has been provided for future work leading to the ultimate development of an ultra-thin reinforced magnetic tape suitable for military usage.

ACKNOWLEDGMENTS

The authors acknowledge the direction of Dr. E. Both, who, as Chief of the Materials Branch, Electronic Parts & Materials Division, approved this project and offered helpful suggestions in the early stages. Acknowledgment is also made to Messrs. David Haratz and H. Cashman Jr., Data Equipment Branch, Data Processing Facilities Division, for their valuable suggestions and information relative to the requirements for improved magnetic tapes for use in automatic field data processing systems; to Mr. George V. Kedrowsky, Technical Staff, Astro-Electronics Division, relative to improvements required in magnetic tapes for use in ground-satellite communication systems; to Mr. John H. Kwik Jr., Mechanical Engineering Branch, Engineering Design Division, for his assistance in simulated testing to determine difficulties involved in magnetic tapes used for ground-satellite communications; and to Mr. William L. Branch, Reliability & Electronic Parts Branch, EP&M Division, for his helpful suggestions and assistance in tensile testing procedures.

AN EXAMPLE OF DISTORTION AND FLAKING FAILURES

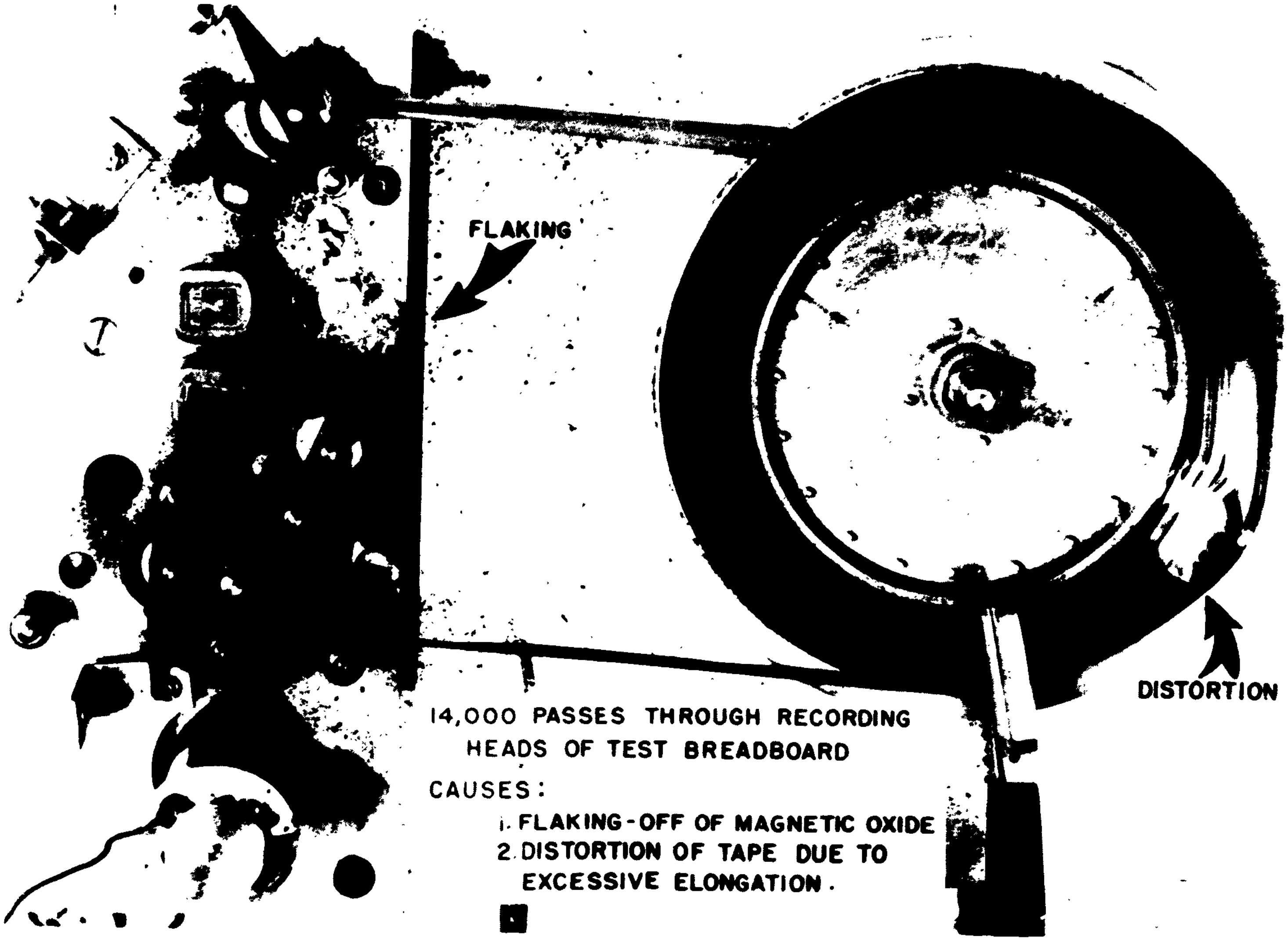


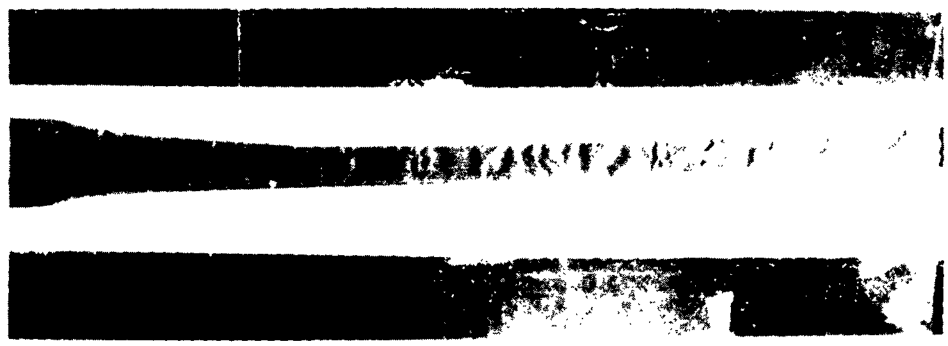
Fig. 1

DEFICIENCIES OF BEST COMMERCIAL GRADE POLYESTER MAGNETIC TAPES USED BY THE SIGNAL CORPS FOR FIELD DIGITAL MAGNETIC TAPE TRANSPORTS, COMPUTER TYPE AND COMMUNICATION SYSTEMS

A.

B.

C.



* A. & C. SHOWS FLAKING-OFF OF MAGNETIC COATING UNDER TEMPERATURE AND HUMIDITY CYCLING

** B. NECKING DUE TO TENSILE LOADING BEYOND ELASTIC LIMIT

* EXPOSURE TO ENVIRONMENTAL CONDITIONS IN ACCORDANCE WITH MIL-STANDARD-170 TITLE "MILITARY MOISTURE RESISTANT TEST CYCLE FOR GROUND SIGNAL EQUIPMENT" AND 2 HOUR OPERATION WITH DIGITAL MAGNETIC TAPE TRANSPORT.

TAPE SPEED 150" PER SECOND
STOP RATE 3 MILLISECONDS
84° F — 95% HUMIDITY

** ABRUPT STOP — TAPE SPEED 60" PER SECOND
ANALOG TYPE RECORDER- NO MECHANICAL TENSILE LOAD COMPENSATOR

M-62-468

Fig. 2


MAGNETIC TAPES
ACETATE TYPE
TENS. POLYESTER
REG. POLYESTER
REG. POLYESTER
D
C
B
A
EXPOSED TO TEMP. OF 160° F.
FOR 240 HOURS

Fig. 3

DEVELOPMENT OF REINFORCED PLASTIC MAGNETIC TAPE BACKING MATERIALS

STEP 1

MAGNETIC TAPE EVALUATION

CELLULOSE ACETATE TYPE
POLYESTER TYPE

STEP 2

FILM EVALUATION

MOST SUITABLE:
POLYESTER & POLYCARBONATE

POLYESTER REJECTED DUE TO POOR ADHESION TO MAGNETIC OXIDE COATINGS

STEP 3

REINFORCING YARN EVALUATION

MOST SUITABLE:
CONTINUOUS FILAMENT SAPONIFIED ACETATE & CONTINUOUS FILAMENT GLASS YARNS

STEP 4

YARN DEVELOPMENT

MICRO-SIZE YARNS DEVELOPED UNDER USAELRDL DIRECTION

STEP 5

FABRIC DEVELOPMENT

CONSTRUCTION & WEAVES DEVELOPED BY USAELRDL

STEP 6

TAPE FORMING TECHNIQUES

CONTINUOUS REINFORCED FILM FORMING BY TECHNIQUES DEVELOPED AT USAELRDL

Fig. 4

MC-62-863

TENSILE PROPERTIES
MAGNETIC TAPES

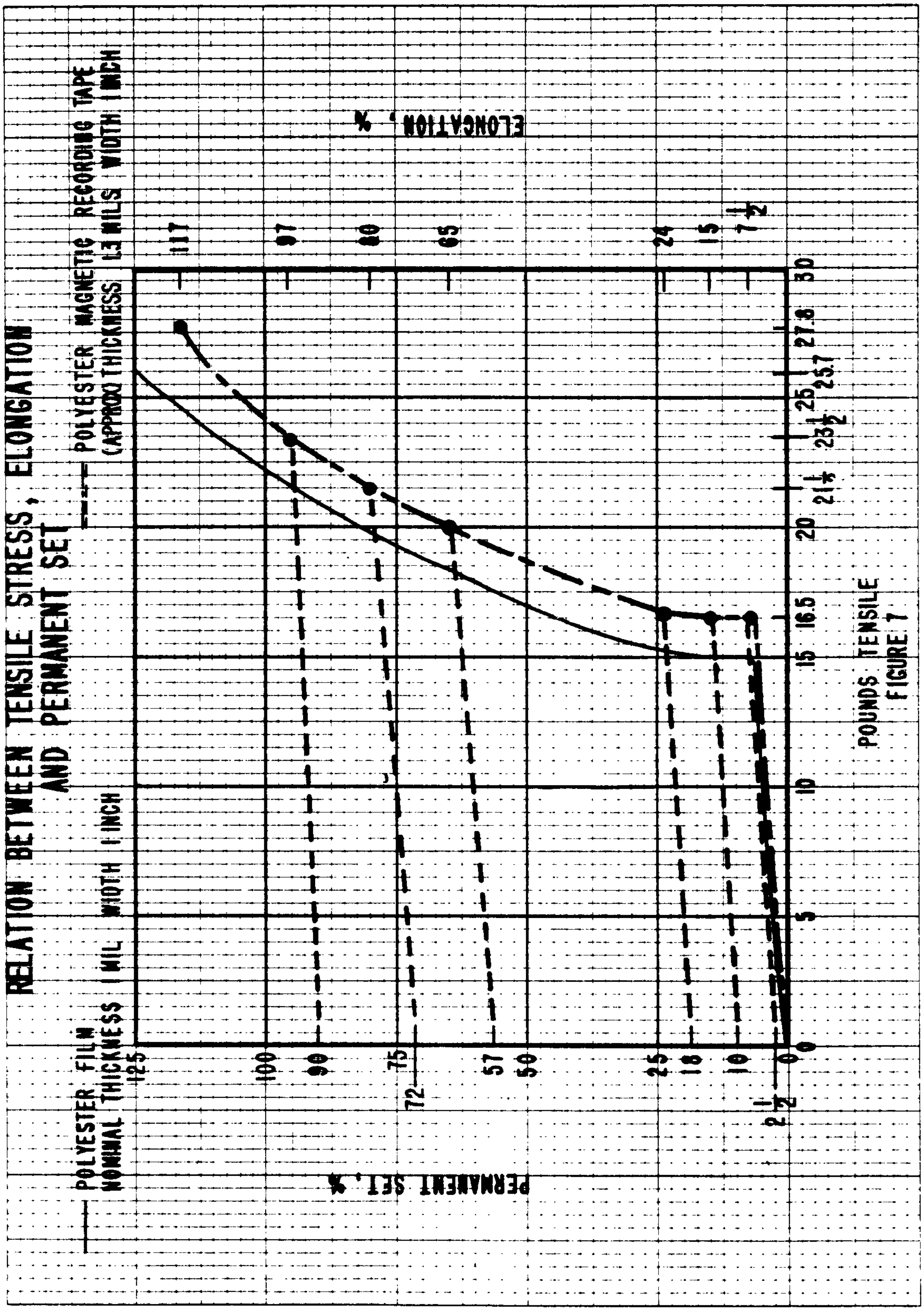
	REGULAR POLYESTER		TENSILIZED POLYESTER	CELLULOSE ACETATE TYPE	REQUIRED	
WIDTH INCHES	1/4	1	1/4	1/4	1	1/4
THICKNESS MILS (APPROX)	1.3	1.3	1.0	1.3	0.7 – 1	0.7 – 1
TENSILE LOAD LBS. TO BREAK (AVERAGE)	7.54	27.8	6.62	4.15	36	9
ELONGATION AT BREAK % (AVERAGE)	169	117	32.6	19.18	6 OR LESS	6 OR LESS

FIGURE 5

TENSILE PROPERTIES
PLASTIC FILMS - UNCOATED

	REGULAR POYESTER	TENSILIZED POYESTER	CELLULOSE ACETATE TYPE	POLYCARBONATE	REQUIREMENTS
WIDTH INCHES	1	1	1	1	1
THICKNESS MILS (APPROX)	1	0.65	1	1	0.5-0.7
TENSILE LOAD LBS. TO BREAK (AVERAGE)	25.7	25.3	15.5	19.0	36
ELONGATION AT BREAK % (AVERAGE)	125.2	30.	25.3	125	6 OR LESS
P. S. I. TENSILE LONGITUDINAL (APPROX.)	25,700	38,923	15,500	19,000	60,000

FIGURE 6


RELATION BETWEEN TENSILE STRESS, ELONGATION AND PERMANENT SET
POLYESTER FILM NOMINAL THICKNESS 1 MIL WIDTH 1 INCH
POLYESTER MAGNETIC RECORDING TAPE (APPROX) THICKNESS 1.3 MILS WIDTH 1 INCH
ELONGATION, %
PERMANENT SET, %
POUNDS TENSILE
117
97
80
65
24
15
7 1/2
125
100
90
75
72
57
50
25
18
10
0
2 1/2
5
10
15
16.5
20
21 1/4
23 1/2
25
25.7
27.8
30
FIGURE 7

RELATION BETWEEN TENSILE STRESS, ELONGATION AND PERMANENT SET OF TYPICAL TENSILIZED POLYESTER FILM

THICKNESS 0.65 MILS (APPROX) WIDTH 1 INCH

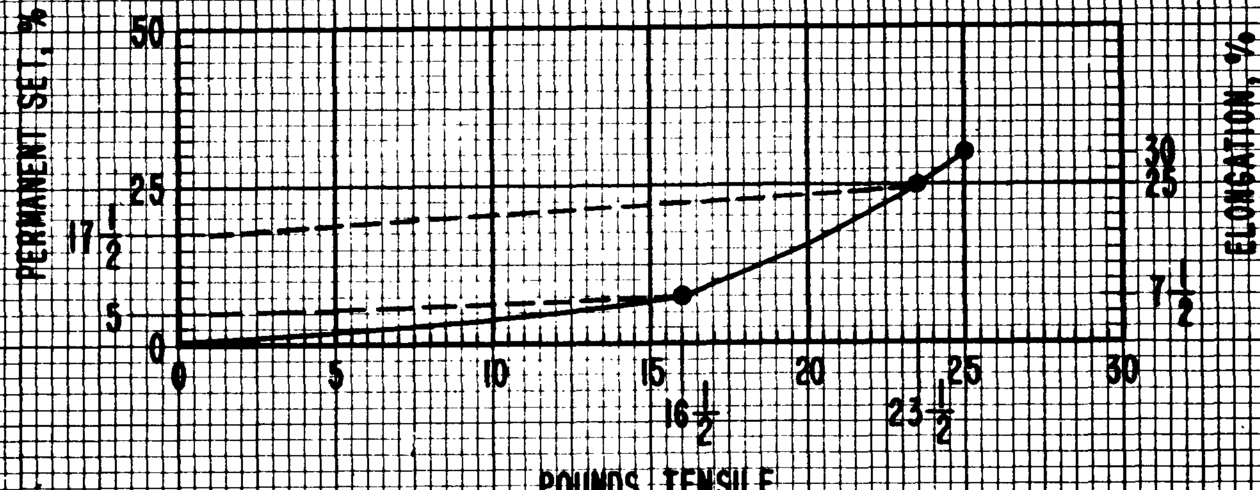


FIGURE 8

RELATION BETWEEN TENSILE STRESS, ELONGATION
AND PERMANENT SET OF
REPRESENTATIVE CELLULOSE ACETATE TYPE FILM

NOMINAL THICKNESS 1 MIL WIDTH 1 INCH

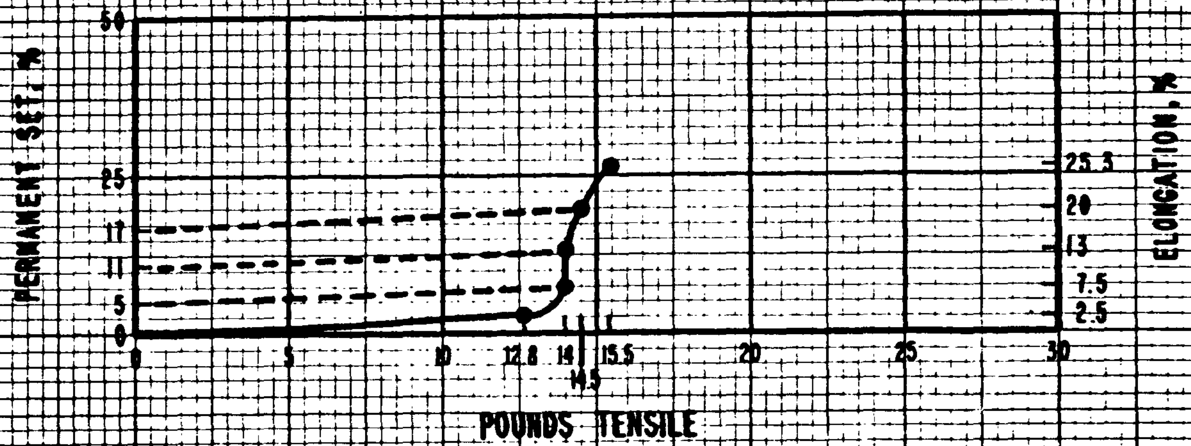
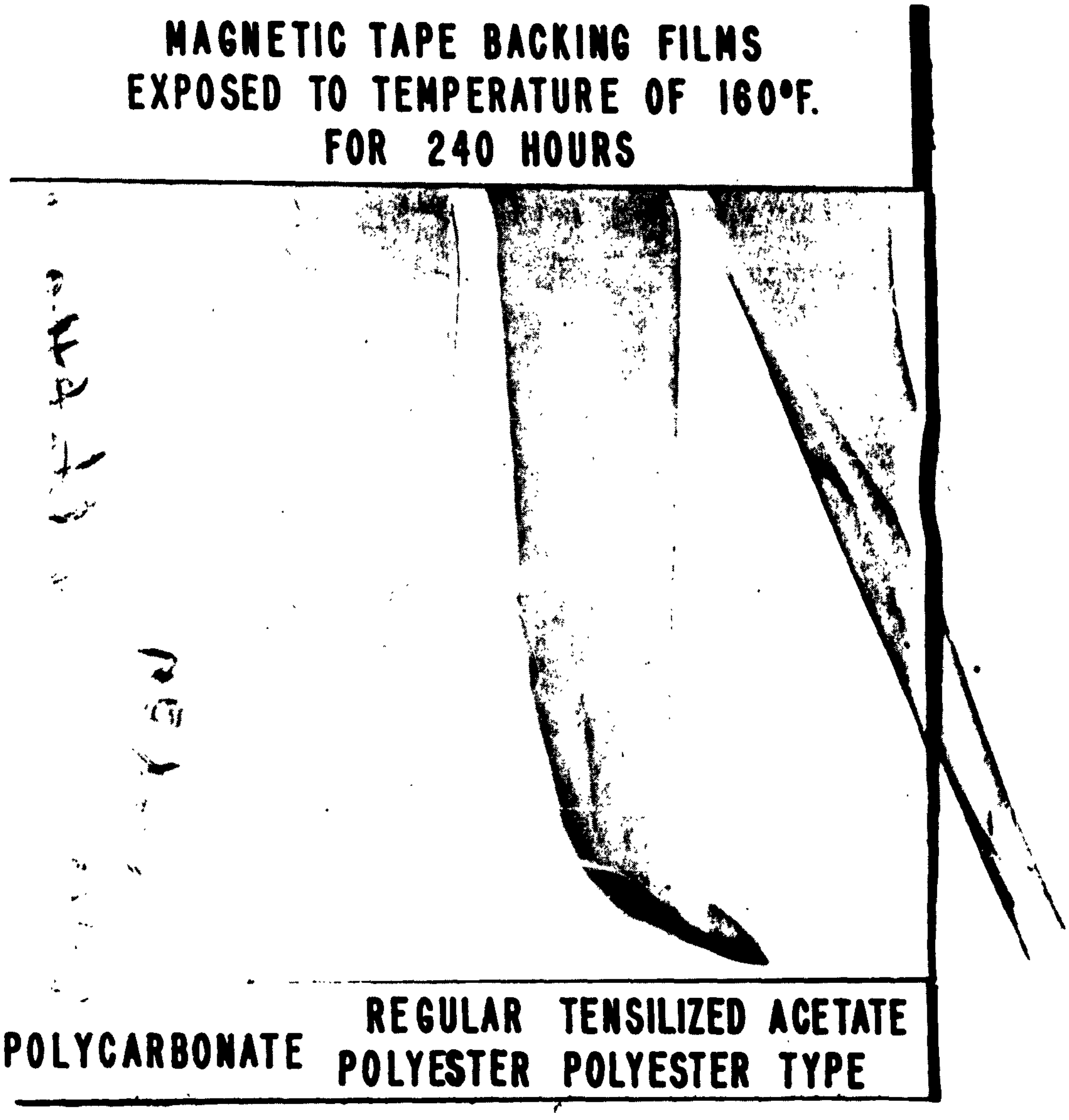


FIGURE 9



MAGNETIC TAPE BACKING FILMS
EXPOSED TO TEMPERATURE OF 160°F.
FOR 240 HOURS
POLYCARBONATE
REGULAR POLYESTER
TENSILIZED POLYESTER
ACETATE TYPE

Fig. 10

ULTRA-THIN REINFORCING YARNS
USED IN THE DEVELOPMENT OF USAELRDL REINFORCED PLASTIC MAGNETIC TAPES

	SAPONIFIED ACETATE	SAPONIFIED ACETATE	GLASS
SIZE	20 DENIER	12 DENIER	1800
FILAMENTS	40	20	51
TWIST	0.5	0.5	1
YARDS PER LB.	223,288	372,145	180,000
STRENGTH LBS.	0.29	0.18	0.34
ELONGATION	4½%	6%	3%
THICKNESS MIL.	0.39	0.25	0.30

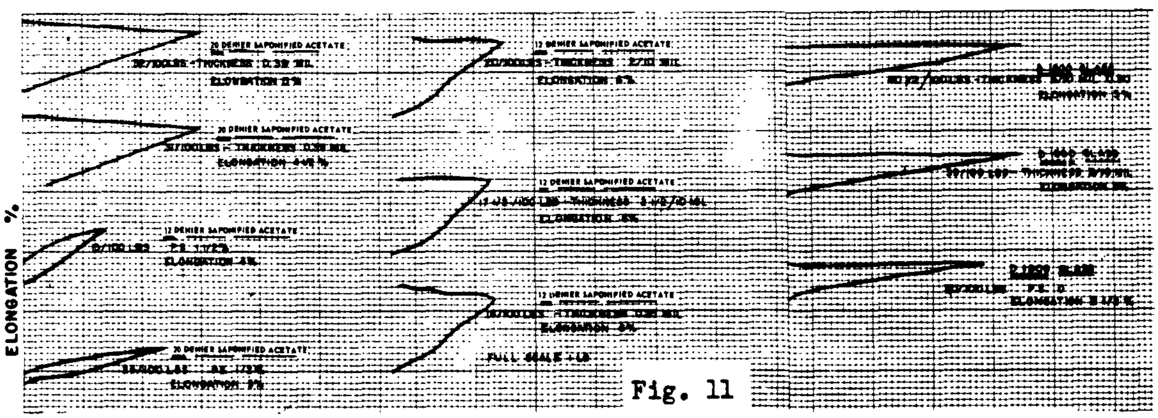


Fig. 11

MC-62-862

WEAVE & FABRIC CONSTRUCTION REINFORCEMENT FOR REINFORCED PLASTIC MAGNETIC TAPE

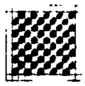
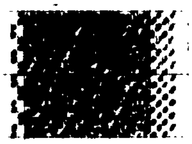
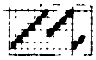
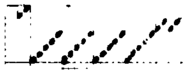
	THINNEST REINFORCING FABRIC COMM AVAILABLE	USAELRDL PROPOSED REINFORCING FABRIC
WEAVE DESIGN		
DRAFT		
CHAIN		
WARP ENDS	60	150
FILLING PICKS	52	88
MATERIAL WARP	Glass 900	Glass 1800
MATERIAL FILLING	Glass 1800	Sap. Acetate 12 Denier
LONGITUDINAL TENSILE STRENGTH LAM.	30-40 lbs	50-60 lbs
THICKNESS	1 Mil	0.7 Mil

Fig. 12

MC-62-861

HIGH-STRENGTH REINFORCEMENTS
AND
M.F. OXIDE ADHESIVE SYSTEMS
FOR
POLYCARBONATE MAGNETIC TAPE

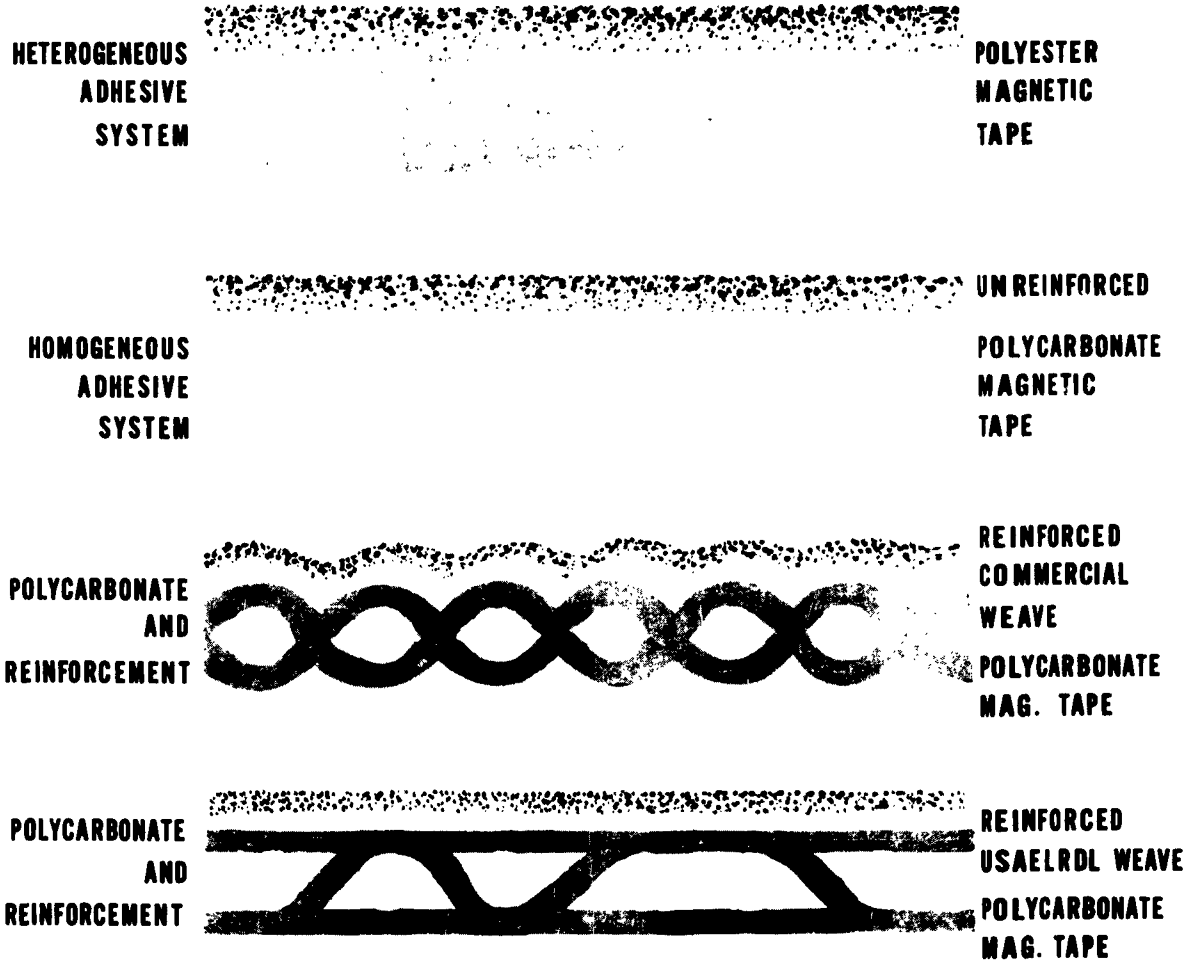
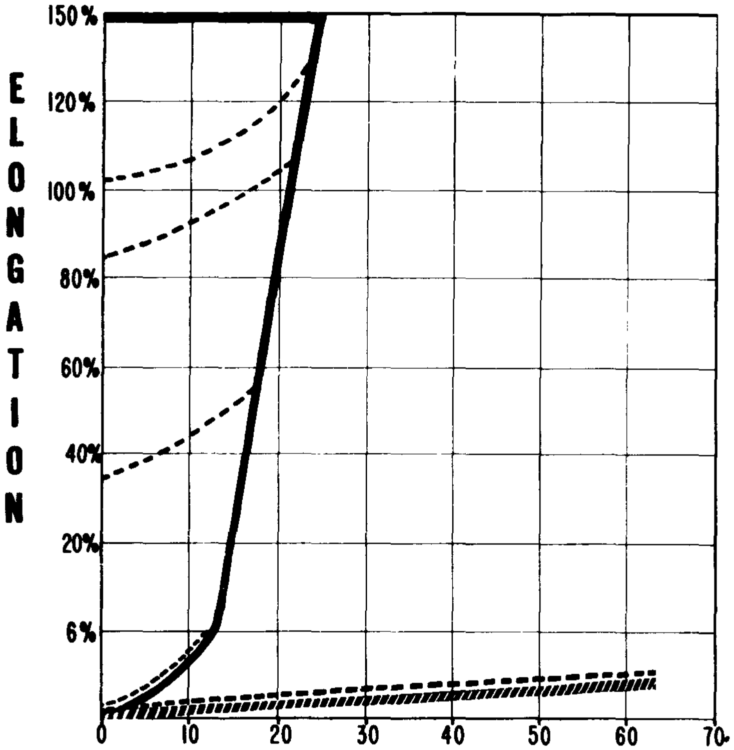


Fig. 13

MC-62-860

COMPARISON OF MAGNETIC TAPE BACKING MATERIALS
TENSILE STRENGTH & % ELONGATION DATA



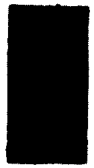
	BEST COMMERCIAL GRADE AVAILABLE FOR MILITARY USE	USAELRDL EXPERIMENTAL DEVELOPMENT
THICKNESS - MILS	1	0.7
WIDTH - INCHES	1	1
ULTIMATE STRENGTH-LBS.	26	62
USABLE STRENGTH-LBS.	15	50
ULTIMATE ELONGATION %	OVER 100	UNDER 5
ULTIMATE PERMANENT SET %	OVER 90	0.5
ADHESION MAGNETIC OXIDE	FAIR	GOOD

MC-61-291

U.S. PATENT APPLICATION 4 OCT. 1961
SERIAL No. 142988 FILED A. RUSCH

Fig. 14

DIMENSIONAL STABILITY UNDER TENSILE LOAD

CONVENTIONAL	USAELRDL EXPERIMENTAL
BEST MILITARY GRADE MAGNETIC TAPE	IMPROVED MAGNETIC TAPE
	
ELONGATION OVER 100 % AND NECKING	ELONGATION UNDER 5 % NO NECKING

1 INCH ---- WIDTH ----- 1 INCH
1 MIL --- THICKNESS --- 0.7 MIL
25 LBS -- TENSILE LOAD -- 50 LBS

Fig. 15

DISTRIBUTION LIST

	Copies
Commanding General U. S. Army Electronics Command ATTN: AMSEL-AD Fort Monmouth, New Jersey	3
Office of the Assistant Secretary of Defense (Research and Engineering) ATTN: Technical Library Room 3E1065, The Pentagon Washington 25, D. C.	1
Chief of Research and Development Department of the Army Washington 25, D. C.	2
Chief, United States Army Security Agency ATTN: ACofS, G4 (Technical Library) Arlington Hall Station Arlington 12, Virginia	1
Commanding Officer U. S. Army Electronics Research and Development Activity ATTN: Technical Library Fort Huachuca, Arizona	1
Commanding Officer U. S. Army Electronics Research and Development Activity ATTN: SELWS-AJ White Sands, New Mexico	1
Commanding Officer U. S. Army Electronics Research Unit P. O. Box 205 Mountain View, California	1
Commanding Officer U. S. Army Electronics Materiel Support Agency ATTN: SELMS-ADJ Fort Monmouth, New Jersey	1
Commanding General U. S. Army Satellite Communications Agency ATTN: Technical Documents Center Fort Monmouth, New Jersey	1
Director U. S. Army Engineer Research and Development Laboratories ATTN: Technical Documents Center Fort Belvoir, Virginia	1
Commanding Officer U. S. Army Chemical Warfare Laboratories ATTN: Technical Library, Building 330 Army Chemical Center, Maryland	1
Commanding Officer Harry Diamond Laboratories ATTN: Library, Building 92, Room 211 Washington 25, D. C.	1
Headquarters, United States Air Force ATTN: AFCIN Washington 25, D. C.	2
Rome Air Development Center ATTN: RAALD Griffiss Air Force Base New York	1
Headquarters Ground Electronics Engineering Installation Agency ATTN: ROZMEL Griffiss Air Force Base New York	1
Commanding General U. S. Army Materiel Command ATTN: R&D Directorate Washington 25, D. C.	2

Distribution List (Cont)

Addressee	Copies	Addressee	Copies
Aeronautical Systems Division ATTN: ASAPRL Wright-Patterson Air Force Base Ohio	1	Chief, Bureau of Ships ATTN: Code 454 Department of the Navy Washington 25, D. C.	1
U. S. Air Force Security Service ATTN: ESD San Antonio, Texas	1	Chief, Bureau of Ships ATTN: Code 686B Department of the Navy Washington 25, D. C.	1
Headquarters Strategic Air Command ATTN: DOCE Offutt Air Force Base, Nebraska	1	Director U. S. Naval Research Laboratory ATTN: Code 2027 Washington 25, D. C.	1
Headquarters Research & Technology Division ATTN: RTH Bolling Air Force Base Washington 25, D. C.	1	Commanding Officer & Director U. S. Navy Electronics Laboratory ATTN: Library San Diego 52, California	1
Air Proving Ground Center ATTN: PGAPI Eglin Air Force Base, Florida	1	Commander U. S. Naval Ordnance Laboratory White Oak Silver Spring 19, Maryland	1
Air Force Cambridge Research Laboratories ATTN: CRXL-R L. G. Hanscom Field Bedford, Massachusetts	2	Commander Armed Services Technical Information Agency ATTN: TISIA Arlington Hall Station Arlington 12, Virginia	20
Headquarters Electronic Systems Division ATTN: ESAT L. G. Hanscom Field Bedford, Massachusetts	2	USAELRDL Liaison Officer U. S. Army Tank-Automotive Center Detroit Arsenal Center Line, Michigan	1
AFSC Scientific/Technical Liaison Office U. S. Naval Air Development Center Johnsville, Pa.	1	USAELRDL Liaison Officer Naval Research Laboratory ATTN: Code 1071 Washington 25, D. C.	1
Chief of Naval Research ATTN: Code 427 Department of the Navy Washington 25, D. C.	1	USAELRDL Liaison Officer Massachusetts Institute of Technology Building 26, Room 131 77 Massachusetts Avenue Cambridge 39, Massachusetts	1
Bureau of Ships Technical Library ATTN: Code 312 Main Navy Building, Room 1528 Washington 25, D. C.	1		

Distribution List (Cont)

	Copies
USAELRDL Liaison Office Aeronautical Systems Division ATTN: ASDL-9 Wright-Patterson Air Force Base Ohio	1
U. S. Army Research Liaison Office Lincoln Laboratory P. O. Box 73 Lexington, Massachusetts	1
USAELRDL Liaison Officer Rome Air Development Center ATTN: RAOL Griffiss Air Force Base New York	1
Commanding Officer U. S. Army Security Agency Processing Center Deal Area, Bldg. 5001	1
File Unit Nr. 1, Rm. 3D-116 Hexagon	1
USAEMSA Liaison Engineer USASCAJ APO 343 San Francisco, California	1
Technical Dir., SELRA/CS Headquarters, USAELRDL	1
USAELRDA-White Sands Liaison Office SELRA/LNW, USAELRDL	1
AFSC Scientific/Technical Liaison Office SELRA/LNA, USAELRDL	1
Corps of Engineers Liaison Office SELRA/LNE, USAELRDL	1
Marine Corps Liaison Office SELRA/LNR, USAELRDL	1
USACDC Liaison Office SELRA/LNF, USAELRDL	2

	Copies
Chief, Technical Information Division Headquarters, USAELRDL	6
USAELRDL Technical Documents Center SELRA/ADT, Hexagon	1
USAELRDL Liaison Officer Hq, U. S. Army Combat Developments Command CDCLN-EL Fort Belvoir, Virginia	1
Director, Electronic Parts & Materials Division SELRA/PE	1
Reliability and Electronic Components Dept., SELRA/PEE	40
Director, Electronic Components Dept., SELRA/P	1

Army-Ft Monmouth, NJ-MON 1058-63

AD ____________ Div. ____________ UNCLASSIFIED

Army Electronics Research and Development Laboratory, Fort Monmouth, N. J.
REINFORCED PLASTIC MAGNETIC TAPES, by A. Rusch, E. Beekman, C. P. Lascaro. January 1963, 26 p. incl. illus. (USAEIRDL Technical Report 2324) (DA Task 3A99-15-003-05) Unclassified report

Presently available magnetic recording tapes fail to provide the degree of dimensional stability required by high-speed military information sensing and data recording equipment. Tests on a recently developed experimental tape backing material, composed of ultrathin glass fabric impregnated with polycarbonate resin, indicate the feasibility of developing a magnetic recording tape which will be free from excessive elongation, permanent set, and oxide film flaking. Steps in the development of the improved experimental tape backing material are described.

1. Recording Tapes
2. Data Processing Equipment
3. Thin Plastic Films, Reinforced

I. Rusch, A.
Beekman, E.
Lascaro, C. P.
II. Army Electronics Research and Development Laboratory, Fort Monmouth, N. J.
III. DA Task 3A99-15-003-05

UNCLASSIFIED

AD ____________ Div. ____________ UNCLASSIFIED

Army Electronics Research and Development Laboratory, Fort Monmouth, N. J.
REINFORCED PLASTIC MAGNETIC TAPES, by A. Rusch, E. Beekman, C. P. Lascaro. January 1963, 26 p. incl. illus. (USAEIRDL Technical Report 2324) (DA Task 3A99-15-003-05) Unclassified report

Presently available magnetic recording tapes fail to provide the degree of dimensional stability required by high-speed military information sensing and data recording equipment. Tests on a recently developed experimental tape backing material, composed of ultrathin glass fabric impregnated with polycarbonate resin, indicate the feasibility of developing a magnetic recording tape which will be free from excessive elongation, permanent set, and oxide film flaking. Steps in the development of the improved experimental tape backing material are described.

1. Recording Tapes
2. Data Processing Equipment
3. Thin Plastic Films, Reinforced

I. Rusch, A.
Beekman, E.
Lascaro, C. P.
II. Army Electronics Research and Development Laboratory, Fort Monmouth, N. J.
III. DA Task 3A99-15-003-05

UNCLASSIFIED

AD ____________ Div. ____________ UNCLASSIFIED

Army Electronics Research and Development Laboratory, Fort Monmouth, N. J.
REINFORCED PLASTIC MAGNETIC TAPES, by A. Rusch, E. Beekman, C. P. Lascaro. January 1963, 26 p. incl. illus. (USAEIRDL Technical Report 2324) (DA Task 3A99-15-003-05) Unclassified report

Presently available magnetic recording tapes fail to provide the degree of dimensional stability required by high-speed military information sensing and data recording equipment. Tests on a recently developed experimental tape backing material, composed of ultrathin glass fabric impregnated with polycarbonate resin, indicate the feasibility of developing a magnetic recording tape which will be free from excessive elongation, permanent set, and oxide film flaking. Steps in the development of the improved experimental tape backing material are described.

1. Recording Tapes
2. Data Processing Equipment
3. Thin Plastic Films, Reinforced

I. Rusch, A.
Beekman, E.
Lascaro, C. P.
II. Army Electronics Research and Development Laboratory, Fort Monmouth, N. J.
III. DA Task 3A99-15-003-05

UNCLASSIFIED

AD ____________ Div. ____________ UNCLASSIFIED

Army Electronics Research and Development Laboratory, Fort Monmouth, N. J.
REINFORCED PLASTIC MAGNETIC TAPES, by A. Rusch, E. Beekman, C. P. Lascaro. January 1963, 26 p. incl. illus. (USAEIRDL Technical Report 2324) (DA Task 3A99-15-003-05) Unclassified report

Presently available magnetic recording tapes fail to provide the degree of dimensional stability required by high-speed military information sensing and data recording equipment. Tests on a recently developed experimental tape backing material, composed of ultrathin glass fabric impregnated with polycarbonate resin, indicate the feasibility of developing a magnetic recording tape which will be free from excessive elongation, permanent set, and oxide film flaking. Steps in the development of the improved experimental tape backing material are described.

1. Recording Tapes
2. Data Processing Equipment
3. Thin Plastic Films, Reinforced

I. Rusch, A.
Beekman, E.
Lascaro, C. P.
II. Army Electronics Research and Development Laboratory, Fort Monmouth, N. J.
III. DA Task 3A99-15-003-05

UNCLASSIFIED