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PLAINTIFF'S EXHIBIT
6-302

Minutes
GENERAL MEETING
Asbestos Textile Institute
February 11, 1966
Barbizon-Plaza Hotel, New York, N.Y.

In Attendance:

AMERICAN ASBESTOS TEXTILE CORP.
J.L. Rainey
J.W. Christenbury
Wm. Maaskant

ASBESTOS CORPORATION LTD.
M.P. Carson
A.C. Steele
G.F.A. Brink
E.L. Alexander (A.C.S. Ltd.)
W.W. Oughtred

BELL ASBESTOS MINES LTD.
G.W. Smith
F.P. Smith
Wm.J.W. Smith
R. Dodds-Hebron

JOHNS-MANVILLE CORPORATION
W.S. Hough
E.A. Schuman
W.C. Atkinson
J. Barnett
C.L. Sheckler
T.C. Rogers
J.W. Axelson

CADWALADER, WICKERSHAM & TAFT
T.Jay Flocken (Legal Counsel)

ASBESTOS TEXTILE INSTITUTE
H.E. Sunbury (Exec. Secretary)

CANADIAN JOHNS-MANVILLE CO.
N.W. Hendry

GARLOCK, INC.
N.L.A. Martucci
G.E. Houghton

H.K. PORTER COMPANY INC.
J.D. McCluer
A.P. Gouveia
D.E. Childers

RAYBESTOS-MANHATTAN INC.
J.A. Bettes, Jr.
L.C. Williams
J.P. Wronski
J.W. Hawkins
R.B. Smith

TALLMAN-McCLUSKEY FABRICS CO.
J.L. Mitchell
T.C. McCluskey, Jr.

TURNER BROS. ASBESTOS CO. LTD.
W.M. Deckman

LAKE ASBESTOS OF QUEBEC LTD.
K.W. Nelson

UNITED STATES RUBBER COMPANY
S.J. Peele, Jr.
A.C. Link
D.T. Austin, Jr.
E.A. Morris

CASSIAR ASBESTOS CORP. LTD.
R. Marson (Ont. Res. Fdtn.)

Luncheon Guests
Feb. 11, 1966

P.J. Smith - ASTM Headquarters - Phila., Pa.
W.C. Hitchcock, U.S. Rubber Company, New York City
Mrs. R. Marson; Mrs. J.A. Bettes, Jr.; Mrs. W.C. Atkinson;
Mrs. E.A. Schuman; Mrs. W.S. Hough; Mrs. W.M. Deckman; Mrs.S.J.Peele,

Minutes

1. Vice President Rainey called the meeting to order at 9:30 A.M. and informed the members that President Brown was unable to attend because he was convalescing from a recent operation. Mr. Rainey asked Mr. Bettes to convey our best wishes to Mr. Brown.

2. Mr. Rainey asked each person present to stand and identify himself and his company affiliation. A most cordial welcome was extended to Messers. Martucci and Houghton, representing GARLOCK, INC., who have rejoined the Institute this year.

Mr. Rainey mentioned that the Secretary had received a nice letter from George F. Jenkins expressing his appreciation for the plaque that was given him in absentia at our last meeting. A copy of Mr. Jenkin's letter is attached to these minutes.

3. The minutes of the last meeting were presented for reading. Mr. Bettes moved that the reading be omitted, seconded by Mr. Hough, and so voted.

4. The Financial Report was presented by Mr. E.A. Schuman, Treasurer. Mr. Atkinson moved that the report be accepted as read, seconded by Mr. Peele, and so voted. The report is attached to these minutes.

5. Mr. P.Jay Flocken, Legal Counsel, discussed several recent decisions by the Federal Trade Commission on area price discrimination under Clayton Act #2(a), as amended by the Robinson-Patman Act. A summary of his remarks is attached to these minutes.

6. Mr. M.P. Carson, Vice President - Sales, Asbestos Corporation ltd., Thetford Mines, P.Q., Canada, gave the members a very interesting review of the asbestos mining situation in respect to production and sales of asbestos fibre. Some of the highlights in his talk: Overall shipments of the Canadian asbestos industry last year were 1,230,000 tons, about 5% below the prior year. However, there was some overpurchasing in 1964 to beat the price increase on No.4 and lower grades. Russia in 1965 supposed to have produced 1,500,000 tons. The No.3 spinning grades of asbestos fibre are in good supply at this time. However, the situation in Rhodesia could affect this in 1966. Some countries have boycotted Rhodesia, but others have not. The situation on long fibres could change.

Shipments of Canadian fibre to North America were about the same in 1964 and 1965. Shipments to Japan have been off, caused by a business depression there; this may improve in late 1966. The demand in India has been high for asbestos-cement grades, and Russia has supplied substantial quantities to India. The Canadian producers are now real "busy". New capacity for producing the shorter grades, now available or soon to be available, promises to meet the ever increasing demand.

7. Mr. J.P. Wronski, Head-Physics Section, Research & Development Dept., Raybestos-Manhattan Inc., Manheim, Pa., gave a technical paper entitled: "The Role of Fibers and Whiskers in Reinforcement". This proved to be a most interesting paper, and was followed by an extensive question and answer period. By courtesy of Mr. Wronski and Raybestos-Manhattan, the full text of the paper is attached to these minutes.

8. Mr. Rainey read the letter that President Brown sent to Mrs. M. C. Shaw on behalf of the Institute, following the sudden death of Dr. Shaw on November 12th, 1965. The reply, expressing Mrs. Shaw's appreciation, was read. Both letters are made a part of these minutes. Following the reading of the letters, Vice President Rainey asked that the members stand and observe a minute of silence in memory of Dr. Shaw.

9. The committee reports were given by the chairmen of their respective committees as listed below. The full text of their reports is attached to these minutes.

Air Hygiene & Mfg. Committee - W.C. Atkinson, Chairman

Sales Promotion Committee - W.S. Hough, Chairman

Technical Committee - J.D. McCluer, Chairman

Fiber Testing Committee - J.P. Wronski, Chairman

10. Vice President Rainey announced that the next meeting of the Institute would be held on June 9th and 10th, 1966, at the Barbizon-Plaza Hotel in New York City.

11. The annual meeting in the fall will be held on October 6th and 7th, but the location has not been settled as yet. This will be the BIG MEETING of the year, and members are urged to bring their wives. We hope to find a location that will be equally attractive to both the men and their wives. (See footnote)

12. There being no further business to come before this meeting, on motion duly made and seconded, it was voted to adjourn. The luncheon that followed the meeting was made more enjoyable by presence of many wives.

Respectfully submitted,

H.E. Sunbury

H.E. Sunbury
Exec. Secretary

Note:

Subsequent to the meeting, arrangements were completed to hold the October meeting at The Homestead, Hot Springs, Va. This is reported, by those fortunate enough to have stayed there, to be a wonderful place to hold our annual meeting, and one that will be equally attractive to both the men and their wives. So - we suggest that you start planning NOW to bring your wife to the October meeting, to be held October 6th and 7th, 1966, at the world famous "Homestead", Hot Springs, Va.!

H.E.S.

Minutes: Air Hygiene and Manufacturing Committee
February 10, 1966
Barbizon-Plaza Hotel
New York City, New York
9:30 A.M. to 4:00 P.M.

Attending:

Members:	W.C. Atkinson, Chairman	Johns-Manville Corp.
	L.C. Williams	Raybestos-Manhattan, Inc.
	C.L. Sheckler	Johns-Manville Corp.
	R.B. Smith	Raybestos-Manhattan, Inc.
	A.C. Link	United States Rubber Co.
	T.C. McCluskey, Jr.	Tallman-McCluskey Fabrics Co.
	K.W. Nelson	American Smelting & Refining Co.
	A.P. Gouveia	H.K. Porter Co., Inc.
Guests:	W.K. Deckman	Turner Brothers Asbestos Co.Ltd.
	Dr. L.J. Cralley	U.S. Dept. of Health, Education and Welfare
Absent:	H. Walter	American Asbestos Textile

Bausch and Lomb Automatic Dust Counter

There was a short discussion on the Bausch and Lomb automatic dust counter. Mr. Nelson stated that his company had placed an order for one of the 40-2 machines and expected delivery in March. All members of the committee will be interested in the results obtained from the use of this machine.

Materials Handling Methods

This matter was brought up for discussion relative to loading trucks from ground level.

Methods discussed were: (a) fork lift trucks, and (b) electric hoists, and (c) hydraulic lifts.

Advantages and disadvantages of all three were discussed. Most companies have fork lift trucks, but, in some cases, they may be in use elsewhere at the time they are needed for loading a truck. Electric hoists are adequate for indoor use but not practical for outdoors. Hydraulic lifts require a permanent installation and lack the flexibility of a mobile unit.

Dust Bags for Dust Collectors

The relative merits of bags made from cotton, Nylon and Dacron came up for discussion. In most cases cotton bags are used. Some companies have experimented with Nylon and with Dacron bags. The concensus was that the cotton bags were more efficient and gave a satisfactory service life.

One company reported that examination after 9 years of service showed no deterioration in their cotton bags.

Dust Control by the Use of Oils, etc.

Most of the member companies have at one time used oils or emulsions, sprayed on the stock, to hold down dust in subsequent operations. In many cases it has been found to be of little, if any, value.

Two companies are currently experimenting with the use of a new substance called Lenospin Anti-Fly SD-5, which was developed by Lenox Chemical Co. Initial results indicate that larger scale runs for evaluation would be worthwhile. This will be reported on at future meetings.

Audiometry

Because of the growing number of compensation cases due to loss of hearing, the subject is being given serious consideration by most companies. Detailed programs are being developed for pre-employment testing, as well as regularly scheduled testing after employment. In addition, all areas of the plants are being tested for noise levels and decibel count. Maximum allowable levels are established and, wherever possible, corrective action is being taken.

One company has started issuing industrial earmuffs and requiring the employees to wear them in areas where the noise level is above the maximum allowable limits.

It was brought out, during the discussion, that there have been four manufacturing companies forced into bankruptcy due to compensation awards for loss of hearing, and one well-known steel manufacturing company has 950 claims filed against it that could run over a million dollars.

One of the member companies distributed sample forms showing the results of their noise survey.

Mr. Sheckler exhibited and recommended for study a copy of the Industrial Noise Manual published by the American Industrial Hygiene Association. It can be purchased for $15.00.

Several States already have industrial noise legislation, and it is being considered by others.

This subject will be followed up in future meetings.

Environmental Health Survey

During the afternoon session Dr. Lewis Cralley joined us and brought the committee up-to-date on the status of the Environmental Health Survey.

He stated that the plant surveys in Asbestos Textiles had been completed. The next phase, consisting of analyzing the data, is progressing. In addition, it is their intention to analyze trace contaminants, to determine whether they are present and, if so, still active. They will determine whether there is any radioactivity.

Environmental Health Survey (continued)

Dr. Cralley stated that within a year they hope to make a report on chemical content of asbestos fiber and its relationship to health hazards.

He also related that the Q.A.M.A. has organized an institute for the study of asbestos and its environmental health effects in order to bring a previous study up-to-date.

More and more publicity is being given to the health hazards in working with asbestos. The latest, a clipping from the National Observer of 2-7-66, written by John Henderson, M.D., discussed some symptoms of asbestosis and stated that the incidence of asbestosis is rising and that 30 years from now it would be much higher.

The article stated that "doctors are mystified by the appearance of a rare tissue tumor, mesothelioma, which is found increasingly in asbestosis victims".

The increasing number of these articles, apparently being written for personal publicity reasons, is disturbing to the industry and points up the need for an impartial survey such as is being made by the U.S. Department of Health, Education and Welfare.

Published Pamphlet - "Method for Determining Asbestos Dust Concentration"

In an effort to obtain a wider circulation of the subject pamphlet, the Sales Promotion Committee was asked to consider a plan whereby sales departments of the member companies might distribute the booklet to customers.

The Sales Promotion Committee, after due consideration, voted negatively.

Respectfully submitted,

W.D. Atkinson, Chairman
Air Hygiene & Mfg. Committee

GEORGE F. JENKINS

Knowlton, Quebec

November 24, 1965

Mr. H.E. Sunbury
Executive Secretary
Asbestos Textile Institute
P.O.Box 239
Pompton Lakes, N.J. 07442

Dear Herb:

It will be greatly appreciated if you will express my sincere thanks to the President, Board of Governors and members of the Asbestos Textile Institute for the extremely thoughtful gift presented to me in absentia at your last meeting held at Buck Hill Falls.

The illuminated scroll is truly a beautiful memento and while I am far from deserving the inscribed commendation on the scroll, I shall certainly cherish this as one of my most prized possessions. It will always occupy a place in my home where I shall have it as a constant reminder of the pleasant and interesting association with the Institute and all its members, past and present.

Mrs. Jenkins and I would have enjoyed nothing more than to have been able to accept your President's kind invitation to be present at the Buck Hill Falls meeting, however prior obligations intervened.

Please extend my kindest regards to all present at your next meeting and best wishes for the continued success of the Institute.

Yours sincerely,

(Signed) GEORGE F. JENKINS

ASBESTOS TEXTILE INSTITUTE
Report of Funds — January 10, 1966

Balance on Hand at Last Report, Sept. 9, 1965

General Fund	$ 2049.05	
Savings Fund	21323.14	
Petty Cash	10.44	
		$23382.63
Receipts		
To Savings Fund (Interest)	475.05	
To General Fund (Book Sales)	24.94	
		499.99
Total On Hand and Received		23882.62
Disbursements		
Legal Retainer (3 months ending 11/30/65)	500.00	
Legal Travel	70.68	
Telephone (4 months)	194.69	
Meeting Expense (October 1965)	607.12	
Fibre Test Manual Expense	598.32	
Handbook Expense (3rd Edition)	53.02	
Secretary's Travel	332.00	
F.I.C.A. Tax	21.75	
Office Rent (Two months)	83.32	
Exhibit Expense	216.67	
Exhibit Insurance (3 yrs)	135.00	
ASTM dues (1966)	35.00	
Printing & Office Supplies	157.15	
Flowers (Dr. M.C. Shaw)	25.70	
Petty Cash, vouchers 198-222 inclusive	161.59	
		3192.01
Balance On Hand as of Jan. 10th		20690.61
Funds		
General Fund (Bank statement of 1/10/66	1877.40	
Savings Fund	18798.19	
Petty Cash Fund	15.02	
Total Funds		20690.61
Assets as of January 10, 1966		
General Fund	1877.40(*)	
Savings Fund	18798.19	
Petty Cash on Hand	15.02	
Accounts Receivable (1966 Dues)	9250.00	
" " (Book Sales)	1.00	
Postage on Hand	2.04	
Furniture & Equipment (Nominal Value)	1.00	
Total Assets		$29944.65
Liabilities (None)		
Net Worth		$29944.65

(*) $1000.00 transferred from Savings to General Fund 11/19/65
$2000.00 " " " " " " 1/5/66

Respectfully submitted,
H.E. Sunbury
H.E. Sunbury, Asst. Treasurer

Legal Counsel Report
February 11, 1966, ATI Meeting

F. Jay Flocken, ATI counsel, discussed several recent decisions by the Federal Trade Commission on area price discrimination under Clayton Act #2(a), as amended by the Robinson-Patman Act. Area or territorial price "discrimination" occurs whenever a seller charges different prices in different geographic areas or markets. Such "discrimination" is not illegal unless proven to cause the competitive injury forbidden by the Clayton Act. The standards of proof of such injury have always been a sore spot and the FTC's traditional approach has been responsible for the common criticism that its Clayton Act price discrimination decisions require "soft" competition in conflict with the Sherman Act's philosophy of "hard" competition; that sellers who compete effectively in the spirit of the Sherman Act are inviting price discrimination charges under the Clayton Act.

Mr. Flocken noted that in a series of cases, ending with Dean Milk Co. (FTC Docket 8032), the FTC appears to be shifting away from its old attitude toward territorial price discrimination and to be gradually accepting the views of what Commissioner Elman calls the FTC's "responsible critics". At least, the FTC is attempting to announce meaningful standards, drawn from the basic antitrust policy of promoting competition.

This slow tentative shift after almost 30 years has been accomplished by narrowly divided votes in these recent cases. But Commissioner Elman is gradually forcing grudging Commission recognition of his point of view that competition--not protection of competitors from price competition--is the ultimate antitrust goal.

Utilizing Mr. Elman's dissent in the Dean Milk case, counsel elaborated on Elman's view that the proper standard for measuring competitive injury at the seller level in area price discrimination cases must focus on "the condition of the market as a whole" and that the standard is not satisfied merely by showing temporary diversion of business, minor losses in sales and profits, or temporary shifts in market shares. Counsel also expressed doubt that the Commission's rejection of a defense by Dean Milk--that its discounts were in response to a price-fixing conspiracy among its competitors and that the decline in its competitors' profits resulted not from Dean's discounts but from a decline of prices from a conspiratorial to a competitive level--would be upheld by the courts if challenged.

One pro-competitive result of the FTC's slowly changing attitude has been reflected in the orders issued by the Commission in recent territorial price discrimination cases. These orders have tended to prohibit only those area price differences in which the seller's price in a particular local market or its sales from a single plant undercut all the prices of its small competitors in the local market involved. Formerly, typical FTC orders in such cases prohibited area price discrimination in broad terms and, in the view of some critics, tended to make pricing inflexible and unresponsive to the vagaries of local market competitive realities.

Minutes: Sales Promotion Committee
Asbestos Textile Institute
February 10, 1966
Barbizon-Plaza Hotel
New York, N.Y.

The Meeting was called to order at 9:30 A.M. by the Chairman.

Representatives of all member companies were present including Garlock, Inc., except H.K. Porter Co.

Mr. Howard Bain, our A.T.I. handbook editor, was present and we reviewed in detail prepared copy for the third edition. 90% of the editorial work has been completed and it is estimated by the June meeting all of the editorial work and new photographs will be available and ready pending approval and availability of new A.S.T.M. specifications.

It was decided to not distribute the A.T.I. booklet on Method for Determining Asbestos Dust Concentration as requested by the Air Hygiene & Manufacturing Committee, but to make this booklet available if and when customers request information.

The A.T.I. display has been offered to the Franklin Institute Museum at Philadelphia, Pa., for a minimum of six months, maximum period of two years. No word has been received to date.

Mr. Peele reported on what appears to be increased activity on the part of A.R. Simon Co., New York City, importers of European and Japanese manufactured asbestos textiles. Quantities during the past three months have increased appreciably.

Mr. Peele offered examples of a new type of colorful sales promotion literature being used by U.S. Rubber throughout their entire industrial textile line. It is thought that a similar type of advertising could be useful for the A.T.I. members in general as a sales presentation piece. Mr. Peele will invite Reis Kapelow & Caldwell, New York City advertising agency, to attend one of our coming meetings.

There was a brief discussion of Carborundum Corp. new fiber boron-nitride, for high temperature applications. Extremely high price will probably prevent ready acceptance.

We referred to our Technical Committee study of weight tolerances of asbestos cloth under A.S.T.M. specifications. In addition, we asked for the Technical Committee's recommendation regarding inclusion of two or more wire inserted asbestos cloths in official A.S.T.M. specifications.

The meeting adjourned at 3:00 P.M.

Respectfully submitted,

W.S. Hough
Chairman

MINUTES: Asbestos Textile Institute
Technical Committee Report
February 10, 1966

The meeting was held at Barbizon - Plaza Hotel, New York, N. Y.

ATTENDANCE:
Edward A. Morris - U. S. Rubber Co.
D. T. Austin - U. S. Rubber Co.
G. E. Houghton - Garlock, Inc.
J. W. Hawkins - Raybestos - Manhattan, Inc.
William Maaskant - American Asbestos Textile Corp.
Irvin Barnett - Johns - Manville Corp.
J. D. McCluer - H. K. Porter Co., Inc.
H. E. Sunbury - Asbestos Textile Institute
Ralph Marson - Ontario Research Foundation
(Representing Cassiar Asbestos Corp.)
Paul J. Smith - A.S.T.M.

SUBJECTS DISCUSSED:

Revision of Tentative A.S.T.M. Specifications, preliminary remarks. The Technical Committee has been made the Task Group for revising all the Tentative A.S.T.M. Specifications, There is an A.S.T.M. ruling that any tentative specification not revised within 5 years of its last revision will be dropped from the Book of A.S.T.M. Standards. Several are in or near this condition:

D 1571 - 58 T Asbestos Cloth. This has stood over 5 years and had to be revised before the end of 1965.

D 315 - 62T Asbestos Tape.

D 1918 - 62T Test for Asbestos Content.

The above two require revision during 1966 to avoid running too close to the dead line.

This work was initiated in November 1965 by the Technical Committee in order to complete D 1571, Cloth, on time. A resume of these early meetings will be given later

At the meeting of this date, the discussion was on D 1918 - 62T - Test for Asbestos Content of Asbestos Textile Materials. The committee spent the major part of the day preparing the 1st Draft of a revision. This draft will be circulated to all members of the Committee for their consideration and possible comments, after which a 2nd Draft may be prepared based on comments.

RESUME OF PREVIOUS MEETINGS:

November 18, 1965 at A.S.T.M. Headquarters, Philadelphia, Pa.

IN ATTENDANCE:		
	D. T. Austin	Irvin Barnett
	J. W. Hawkins	J. D. McCluer
	William Maaskant	H. E. Sunbury

At this meeting the 1st Draft of D 1571, Cloth, was prepared using as a starting point a preliminary revision which Dr. Shaw had prepared before his death.

This 1st Draft was circulated to members and on basis of comments by correspondence a 2nd Draft was made using A.S.T.M. format of decimal paragraphing with metric equivalents for all U. S. Measurements and Weights.

December 2, 1965 at A.S.T.M. Headquarters - Philadelphia, Pa.

IN ATTENDANCE: Same group as November 18, meeting plus Paul J. Smith, Senior Assistant Technical Secretary, A.S.T.M.

At this meeting a 3rd Draft was made based on some recommendations from Dr. Scroggie and Mr. P. O. Nicodemus. Copies of this draft were sent to Mr. Nicodemus and Dr. Scroggie for their respective committeed.

January 6 & 7, 1966 at Marriott Motor Hotel, Atlanta, Georgia

IN ATTENDANCE:		
	D. T. Austin	J. D. McCluer
	J. W. Hawkins	H. E. Sunbury
	William Maaskant	Paul J. Smith (2nd day)

On January 6th, the committee made the 1st Draft of a revision of D 315, Tape, using experience gained on the D 1571 which was assumed to be approved.

On January 7th, Paul Smith joined the committee and submitted a letter from Dr. Scroggie on recommended changes in the 3rd Draft of D 1571. The committee spent this day going over these recommendations, most of which were accepted, and prepared the 4th Draft of D 1571. Exceptions were taken by the committee to some of Dr. Scroggie's recommendations, but reasons were submitted for each exception taken. This draft was circulated to all members for approval. The committee was advised by Mr. Nicodemus that we would have until January 21st, to get copies to him for a letter ballot within the A-4 committee. 20 copies were sent to Mr. Nicodemus and 10 copies to Dr. Scroggie for their respective committees. Letter ballots were sent out to members of the A-4 committee by Mr. Nicodemus.

In the meantime, a 2nd Draft of D 315, Tape, was prepared based on comments by correspondence from committee members.

February 9, 1966 at Barbizon - Plaza Hotel - New York, N. Y.

(THIS WAS A SPECIAL MEETING AT 1:00 P.M.,, ONE DAY IN ADVANCE OF THE REGULAR TECHNICAL COMMITTEE MEETING.)

<u>IN ATTENDANCE:</u>	Edward A. Morris	William Maaskant
	D. T. Austin	Irvin Barnett
	G. E. Houghton	J. D. McCluer
	J. W. Hawkins	H. E. Sunbury
		Paul J. Smith

At this meeting D 315 Tape, was again discussed and the 3rd Draft was made. By common consent of the committee, this draft was to be typed in usual way and copies sent to Mr. Nicodemus and Dr. Scroggie for their respective committees.

J. D. McCluer,
Chairman of Technical Committee

Minutes: ASBESTOS TEXTILE INSTITUTE
FIBER TESTING COMMITTEE
February 10, 1966

The meeting was held at the Barbizon-Plaza Hotel, New York.

In attendance:

	J. Wronski	Raybestos-Manhattan, Inc.
Dr.	J. Axelson	Johns-Manville
	I. Barnett	Johns-Manville
	F. Bodycomb	Johns-Manville
	G.F.A. Brink	Asbestos Corp. Ltd.
	D.E. Childers	H.K.Porter, Inc.
	R.Dodds-Hebron	Bell Asbestos Mines,Ltd.
Dr.	R. Marson	Ontario Research Foundation
	J.L.Tucker	A.T.I. Consultant

Subjects Discussed

1. The new fiber testing manual is ready for the printer. Mr. Sunbury has received orders from various companies totalling 2790 complete manuals and 5026 copies of individual tests. Based on the lowest printing bid, this brings the price per manual to $1.71 and the price per individual test to 0.16. Since some members have indicated they may purchase more test manuals than they have already pledged to buy and also since there may be a price concession for the purchase of 3000 instead of 2790 manuals, the committee recommends that the Board of Governors authorize the purchase of 3000 copies of the complete manual together with 5025 copies of individual tests.

2. Preliminary data was presented on two proposed test procedures -- one for the determination of frictional properties of asbestos fibers and the other for the determination of the amount of spicules and unopened fiber bundles in milled fiber. Further test data on these procedures will be gathered for presentation at the next meeting.

3. A two man Task Force was appointed to follow the deliberations of ASTM Committee A-4 in their efforts at revising the present ASTM procedure for determining the magnetic rating of asbestos fibers. The magnetic rating test we now have in our test manual follows the present ASTM procedure very closely and the Fiber Testing Committee feels it should know what changes, if any, will be made in the ASTM procedure so that it can decide whether to make corresponding modifications in our own procedure.

The Task Force will keep the Technical Committee as well as the Fiber Testing Committee informed of these developments.

Respectfully submitted,

J. P. Wronski

ASBESTOS TEXTILE INSTITUTE

18 November 1965

Mrs. M. C. Shaw
563 Gates Street
Philadelphia 28, Pa.

Dear Mrs. Shaw:

The sad news of your husband's passing was indeed a great shock to all of his friends and long time associates in the Institute. I want to express on their behalf our most sincere sympathy to you in the loss of your beloved husband, and to your children, Marilyn and Myril, Jr., in the loss of their devoted father.

"Doc" Shaw as he was affectionately known throughout the Asbestos Industry, gave unstintingly of his time and talents to the Institute over a period of seventeen years as Research Fellow, Executive Director, and Assistant Treasurer. More than any other single individual he was responsible for the success and continued growth of the Institute.

Your husband was a most capable and efficient administrator of the Institute's affairs, and commanded the utmost respect from our members and the entire Asbestos Industry. The fact that you were his only assistant for those many years is known and appreciated greatly.

Dr. Shaw's fine Christian character and exemplary personal habits were greatly admired by his associates, and those who knew him best are lastingly enriched by their opportunity for close acquaintance with him.

Our Industry has lost a fine individual, and an outstanding authority on asbestos, and he will be greatly missed.

I have instructed the Secretary to make this letter a part of the permanent records of the Institute, also to circulate it to the Board of Governors.

At our next General Meeting, to be held in February, I will inform our members of this official action.

You may be sure that our thoughts and best wishes will go out to you and your children on that occasion.

Most sincerely,

John A. Brown, Jr. - President
msg

Mrs. Myril C. Shaw
563 Gates St.
Philadelphia, Pa. 19128

December 2, 1965

Mr. John A. Brown, Jr., President
Asbestos Textile Institute
P.O. Box 239
75 Center St.
Pompton Lakes, N.J. 07442

Dear Mr. Brown:

Thank you so much for your letter and kind words about Myril. To realize that Myril was so appreciated by all of his associates is a great source of strength and comfort to me. Myril always considered all of you of the Asbestos Textile Institute as personal friends, and he was so happy to once again be a part of the textile branch of the industry. He had marked the dates of the next A.T.I. meeting in his "date" book and was looking forward to greeting and working with all of you.

Please express my heartfelt thanks to the members of the Asbestos Textile Institute for the beautiful flowers sent to Myril and for their many expressions of kindness and sympathy to me and the children.

Very sincerely,

(Signed) Mrs. Myril C. Shaw

TECHNICAL PAPER

"THE ROLE OF FIBERS AND WHISKERS IN REINFORCEMENT"

Presented at the General Meeting

Asbestos Textile Institute
February 11, 1966
by
Joseph P. Wronski
Head of the Physics Section
Research & Development Dept.
Raybestos-Manhattan, Inc.
United States Asbestos Div.
Manheim, Pa.

About the Author:

"Joe" Wronski was graduated from the University of Minnesota in 1940 with a Bachelor of Chemistry degree. He received his Masters Degree in Physics from the same institution in 1947, and did further graduate work in physics at Ohio State University.

He was at Battelle Memorial Institute for eight years working on electro-optical properties of dielectrics, stresses in thin walled pipes, and operations research. Prior to his employment with the U.S. Asbestos Division of Raybestos-Manhattan he was with the Westinghouse-Bettis Atomic Power Division in Pittsburgh working on problems associated with the construction of nuclear reactors for the Navy.

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By courtesy of Mr. Wronski and Raybestos-Manhattan, Inc., the full text of his paper is being distributed with the minutes of this meeting.

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THE ROLE OF FIBERS AND WHISKERS
IN REINFORCEMENT

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THE ROLE OF FIBERS AND WHISKERS

IN REINFORCEMENT

When I was invited to give a talk at this meeting it wasn't very hard for me to decide on my topic. The subject of fiber-reinforced materials has been of great interest to me ever since I joined Raybestos-Manhattan about seven years ago -- not only because we at Manheim are very active in producing asbestos-reinforced materials but also because I feel there is a great economic future for fiber-reinforcements. The recent development of strong, inorganic, fiber-like, synthetic materials called "whiskers" and their use as reinforcements has further stimulated my interest in the whole subject of reinforcements.

In looking over much of the recent literature on this whole subject of fiber and whisker reinforcement I have learned a few things and gained a few insights which I would like to share with you today. I am no expert on the subject. It would take a lot more study and research on this subject than I have done to come anywhere near being an expert. Even those I would qualify as experts admit that there is a lot they don't understand about fiber reinforcement. However, they have outlined the basic engineering principles that govern the physical behavior of fiber-reinforced composites. From these principles they have pinpointed the properties of the fiber and of the matrix in which these fibers are imbedded that are important in establishing the physical properties of the fiber-matrix composite or reinforcement.

This is mainly what I want to talk to you about today; -- what are some of the simple, basic principles that determine the physical properties of reinforcements? -- what makes a fiber-reinforced material good or bad? In doing so, I hope to be able to show you at the same time how asbestos fibers compare with some of the new synthetic fibers as reinforcements.

First of all -- what are "whiskers" and why is there so much to-do about them? Whiskers are inorganic crystals that are grown under special temperature and pressure conditions. The conditions are such that the growth of these crystals takes place primarily in one direction. They can be grown to a length which may be many hundreds of times their diameter. As we will see later on, many materials can be grown in whisker form -- iron, silver, silicon carbide and even sodium chloride, to mention a few. Not all are novel. Silver whiskers, for example, were known to the medieval silversmiths who knew that they could be made to grow by gently heating a scratch made on freshly cast silver.

One whisker material that has received a lot of attention lately is crystalline aluminum oxide -- or sapphire. I have a sample of this material which I'll pass around for you to see. The sample contains three different forms of the fiber. The slide coming up will show you what the so-called "wool" form of this fiber looks like when magnified a hundred times. Incidentally, from here on I will use the terms 'fibers' and 'whiskers' interchangeably.

(See Slide #1 - Appendix)

These "wool" fibers are about ten microns (400 millionths of an inch) in diameter and are up to about 1000 microns, or 40 thousandths of an inch long.

Just for comparison, the next slide shows you the old, familiar photograph of asbestos fibers as seen under an electron microscope. Magnification is 35,000 times. The diameter of the unit asbestos fibers is about 2 hundredths of a micron (less than one millionth of an inch) and is about 500 times smaller than the sapphire fibers you saw. I will point out later on how important this difference in diameter is from the standpoint of reinforcing properties.

(See Slide #2 - Appendix)

Many of the whiskers produced to date are extremely strong -- with tensile strengths in the millions of pounds per square inch. But their high tensile strength is not the only reason these fibers have created so much interest. They are also light. It is really their strength in relation to their weight that has stimulated so much interest in them. This matter of fiber weight is very important when we talk about using the fibers as a reinforcement. We add fibers to a matrix material -- such as resin, ceramic or even metal -- to make a composite that is stronger than the original matrix material. This, of course, is what we mean by reinforcement. The strength of the final composite will be somewhere between the strength of the fiber we've added and the strength of the matrix material we've used. We can add strength by adding more fiber. But if the fiber is heavy we are also adding more weight. In this case we may wind up with a composite that has good strength -- say a strength as good as the strongest steel. But if its weight is very close to that of steel we have gained very little -- and have proably paid too high a price for what little we have gained.

In addition to their high strength to weight ratio many of these new whisker materials possess another important characteristic that makes them valuable as reinforcements and that is their high modulus.

This matter of high-modulus brings us to the point where I would like to discuss some of the simple mechanical principles involved in fiber reinforcement and which, I hope, will give us a better insight into the factors that affect the performance of fiber reinforced composites.

The next slide depicts a physical situation which I hope will give you some idea of what we mean when we talk about the modulus of a material. For those of you for whom this is old stuff, please bear with me.

(See Slide #3 - Appendix)

When a force is applied to a solid -- whether the solid is a piece of resin, a piece of wax, or a piece of steel -- it responds to this force by changing its shape. For simplicity, we can visualize any material as behaving like a spring. It stretches a certain amount when it is pulled and compresses a certain amount when it is pushed. Our picture shows a condition of stretching -- or tension. When a load is applied to this spring it stretches a certain amount. The <u>fractional</u> increase in its length is called strain. When a load or stress is applied to the spring it strains a certain amount. When the stress is doubled the amount of strain it undergoes is also doubled. Triple the stress and you triple the strain, etc. The modulus of this spring is the amount of stress it requires to strain it by a certain amount. In other words, the modulus of a material is a measure of its stiffness.

Now let's relate this notion to a fiber-reinforced material. The next slide depicts this condition.

(See Slide #4 - Appendix)

Here we have a composite subjected to a tensile load. The applied force acting over the indicated area of the composite is the applied stress. Under this stress the material stretches -- or strains. If the fibers are strongly bonded to the matrix, they will strain right along with the matrix. The stress is shared by both the matrix and the fiber. But, if the matrix has a smaller modulus than the fiber -- and this is usually the case -- the fibers will take over most of the load. This situation is shown in the stress-strain diagram.

This simple illustration depicts a most important aspect of the whole problem of fiber reinforcement. It indicates why it is desirable to have high modulus as well as high-strength fiber for reinforcement. Under a given strain, the higher the fiber modulus, the greater will be the portion of the load transferred to the fiber. This is the way we want it -- because the fiber is much stronger than the matrix. The primary function of the matrix material is simply to support the fibers and to transfer stresses to them.

I have tabulated the modulus values for a few of the new whisker materials along with those for asbestos and glass fibers. These data are shown in the next slide together with other important values pertaining to these fibers.

(See Slide #5 - Appendix)

You will note, for example, that silicon carbide whiskers have a modulus about five times and a strength about twice that of asbestos. Because of its high modulus, a silicon carbide whisker could take over a greater share of the load in a composite than an asbestos fiber could in the same matrix. In other words, fewer silicon carbide whiskers than asbestos fibers would be needed to take over the same amount of load. In addition, a silicon carbide whisker would support twice the stress of an asbestos fiber because of its two-fold greater strength. However, things are not all that much in favor of the silicon carbide when we look at its strength-to-weight ratio. On a pound-for-pound basis, silicon carbide would actually support only 50% more load than an asbestos fiber instead of twice the load. The situation is even more dramatically illustrated in the case of iron whiskers. Here iron, with over twice the strength of asbestos, is 50% weaker on a pound-for-pound basis.

I present this table of modulus values to illustrate how widely these values vary for different fibers. I now want to back up a little and again take up the discussion about the importance of the fiber modulus to the load carrying characteristics of a composite. I think I can do this best by showing you the next slide.

(See Slide #6 - Appendix)

You will remember that high modulus fibers take over more load than low modulus fibers in a composite. This means that fewer high modulus fibers in a composite would be required to support a load than would be required if the composite were made of lower modulus fibers. The slide you see here shows what fraction of the load on a composite material the fibers take over. As you see, this depends on the fiber concentration as well as on the modulus of the matrix material. These curves are for fibers in a resin matrix having a modulus of 1/2 million psi -- which is a typical value for resins.

The curves are based on highly idealized conditions such as perfect resin-to-fiber bonding, perfect alignment of fibers, and pure transfer of stress from resin to fiber -- no matter how far apart the fibers are. These conditions almost certainly would not be realized in practice. Nevertheless, they do provide an insight into what relative performance we might hope to achieve for various fiber-resin composites. You will note from these curves that the asbestos fibers in a composite containing 10% fiber by volume would support about 80% of a load imposed on the composite under the idealized conditions I have just mentioned. At the same concentration and in the same resin, glass fibers would support about 70% of the load. Under these conditions the glass composite would fail before the asbestos composite -- simply because the resin could not support the greater load imposed on it.

I now want to bring out another important characteristic of fibers that affect their performance as reinforcements. This is the shape of the fiber -- or, more specifically the ratio of the length of a fiber to its diameter. The next slide shows why this is

(See Slide #7 - Appendix)

You can imagine, first of all, that we have a fiber reinforced material that is subjected to a stress -- a tensile stress, say. This stress distributes itself throughout the whole composite. The slide you see here illustrates -- in a highly schematic way -- the stresses acting on a single fiber within the composite.

Essentially, there are two stress systems acting on this fiber. One is a shear stress acting at the interface of the fiber and matrix and the other a tensile stress acting on the fiber cross section. We might think of the tensile stress as one tending to pull the fiber apart and the shear stress as tending to drag the fiber back against the action of the tensile stress. Under equilibrium conditions the tensile and shear forces are equal and when we go through the simple mathematics expressing this condition we find that the tensile stress on the fiber is proportional to the interfacial shear stress in the matrix multiplied by the ratio of fiber length to fiber diameter.

It is this relationship between matrix shear stress and fiber tensile stress that brings out the importance of the length-to-diameter ratio of the fiber. Without going into a lot of detail, the situation I have illustrated means simply this: when we use fibers in a reinforcement that are long in relation to their diameter (have a high L/D ratio) then we can use a matrix material with a lower shear strength than we could if the fibers were short in relation to their diameters. This can be a very important consideration in designing a fiber reinforced composite. In developing a fiber reinforced material we might be forced to use a matrix material having a low shear strength. In this case we would want to use a fiber with a high length-to-diameter ratio in order to exploit the full strength of our fiber. Otherwise, the reinforcement might fail under load due to shear failure of the matrix long before we exploited the full strength of the fibers.

As you know, the unit, or ultimate, asbestos fiber has an extremely small diameter. Although I have never seen any figure on what the average length of the ultimate asbestos fiber might be, I have estimated from some of the published strength data that the ultimate length might be on the order of 100 microns -- or about 4 thousandths of an inch. If so, this would make the length of the ultimate asbestos fiber about 5,000 times its diameter. The next slide shows how this length-to-diameter ratio compares with that for other fibers.

(See Slide #8 - Appendix)

The data on the other fibers was obtained from scattered sources. One source will give one value and another will quote some other value. However, I have chosen values that seemed typical to me.

If each of these fibers were used as a reinforcement in some kind of matrix material and we wanted to exploit their full strength -- that is, we wanted the <u>fiber</u> to fail under load before the matrix material failed in shear -- then the minimum shear strengt of the matrix material we would have to use is that shown in the last column.

We can see from these figures that asbestos fibers, if they could be reduced to their ultimate dimensions in a reinforcement, would impose very small shear strength requirements on the matrix material. Graphite and sapphire whiskers, on the other hand, would have to be incorporated with a high shear-strength matrix in order to fully realize their strength potentials.

There is yet another factor concerning fiber-fineness that is important. This has to do with the stresses that are built up around the ends of fibers imbedded in a matrix. The next slide illustrates what I mean.

(See Slide #9 - Appendix)

The fiber you see is a sapphire whisker imbedded in a birefringent plastic. The plastic, with the fiber in it, is stressed in the fiber direction. Because of its birefringent nature, the plastic produces different colors (interference fringes) in those areas where the stresses are different. The blue areas you see near the ends of the fiber represent areas of high stress and the yellow coloration along most of the length of the fiber represents about half this stress. The bluntness of the ends of the fiber accounts for most of the high stress concentration at these points. This means that composites reinforced with fibers having large diameters and blunt ends could fail under load much earlier than small diameter fibers because of the high stress concentrations produced at their ends. Also, you may notice that the high stresses at the ends of the fibers extend a short distance along the fiber length. For fibers with a small length-to-diameter ratio this would mean that the high stresses would extend over an appreciable fraction of the length of the fiber. This, obviously, would also be bad from the standpoint of reinforcement.

There is good reason for all the efforts being expended these days to develop high-strength, high-modulus fibers for reinforcing purposes. Whoever can come up with a composite that has all the strength properties of the best of our present metals but with only about a third or a fourth the weight would be in a position to reap tremendous economic rewards. As an example of what can be achieved in the way of fiber-reinforced materials, I give you the following figures: the theoretical tensile strength of a sapphire-whisker reinforced resin containing 50% resin by volume is about 1.4 million psi -- or about four or five times the strength of the finest steel. And this composite would be only about a fourth as heavy as steel. Using asbestos fibers opened to their ultimate dimensions, a similar analysis shows that a theoretical tensile strength of about 700,000 psi is possible; -- and, again, the weight of the composite would be about a fourth that of an equal volume of steel.

It's doubtful that fiber-reinforced composites will ever achieve these theoretical strengths. But there are reports that composites with strengths well above the 300,000 psi strength of fine steel and with densities well below that of steel have already been developed. Cost and difficulty of fabrication are two of the main reasons why quantity production of such composites is being held back. The current cost of whiskers and other high strength synthetic fibers is very high. The next slide shows you some typical cost figures for such fibers.

(See Slide #10 - Appendix)

However, as you can see from this table, it is anticipated that within the next ten years the cost of these fibers will drop by an appreciable amount. On a cost-per-strength basis these fibers in the future may well present a serious challenge to asbestos fibers.

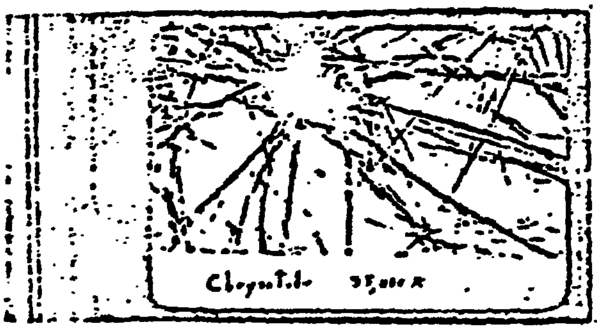
Asbestos shouldn't have to take a back seat to any of these synthetic fibers. When reduced to its ultimate dimensions, asbestos has a tensile strength estimated to be about 1,500,000 psi, a length-to-diameter ratio that is probably much higher than any of the synthetic fibers now have or will ever have, and, finally, a modulus that compares favorably with many of the synthetics. But the exploitation of these excellent properties is going to take research -- vigorous and imaginative research; the kind of research now being done by the producers of synthetic fibers. And if we are going to compete with them in the field of reinforcements, we are going to have to learn a lot about the nature of the interaction of asbestos fibers with various matrix materials -- the principles that determine the bonding of asbestos fibers to other materials.

I think the rewards will be worth the effort.

Joseph P. Wronski

APPENDIX

Slide #1



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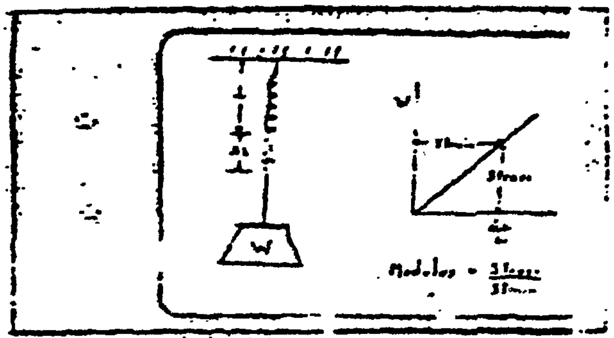

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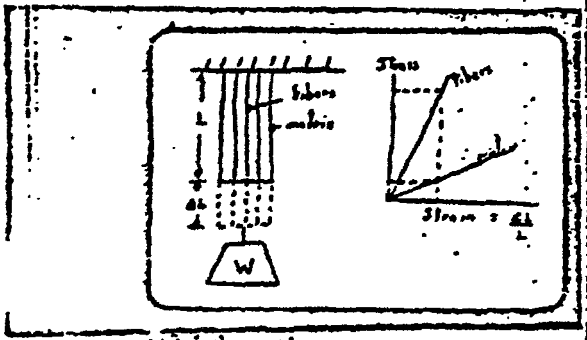

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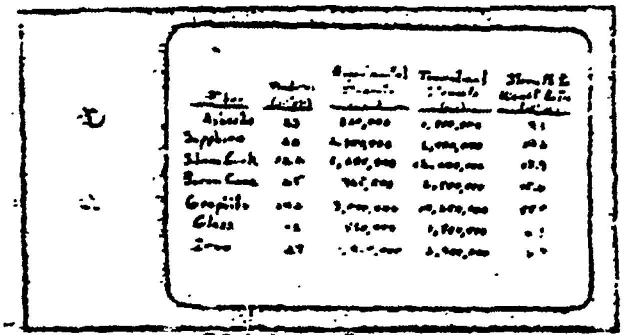

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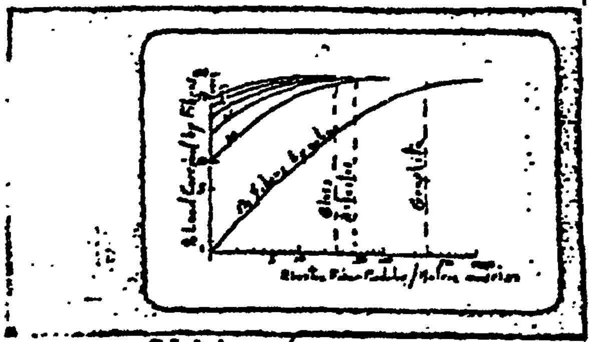
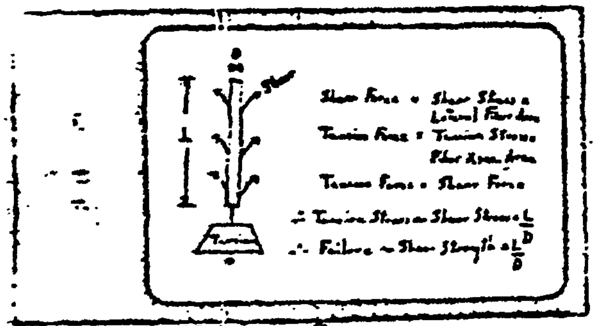


Slide #6



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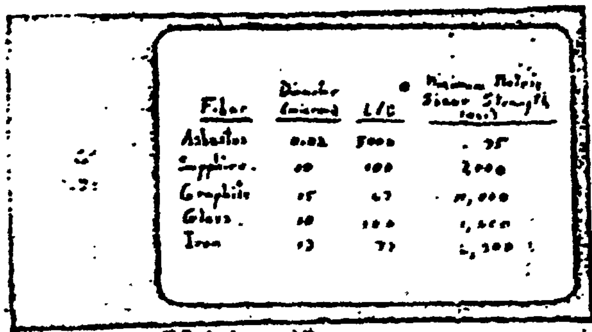

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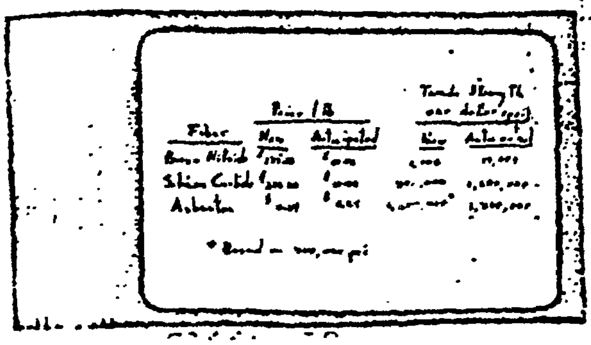

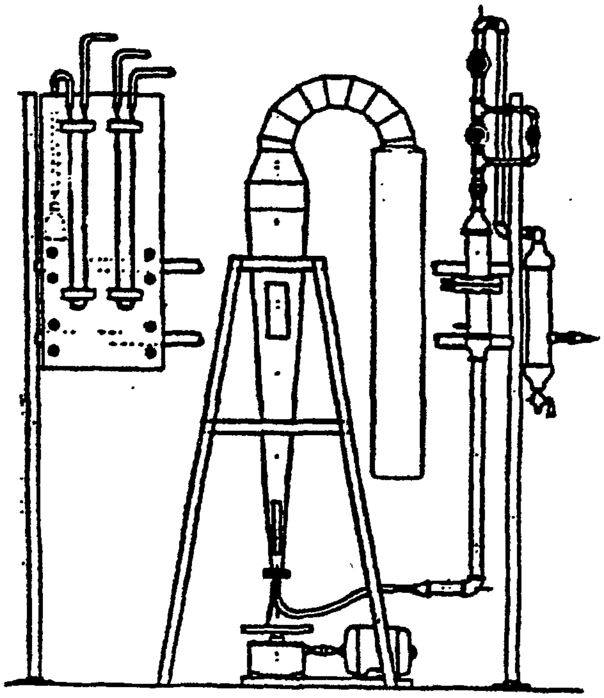

FIGURE 11. AIR ANALYSIS TEST UNIT

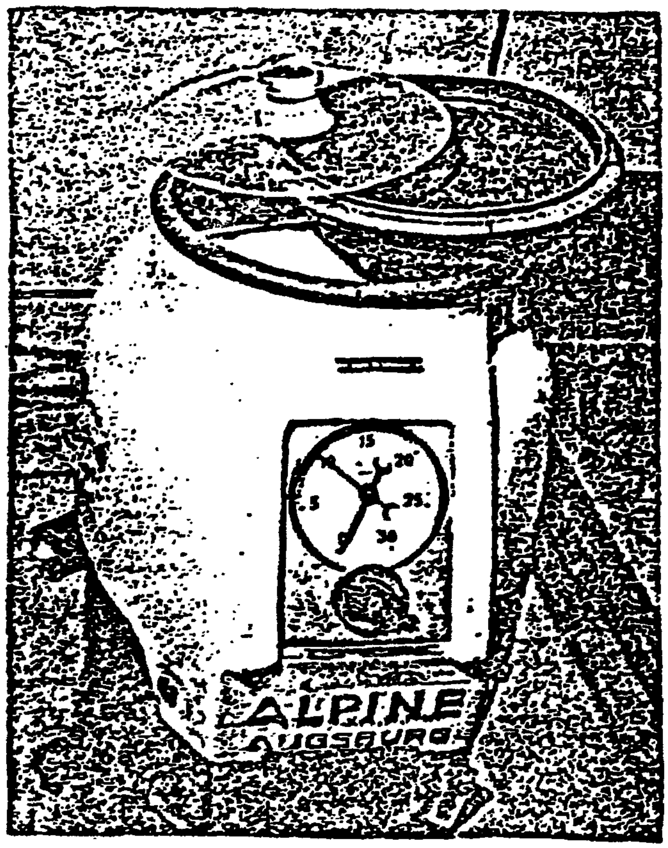

FIGURE 12. ALPINE TESTER