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# THE U. S. FOREST PRODUCTS LABORATORY

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FOREST PRODUCTS LABORATORY  
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UNITED STATES DEPARTMENT OF AGRICULTURE  
FOREST SERVICE

In Cooperation with the University of Wisconsin

# THE U. S. FOREST PRODUCTS LABORATORY

By

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## History

The Forest Products Laboratory at Madison, Wis., can trace its scientific ancestry to the founding fathers of forestry in this country. For Pinchot, Fernow, and the little group that was drawn to them saw forestry as a whole and with vision that carried far into the future. Whatever contributions forest products research has made to the national well being since 1890, a large measure of gratitude is due to the foresight of men who gave it an early start, however modest.

Today's forest products research in a group of universities has a distinguished tradition. Originally federally sponsored studies of the mechanical properties of the more important American woods were begun on a cooperative basis about 1890 at Purdue, California, Oregon, Washington, and Yale Universities. Yale cooperated on studies of wood preservation and kiln drying. Kiln drying research was carried on by H. D. Tiemann, one of the pioneers of the science, whose fundamental work not only laid the groundwork for modern kiln drying but also contributed in a major way to other phases of wood technology.

In addition to the foregoing work, the Division of Forestry initiated research on naval stores in the South and started a small experimental

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<sup>1</sup>Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

pulp mill in Boston, where the chemistry of wood and of wood preservatives were also handled on a small scale by Lee F. Hawley and Arthur D. Little.

Eventually it was decided that, in the interest of interchange of ideas and mutual aid all of the scattered research would be brought together in one place, provided some agency would cooperate to some degree in providing the place. The University of Wisconsin entered into a cooperative agreement to provide certain utilities that still continues after a half century.

The Forest Products Laboratory of the Forest Service, U. S. Department of Agriculture, was formally opened on the campus of the University of Wisconsin at Madison on June 4, 1910. Forty-five people made up the original staff, technical and nontechnical, under Director McGarvey Cline.

The first eight years of the Forest Products Laboratory's existence was a period of foundation laying. No revolutionary developments stand out in the record, but it was in this period that John A. Newlin, up from Purdue, and his staff began the systematic testing of strength that eventually covered 175 of our common woods. Harry D. Tiemann, coming on from Yale, established facts regarding wood-moisture relations that underlie much of modern wood technology. Otto Kress, Sidney D. Wells, G. C. McNaughton, J. H. Thickens, and others began the testing of American woods for pulp and paper. The resulting bulletins on pulping suitability by both chemical and groundwood methods were valuable handbooks so long as they were in print. Lee Hawley, A. W. Schorger, and others began studies of the chemistry of cellulose, lignin, and extractives that are reflected today in every college textbook on wood chemistry. George M. Hunt began the work that made him an international authority on wood preservation.

The demands of the Army and Navy during World War I stimulated research at the Forest Products Laboratory to the permanent benefit of large segments of modern wood manufacturing industries.

There was no Air Force then as such, but the Army was learning to fly and learning to specify the design and manufacture of wood planes. Great quantities of Sitka spruce were kiln dried in the Pacific Northwest under the direction of Tiemann. The water spray kilns then in use have been

long since superseded, but basic experience gained still pays off in the kiln-drying art.

The propeller laboratory maintained at Madison to improve the manufacture of glued and solid wood propellers has no precise modern counterpart at the Laboratory but the lessons learned are applied in modern assembly gluing, in the gluing of glued laminated structural arches and timbers, and in an understanding of the merits and limitations of moisture-excluding finishes for wood.

World War I was our first "export" war on a large scale. The result was that in the early stages, just as in 1941, the loss of military supplies through flimsy packaging amounted to disaster. In the expanded "box lab" at Madison this disaster was combatted. USDA Technical Bulletin 171, "Principles of Box and Crate Construction," was largely a result of the wartime research in better packaging, and the science of modern protective packaging was founded.

From early research on the airplane built of formed plywood glued to Sitka spruce spars came the modern engineering of molded plywood and the stressed-cover panel of modern house prefabrication.

By the end of World War I personnel at the Forest Products Laboratory had increased to 450. With the termination of military-sponsored research the force was reduced by half and a general slow decline began that was to last for 20 years.

Consolidating the data resulting from the war years, a number of accomplishments were recorded. During that period, Baechler discovered the toxic properties of chlorinated phenols. Trayer and Luxford developed the stressed-cover plywood wall panel for house prefabrication. Rue and Rawling initiated the semichemical pulping process. The late T. R. C. Wilson worked out design principles for glued laminated structural timbers and Scholten and his associates performed a similar service for modern timber connectors. Stamm and Dunlap developed electric moisture meters. The complete carbohydrate fraction of wood was first isolated and the term "holocellulose" coined to describe it. The modern stabilized woods -- impreg, compreg, and staypak -- were developed and improved.

In 1932 the research facilities of the Forest Products Laboratory, housed in several buildings well separated on the University of Wisconsin campus, were brought under one roof in a modern building providing 4 acres of working space and a degree of staff intercommunication better than the Laboratory had known in 22 years.

As international tension increased in the late 30's apprehension increased at the Forest Products Laboratory at the unpreparedness of the military with respect to forest products. It was apparent that when actual war came virtually all branches of the military would have pressing problems concerning a new (to them) material -- wood. Some beginnings were made before Pearl Harbor on problems that were clearly outlined, but as had been anticipated "the roof fell in" then so far as the research load was concerned.

Training planes of wood and plywood were still widely used at the beginning of the war. Problems of supply, preparation, design, and fabrication were pressing.

Many logistics problems of both industry and the military were stated in terms of metals conservation -- diversion of scarce metals to most vital military priorities; substitution of forest products (new products if necessary) wherever possible. The result was an expansion of Forest Products Laboratory research due to the undertaking of scores of military cooperative projects. Some portions of the Laboratory operated on a 3-shift 'round-the-clock' basis. The total personnel at one time reached 680.

About half of the wartime research effort was devoted to improvement of wood for use in aircraft -- mainly wood in the form of plywood. Problems of seasoning, species substitution, bending to form, gluing, finishing, preservation, and other aspects of fabrication and use were involved. Determination of strength was, of course, involved in many projects, large and small.

The selection, seasoning, and fabrication of ship timbers for use in everything from small craft to aircraft carrier decks engaged another large section of research time and personnel.

Packaging research, represented manwise by less than two engineers before the war, expanded to command the time of 150 persons -- perhaps a third of whom were based away from Madison with roving assignments

to improve packaging at contractors' plants and military facilities. Aircraft wood inspectors were trained by the hundreds in a special Laboratory training division. Far greater numbers of both civilian and military personnel were trained in the packaging of ordnance and supplies. The total of trainees, principally in short courses of 2 weeks' duration, was over 14,000 for the war period.

Improvements in World War II forest products technology continue to pay off. The fighting plane of wood is gone but the improved methods for cutting veneer and fabricating modern plywood remain. The Navy retains its nonmagnetic minesweepers which participated in the Korean action, and the production of glued laminated structural members continues to improve in civilian applications. Through Korean experience Army, Navy, and Air Force demonstrated that packaging know-how is at last becoming an established part of military science. The advances made by forest products research in World War II were not wasted.

The post World War II period has, of course, seen the Forest Products Laboratory research program reduced again to peacetime levels. The present force of around 400 is maintained by Forest Service appropriations and by civilian and military cooperative expenditures.

### Forest Products Research Philosophy

It would be presumptuous to put words in the mouths of the early organizers of forest products research or to pretend to know how they thought about it. Nevertheless, it is not presumptuous to believe that the understanding of the potentialities of forest products research has evolved and expanded over the years. A statement by B. E. Fernow, later to become chief of the Division of Forestry, indicates that in 1887 he thought of forest products research as something to be undertaken to guide the forest planter in his selection of species. In the light of subsequent developments, we know that forest products research has not been intensively applied in the guidance of forest planting although the reasons for doing so are as valid as ever.

We know that some early thinking -- and probably a major fraction of more recent thought -- has placed forest products research in the role of combatting waste -- forest waste, mill waste, manufacturing waste,

waste in use. This concept brings waste to the research man as a wholesale proposition and says, "Take it from here. What shall we do with it?"

As it is seen at the Forest Products Laboratory at Madison, research has functions that are more closely allied with today's forestry than the what-to-plant idea and more constructive and versatile than the simple frontal attack on waste. It can, of course, so improve the processing of wood as to reduce avoidable waste in some degree. Almost any research effort that results in better understanding of wood is in this way an effort toward waste reduction and this simple "universal" attack on waste is desirable and important. But research can be a sharper tool, directed effectively to the solution of forest management problems as well as to problems arising in utilization at the other end of the forest-to-consumer line. Through the development of practical utilization of thinnings and weed species, and a proper coordination with the science of forest genetics, it may provide the means for setting in motion in the forest an improvement program that would otherwise be smothered under the incubus of low-quality or "poor relation" trees.

Research is also a sustaining element in promoting integration of forest industries -- one of the major hopes for effective forestry in this country. In this connection it may be necessary only to point out the part that research has played in the integrated industries of Weyerhaeuser in the Pacific Northwest and Crossett in Arkansas.

If it is true that forest products research is an essential of the kind of diversification represented by integrated forest operations, it is even more true that such research is vital to another form of diversification -- the diversification by which wood as a raw material must discover ever-widening markets to compete with other materials. Here lies the future of forest products -- not in blind defense of simple established uses but in aggressive technical diversification that will produce a half dozen better and more satisfying uses for wood for each one lost to a competitor. In the majority of cases early research properly followed by development and promotion can save disputed markets.

There are many reasons why research by public agencies is appropriate in the forest products field, but perhaps the most compelling of these reasons is found in the small size of most of the forest industries. The contributions of the 300 largest lumber producers in the way of research have been substantial, but two-thirds of all lumber production in this

country comes from the other 50,000 producers. Coupled with the great number and small size of the majority of these operations is the fact that the small mills tend to be concentrated where utilization problems are most critical and where waste should be most zealously combatted. Obviously, although we must continue to expect much of our production of forest products from these small operators, they are in no position to undertake research on any effective scale. Coupled with the responsibility for doing needed research for the small forest operator is the obligation to perform tasks in dissemination and education that can be carried on effectively through existing channels.

### How Program is Planned

The research program of the Forest Products Laboratory is formulated with the influence and guidance of a number of agencies that represent diversity of interest with respect to industries and geographical areas. The suggestions of four committees are considered, not to mention regional representatives of the Forest Service and well-informed individuals. The broad recommendations of the National Forest Research Advisory Committee have been made a part of the program. The more specific suggestions of technical committees of the National Lumber Manufacturers' Association, the American Paper and Pulp Association, and the American Wood-Preservers' Association are also solicited and carefully considered before the new research program is launched each July 1. Also making specific recommendations for the new program are Forest Service's Forest Experiment Stations at which are maintained Forest Utilization Research units that help to keep the Laboratory "grass-roots conscious" with respect to utilization problems from coast to coast. In discussions with members of the technical staff, FUR men have the advantage of the clinical approach to their problems, since they can sit down with a full panel of experts and where necessary work out an integrated research approach to their problems.

Cooperative work, which is operated on a shared-cost basis with industrial cooperators, is not a direct part of the year's program but its contribution to the general objectives is considered in planning the program; and, of course, no cooperative research project is accepted unless it does advance the broad objectives of forest products research.

## Organization

Operationally the Forest Products Laboratory is organized in seven technical divisions, two service divisions, and a library, all under the supervision of the Director.

### Technical Divisions

The Timber Growth and Utilization Relations division has broad responsibilities dealing, first, with the relations between growth conditions and wood quality, anatomical structure and properties, and secondly, with more efficient harvesting and utilization of timber. Associated with the first objectives are efforts to extend the scope of identification techniques by which it is made possible to identify many woods to family, genera, and individual species by examination of cell and pore arrangement. A further task is the collection of properly identified samples of foreign wood and the compilation of existing information on foreign wood properties.

In line with the foregoing, one objective of Timber Growth and Utilization Relations is to supply a scientific background for the growing of trees to meet quality standards related to use requirements, and similarly to make possible the selection of trees by species, site, and heredity to meet special use requirements.

This division is concerned with the development of methods for grading logs according to use potentialities; the dissemination of information on improvements in logging and timber handling equipment, and in research to improve the efficiency of small sawmills, and the machining of wood.

The Division of Physics and Engineering is responsible for research on wood seasoning and moisture control and on the strength properties of wood and wood structures.

With respect to wood-moisture relations the Division of Physics and Engineering carries on research to determine optimum yard conditions

for air seasoning under modern conditions involving the use of mechanized handling equipment, spot checking of new and improved kiln drying schedules, research on the control of moisture condensation in frame-house walls, investigation of drying stresses as a basis for improved seasoning, and research on nondestructive testing of wood by electrically induced vibrations. In the field of mechanics original determinations of the basic strength of more than 175 American tree species are being extended by tests of the properties of secondary species and of second-growth material. The data sought provide a basis for structural design, for selection of species for specific uses, and for finding serviceable substitutes for scarcer and higher-priced woods. The performance of wood is investigated under diverse conditions of loading and exposure. Problems having to do with common structural members are investigated as well as the functioning of joints and fastenings, and the engineering of properties of plywood, laminated timbers, and sandwich constructions.

The Division of Packaging Research is responsible for research on shipping containers and packaging. The Division aims to conserve wood and improve its utility by reducing the amount of material required, by saving shipping space and weight, and by producing stronger and safer containers of both wood and wood fiber. Since the container alone cannot protect against changes in temperature and humidity during shipment and storage, work is underway to improve interior packing as well as blocking, bracing, and cushioning. Further refinements are sought in recent work that has made it possible to relate the strength of finished fiberboard boxes to strength of the component papers.

Since the protection of wood against decay, insects, and marine borers is essential to its successful use in some commodities, the Forest Products Laboratory operates a Division of Wood Preservation. In one aspect of this research studies are made of the decay, stain, and mold organisms that attack wood -- especially with regard to diagnosis of decay in wood, classification of fungi, and development of satisfactory short-time laboratory methods for determining the long-range effectiveness of wood preservatives.

The effectiveness of standard and promising preservatives in protecting wood against destructive organisms is determined in experimental treatments and in field tests of considerable size and long duration.

The Division of Timber Processing conducts research on veneer cutting, wood laminating, plywood and assembly gluing, wood paints and finishes for exterior service, and fire retardants. With the development of new adhesives with greatly improved facility of use and durability in service the Laboratory is investigating the durability of many new types of glues so that they may be used to produce better joint work in wood of all types. In the field of veneer production optimum rotary-peeling and slicing techniques are being consistently explored for the guidance of those seeking to use tree species to replace scarcer types.

The Laboratory has made and continues to make definite contributions to methods for obtaining more lasting and satisfactory service from paints and other coatings on wood. Exposure tests have already yielded valuable information on the technique of application, durability, and paint maintenance. Currently long-needed research on the fundamental chemistry and physics of deterioration of house paint is underway.

Research on fireproofing extends over a wide range of chemical treatments and types of fire-resistive construction. Methods of testing are developed and proprietary fire retardants are tested. Full-size house parts can be subjected to flame tests in a separate building with a panel furnace having 67 gas burners.

Chemistry, composition, and derived products of wood and wood waste are investigated in the Division of Wood Chemistry. The chemical composition of wood, the arrangement of the constituent parts in the wood fibers, and the variations of such characteristics according to species are explored for the insight they can yield in all fields of wood research -- in silvicultural control of wood and its properties, in its selection, seasoning, and handling, its impregnation with preservatives, its use in construction, and its conversion into pulp and chemically derived products of all types. Specifically the chemistry of cellulose, lignin, and extractives is explored; hydrogenation, carbonization, and hydrolysis procedures are developed, and methods of microbiological use of wood sugars are refined. Further extension and application of laws governing the relation of chemical constitution to toxicity of chemicals is also the goal of the Division's research.

With the aid of a completely equipped experimental-scale pulp and paper mill, the Division of Pulp and Paper seeks to improve existing pulping and papermaking processes and to develop new and more economical methods.

Since huge stands of second-growth hardwoods abound in the United States, the Pulp and Paper Division has a secondary objective of providing technical data to enlarge the use of hardwoods. Already the semi-chemical process developed at the Laboratory is producing over two million tons of pulp from hardwoods per year and a second new process for hardwoods -- which yields 90 percent of pulp instead of the 70 percent that characterizes semichemical -- is in commercial use. Research is also continuing to effect improvements in sulfite, soda, sulfate, and groundwood (mechanical) pulping, in the improvement of bleaching and other phases of pulp preparation.

### Service Divisions and Library

The Laboratory service divisions attempt to relieve technical divisions of as many routine duties as possible so that researchers may concentrate on constructive analysis of research results.

The Division of Administrative Management deals with Laboratory business affairs, including budget control and planning, and is in charge of personnel transactions and relationships. The Division's services include mail control, stenographic pool, carpenter shop, machine shop, electrical service, purchase and stores, maintenance and housekeeping, engineering, and drafting. The Division's Computing section, equipped with IBM card machines, analyzes technical data according to researchers' needs and checks all technical publications for accuracy.

The Library at the Forest Products Laboratory is one of the most complete on the subject of forest products in the world.

The Forest Products Laboratory's Research Publications and Information Division disseminates the results of Laboratory research and provides editorial and photographic services, as well as handling much general correspondence and taking responsibility for the preparation of exhibits and reception of both casual and consulting visitors.

## Administrative Technical Personnel

Dr. Edward G. Locke is the Director of the Forest Products Laboratory. His predecessors have been McGarvey Cline, 1910-1912; Howard F. Weiss, 1912-1917; Carlisle P. Winslow, 1917-1946; G. M. Hunt, 1946-1951; and J. Alfred Hall, 1951-1959.

Two assistants to the Director are C. C. Bell and Alan D. Freas. Chiefs of the seven technical divisions are: Timber Growth and Utilization Relations, H. L. Mitchell; Physics and Engineering, J. A. Liska; Packaging Research, Kenneth W. Kruger; Wood Preservation, R. M. Lindgren; Timber Processing, H. O. Fleischer; Wood Chemistry, J. F. Saeman; Pulp and Paper, G. H. Chidester.

Of approximately 400 persons employed at the Forest Products Laboratory, about one-third are in technical classifications.

## Accomplishments

The decades of Laboratory research have produced many accomplishments -- some of them relatively striking and quick of application; many more have become so effectively incorporated in the technology of the wood-using industries that their source is no longer evident. The greater number, diversity, and basic character of the latter accomplishments probably make them the more important.

Research on cellulose and lignin at the Forest Products Laboratory has, of course, taken up a task carried on for many decades by research chemists. Some of the Laboratory's efforts have markedly influenced the modern chemist's concept of the wood complex and introduced new terms for describing it. One of these terms is "holocellulose," a word devised by the Forest Products Laboratory to define the total carbohydrate fraction of wood.

The physical properties of the individual wood fiber have been subjected to unique and revealing treatment. Through a method of chemical dissection devised by Dr. G. J. Ritter, the fiber has been shown to be made of several concentric layers, or sleeves, composed of spirally wound fibrils. The fibrils have, in turn, been fractioned into spindle-shaped bodies, and these into small units that are spherical when freed (if not in place). This is the ultimate unit that can be viewed with the ordinary compound microscope.

Beginning with the period of accelerated interest in kiln drying of lumber in World War I, the Forest Products Laboratory has exercised national leadership in the technology of wood seasoning. Kiln-drying schedules for drying the principal native species with a minimum of degrade were published many years ago. Culminating efforts to improve these schedules a new set, which apply new principles for speeding up (and thereby making less costly) the kiln-drying process, has been issued. The new schedules exclude the possibility of inducing seasoning defects. Through thousands of contacts with the widely dispersed lumber industry, the Laboratory is constantly assisting wood-using industries, both large and small, to reap the benefits of scientifically sound seasoning.

Many years of observation of visible and concealed defects in hardwood logs and their manufacture into the basic types of lumber products and veneer have enabled the Forest Products Laboratory to pioneer in the development of log grades, a badly needed device for insuring more efficient use of the forest crop. Through these grades, buyer and seller may deal with each other more equitably in the process of timber marketing, and logs may be channeled to their highest economic use direct from the forest. Eventually, log grades should give rise to workable tree grades that will forecast accurately the kind and quantity of lumber, veneer, and pulpwood that can be harvested from a given tract of timber. Work is now in progress to develop and perfect log grades which will be equally applicable to the softwood species.

Strength in one or another of its several manifestations (compressive, tensile, bending, or otherwise) is a major consideration in most wood uses. The Forest Products Laboratory has tested and published the strength of the clear wood of 175 leading American woods. Through related tests of timbers with the normal complement of knots and other defects and through tests on wooden structures, the Laboratory has provided the data underlying the modern engineering of wood structures, from kitchen floors to aircraft-carrier decks.

Basic engineering has also been worked out to facilitate the design of glued laminated wood arches and timbers, and of timber structures joined with metal connectors to bring about a fourfold increase in strength of bolted joints.

Design criteria for plywood as well as plywood fabrication have been studied intensively at the Laboratory. Formulas developed to explain the behavior of flat and curved plywood under loads have been widely adopted not only for plywood design but, with suitable modifications, in the engineering of other materials.

Research on wood and fiber containers at the Forest Products Laboratory, the object of which is to conduct research looking toward more efficient and economical use of wood and wood fiber for containers, has been in progress since World War I. A separate division for container research was set up in 1940.

Recently the Packaging Research Division elaborated and extended work on the engineering of fiberboard containers, which work was published by T. A. Carlson as far back as 1939. As a result of thousands of tests on fiberboard specimens, fiber boxes, and on container board tubes of rectangular section, the Forest Products Laboratory has made available the means for realistic selection of material and design of fiber containers. Size and weight of load, type of box-body construction, duration of anticipated storage, height of stacking in storage, and storage humidity conditions can be correlated to implement the selection of container fiberboard of adequate strength. Alinement charts have been prepared to facilitate box design and specifications.

In a salient application of the strength data, the Forest Products Laboratory adapted the monocoque principle of construction, long known to designers of aircraft, to the needs of modern housing. In 1935 the monocoque, or stressed-skin plywood building panel, was developed as the basic unit in the prototypes of the modern prefabricated house. In this system, plywood faces are glued to a light framework to provide a unit in which every part of the panel participates in the load-bearing function. More than half of the 100,000 or more prefabricated houses being erected each year are based, with varying adaptations, on the principles used in building the demonstration prefabricated houses that are in service at the Forest Products Laboratory.

The approach of the Forest Products Laboratory to control of shrinkage and swelling in wood has been many-sided. One of the results of research in this field has been the development of a small group of stabilized woods and wood-base plastics which are quite free from the susceptibility of wood to moisture. Stabilization with respect to moisture intake, of course, means relative freedom from shrinking and swelling and all the difficulties that these changes in dimensions involve.

These materials are impreg, compreg, and staypak. Impreg is a resin-impregnated, laminated wood with low shrinkage and swelling.

Compreg is a resin-impregnated, laminated, and compressed wood that is very hard and very stable with respect to moisture and dimensional changes, and, incidentally, quite attractive in appearance. This material, since it has a fairly high resin content, takes a gloss in pressing; smoothly cut surfaces can be dressed back to a polished surface by buffing alone. Compreg has had considerable use for cutlery handles. It has also been used for forming dies in the aircraft industry, a use that employs more of its physical advantages. Impreg is now coming into general use for making die models for automobile body parts.

Staypak, a laminated, heat-compressed wood, containing no resin, is tougher than compreg, since it is not in any degree embrittled by resin. It is free from springback when soaked and has a very slow tendency to pick up moisture.

Modifications intermediate between the foregoing products can be produced to meet special conditions. All are fairly expensive because of the processing involved or materials added.

Generally speaking, the mechanics of stabilizing wood and wood fiber against dimensional changes is fairly well understood. Dissatisfaction with the best of stabilized wood and fiberboard so far has been mainly with the cost of treatment. Current and proposed work is directed toward the development of cheaper methods and toward the use of dimensionally stabilized overlays to control moisture variations in sheet materials.

Papreg, a World War II product of the Forest Products Laboratory's Pulp and Paper Division, is a high-strength laminated paper plastic that found some use in substitution for metal in molded aircraft parts.

Modification of the absorbency and fiber orientation of the basic papers gives this material a tensile strength in the neighborhood of 40, 000 pounds per square inch instead of the 12, 000 to 15, 000 pounds characteristic of the earlier paper plastics.

Later, the Pulp and Paper Division developed a resin-impregnated paper honeycomb core for light, prefabricated wall-panel construction. The core and panel have excellent properties. In the slow evolution of housing methods, this may be the main substance of tomorrow's house.

Research for the Armed Forces on aircraft materials has given the Forest Products Laboratory an outstanding familiarity with sandwich materials of all kinds, including those employing metal and glass fabric laminates for modern high-speed aircraft and guided missiles. The Laboratory has become a center of information on these materials.

Many years ago, the Forest Products Laboratory discovered certain relations between the chemical constitution of benzene derivatives and their toxicity, which seemed to have significance in the field of wood preservation. It was suggested to several manufacturers of chemicals that the more highly chlorinated phenols might be toxic to wood-destroying fungi. As a result of the early tests by the Laboratory and by industry, one of the compounds, pentachlorophenol, has achieved recognition as a wood preservative. Millions of pounds are now in use for protecting wood against decay and stains. One of the most advantageous uses of this oil-soluble preservative has been for the quick protective treating of sash and other millwork -- a treatment which has become almost a standard process in the industry for adding durability to the modern house.

The Laboratory's research on wood and wood structures has inevitably produced an extensive fund of information on frame house construction. Information on the strength of structural timber has been widely employed in the formulation of building codes. Tests of wall structures and thousands of observations on houses throughout the United States have resulted in much information on the moisture- and heat-permeation of walls and the means to control moisture condensation in walls as well as wall deterioration, including paint failure, which, in the colder parts of the country, can result from wall moisture condensation.

## Dissemination of Research Results

The results of research at the Forest Products Laboratory are disseminated through publications, through the Forest Utilization Research units, through consultation with individuals coming to the Laboratory, through field assignments and demonstrations in the field by the staff, and through correspondence.

Major research accomplishments of the Forest Products Laboratory are, of course, intended for publication through the Government Printing Office as Department of Agriculture Technical Bulletins, Agriculture Information Bulletins, Farmers' Bulletins, or other official publications. In the case of minor research data or preliminary aspects of major projects a great deal of information is released in the form of processed reports that are issued directly from the Laboratory. The principal series of these processed reports have been numbered from 1 to (currently) 2000 plus. Since reports are cancelled as soon as data become obsolete or are not suitable for continued distribution for any other reason, the actual number of reports still current is nearer one thousand than two thousand.

One other type of publication is processed at the Laboratory directly. This is the Technical Note series. Forest Products Laboratory Technical Notes are succinct one-subject notes that are much less numerous than the other processed series. Two hundred and sixty Technical Notes have been issued to date.

In addition to the publications issued by the Laboratory many reports of research appear in various trade and technical publications as articles and technical society papers by the staff. Frequently these are available at the Laboratory as reprints.

Since Laboratory publications are numerous and of greatly diversified subject matter, no attempt is made to compile a single list of publications. Instead a list of publications is issued for each major activity or subject matter subdivision with which the Laboratory is concerned. The lists of publications are titled as follows: Growth, Structure, and Identification of Wood, No. 177; Logging, Milling, and Utilization of Timber Products, No. 790; Mechanical Properties and Structural Uses of Wood and Wood Products, No. 200; Box and Crate Construction and Packaging Data, No. 791; Seasoning of Wood, No. 446; Wood Preservation, No. 704; Fungus Defects in Forest Products and Decay in Trees, No. 508;

Wood Finishing Subjects, No. 454; Glue, Glued Products, and Veneer, No. 513; Chemistry of Wood and Derived Products, No. 238; Pulp and Paper, No. 444; Furniture Manufacturers, Woodworkers, and Teachers of Wood Shop Practice, No. 1775; Architects, Builders, Engineers, and Retail Lumbermen, No. 1081; and Structural Sandwich, Plastic Laminates, and Wood-Base Aircraft Components, No. RPI-4.

The foregoing lists are revised when opportunity offers and at intervals of six months a list of recently issued publications is sent to all persons on the Laboratory's general mailing list. No charge is made for single copies of any report issued directly from the Laboratory.

The Forest Utilization Research units of the Forest Service Experiment Stations are important agencies for widely distributing the results of research at the Forest Products Laboratory and for keeping the research program in line with regional and industrial forest products problems. Broadly trained forest products technicians travel widely in the territory assigned to them, advising individuals and industries on wood-using problems. They also return to the Forest Products Laboratory at frequent intervals to avail themselves of latest research results and to carry to the Laboratory a picture of the type of information needed in their home areas. Forest Utilization Research units are maintained at the following stations: Pacific Southwest Forest and Range Experiment Station, Berkeley, Calif.; Central States Forest Experiment Station, Columbus, Ohio; Intermountain Forest and Range Experiment Station, Ogden, Utah; Pacific Northwest Forest and Range Experiment Station, Portland, Oreg.; Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.; Southeastern Forest Experiment Station, Asheville, N. C.; Southern Forest Experiment Station, New Orleans, La.; Northeastern Forest Experiment Station, Upper Darby, Pa.

One effective means of disseminating Forest Products Laboratory research is not susceptible to planning. Currently about 3,500 individuals come to Madison each year to ask for help on technical problems having to do with wood. In an ordinary year practically every state is represented in this group of visitors. Even the telephone is used freely as a consulting medium, with incoming calls on technical problems estimated at 2,500 per year. This direct personal contact is in addition to between 35,000 and 40,000 letters that are written by staff members in response to requests for data.

The Forest Products Laboratory at Madison belongs to the people of the United States. Any citizen is free to inspect the Laboratory during the daily afternoon guided tours; to request publications or answers to his questions about wood; to visit the Laboratory any time during official hours and ask for technical advice; to propose a cooperative project under the regulations governing such projects; or to propose a line of research for inclusion in the regular research program. Thousands avail themselves of these services, in some cases over a period of years. The Laboratory most completely fulfills its public function in contributing by all the means at its command to help the individual wood user while at the same time helping to maintain wood as a vital and renewable national resource.

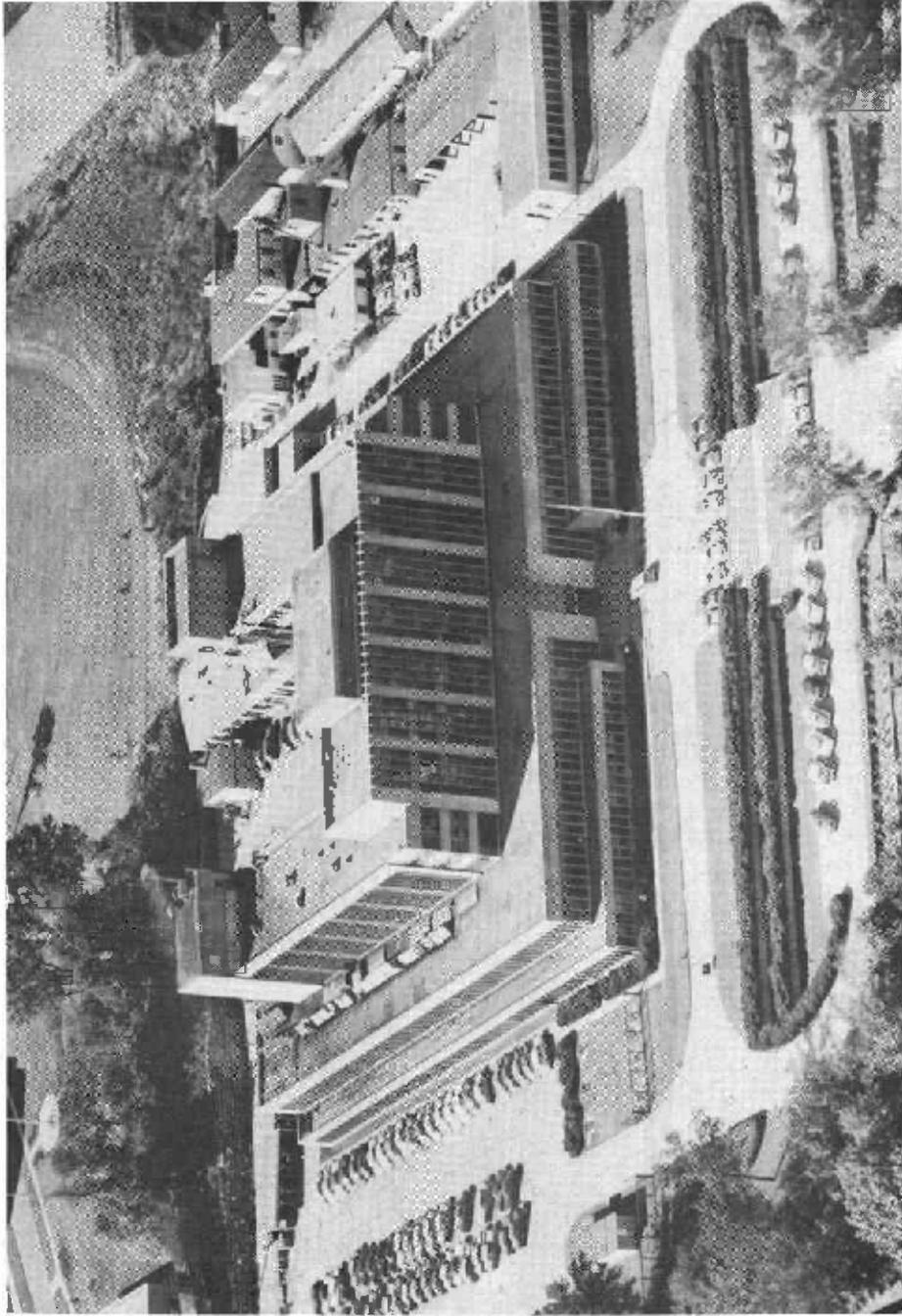


Figure 1. -- The main Forest Products Laboratory building and some of the outlying service units.

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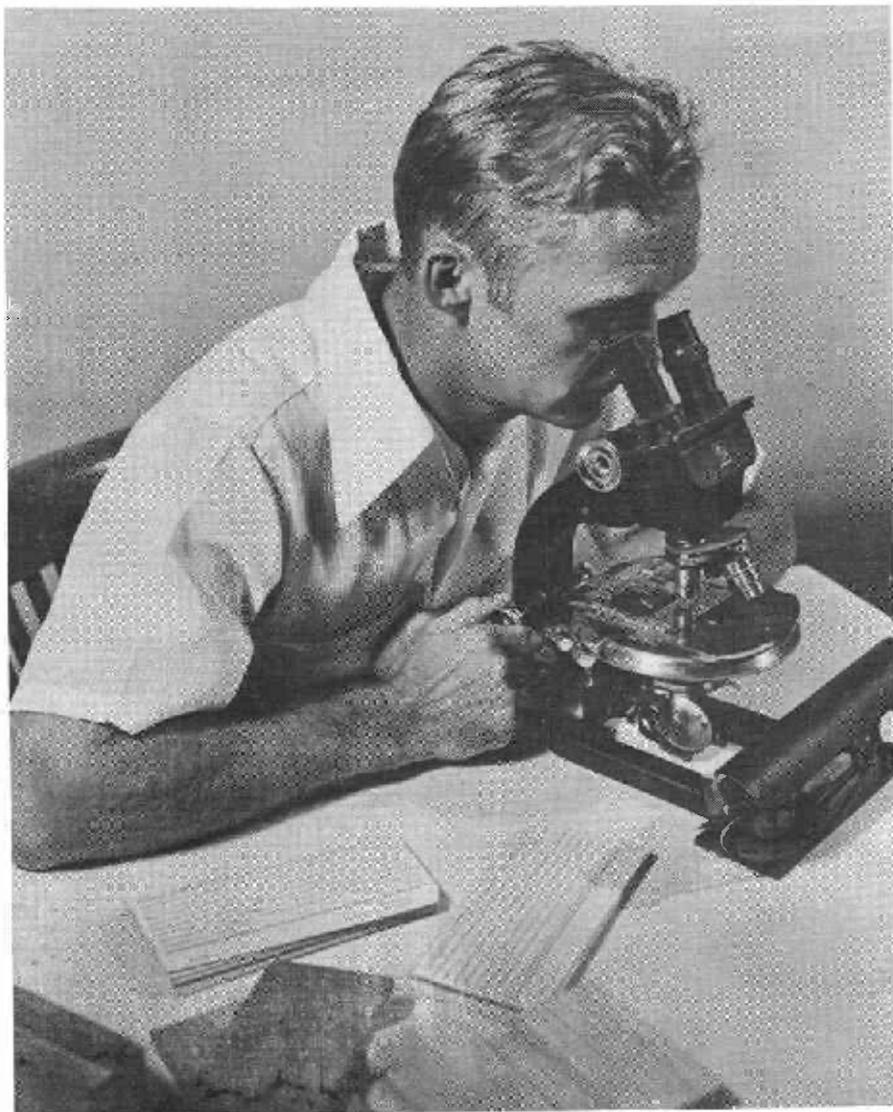


Figure 2. --Dr. B. F. Kukachka is in charge of wood identification research at the Forest Products Laboratory. Thousands of wood samples are identified annually for American industry and research is carried on to make it possible to identify an even greater number of American woods by examination of their microscopic structure.

Z M 99657 F

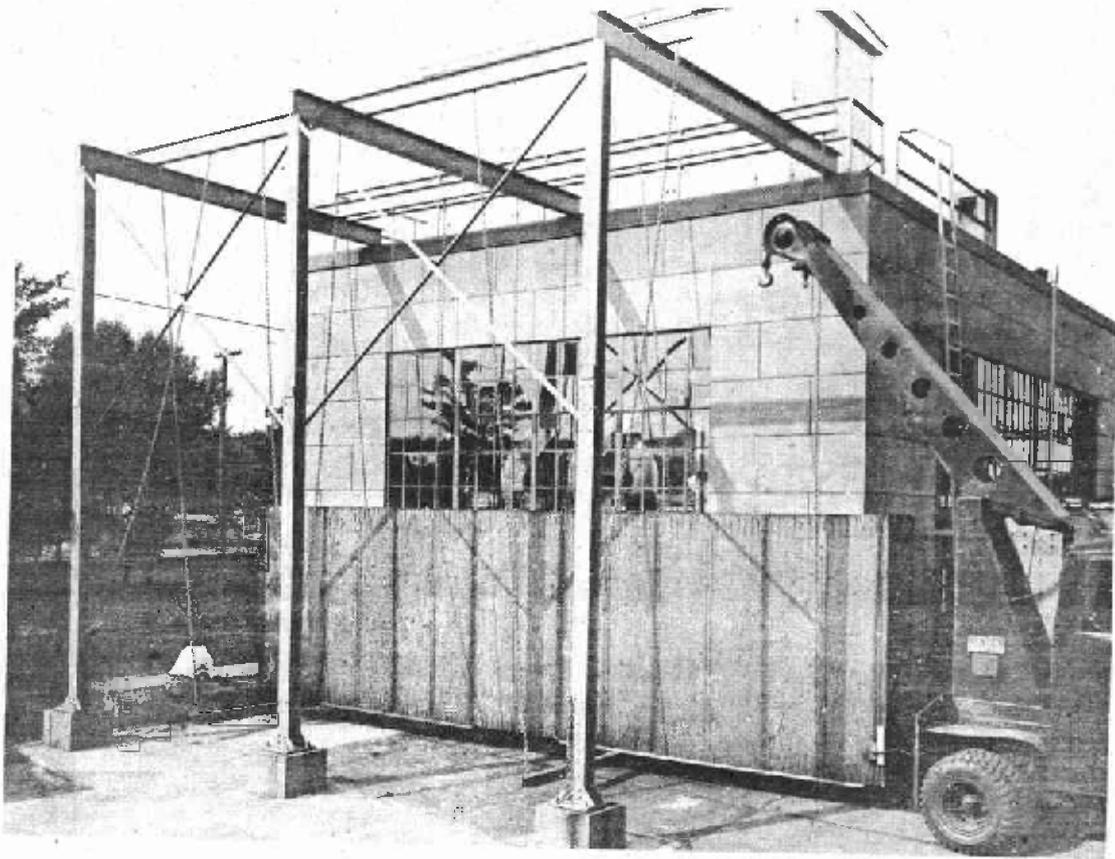


Figure 3. -- Testing a large plywood sheathed crate at the Forest Products Laboratory. Suspended in a sling from the steel framework, the crate is pulled away a measured distance from the concrete bulkhead and then released. The resulting crash simulates the hazards of rough switching or bumping in railroad transportation.

Z M 94040 F

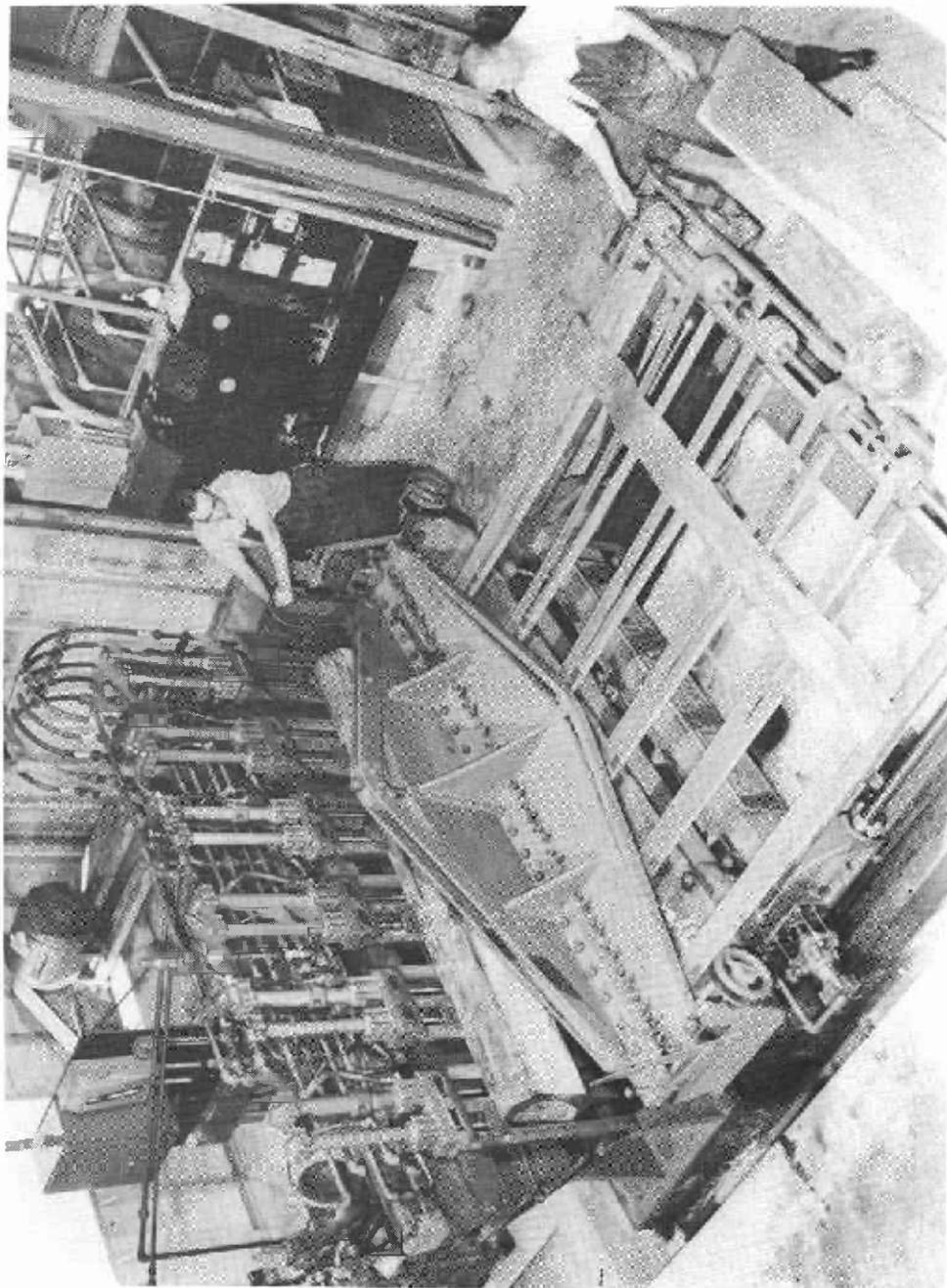


Figure 4. -- With the aid of the veneer slicer above the Forest Products Laboratory plans to extend the scope of research on the suitability of American woods for veneer. The manufacturer has sold several similar slicers, complete with modifications suggested in the Laboratory's purchase specifications.

Z M 94159 F

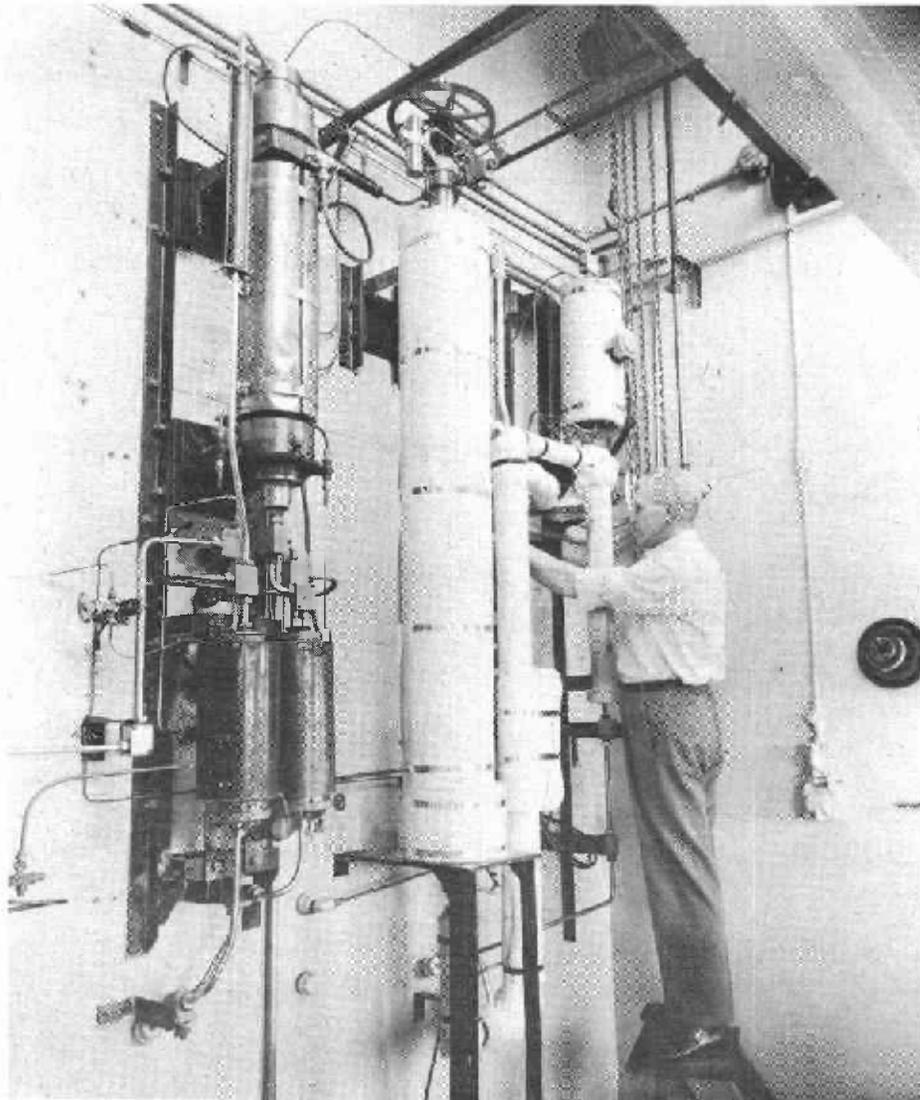


Figure 5. --Continuous hydrogenation of wood sugars and lignin goes on in the tall insulated cylinder, with hydrogenation, catalyst, and subject material being preheated, passed into the cylinder, and feeding upward while being vigorously stirred. A smaller vessel is seen at the left and the smaller cylinders are concerned with hydrogen control and the withdrawal of end product.

Z M 95491 F

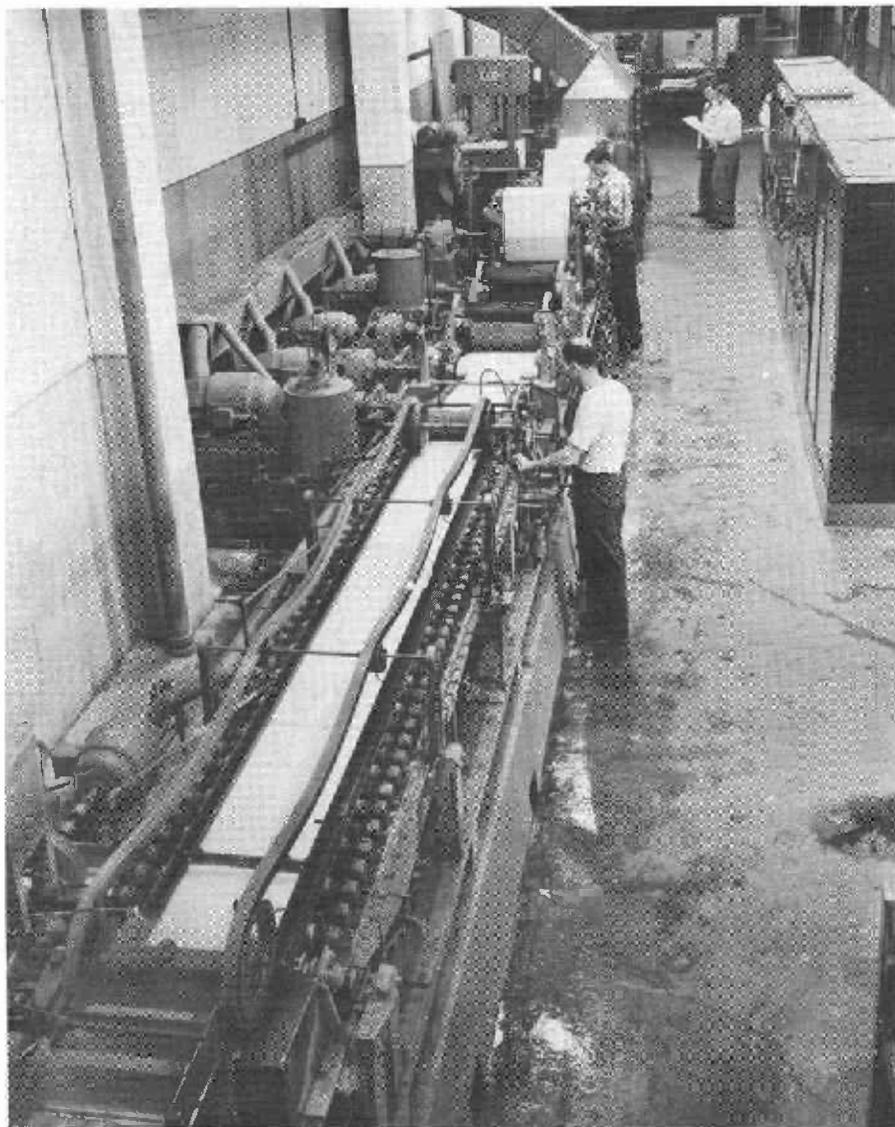


Figure 6. --Sixteen-inch precision experimental paper machine.

Z M 90788 F

SUBJECT LISTS OF PUBLICATIONS ISSUED BY THE

FOREST PRODUCTS LABORATORY

The following are obtainable free on request from the Director, Forest Products Laboratory, Madison 5, Wisconsin:

List of publications on  
Box and Crate Construction  
and Packaging Data

List of publications on  
Chemistry of Wood and  
Derived Products

List of publications on  
Fungus Defects in Forest  
Products and Decay in Trees

List of publications on  
Glue, Glued Products,  
and Veneer

List of publications on  
Growth, Structure, and  
Identification of Wood

List of publications on  
Mechanical Properties and  
Structural Uses of Wood  
and Wood Products

Partial list of publications for  
Architects, Builders,  
Engineers, and Retail  
Lumbermen

List of publications on  
Fire Protection

List of publications on  
Logging, Milling, and  
Utilization of Timber  
Products

List of publications on  
Pulp and Paper

List of publications on  
Seasoning of Wood

List of publications on  
Structural Sandwich, Plastic  
Laminates, and Wood-Base  
Aircraft Components

List of publications on  
Wood Finishing

List of publications on  
Wood Preservation

Partial list of publications for  
Furniture Manufacturers,  
Woodworkers and Teachers of  
Woodshop Practice

Note: Since Forest Products Laboratory publications are so varied in subject no single list is issued. Instead a list is made up for each Laboratory division. Twice a year, December 31 and June 30, a list is made up showing new reports for the previous six months. This is the only item sent regularly to the Laboratory's mailing list. Anyone who has asked for and received the proper subject lists and who has had his name placed on the mailing list can keep up to date on Forest Products Laboratory publications. Each subject list carries descriptions of all other subject lists.