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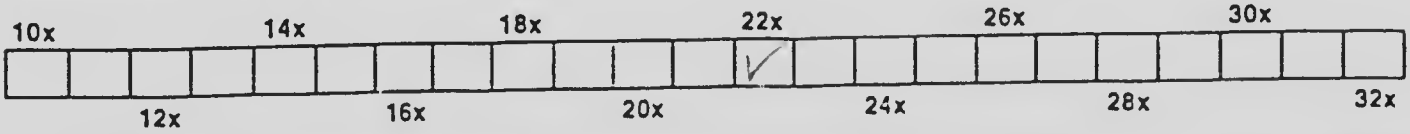

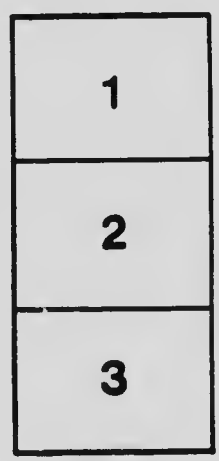

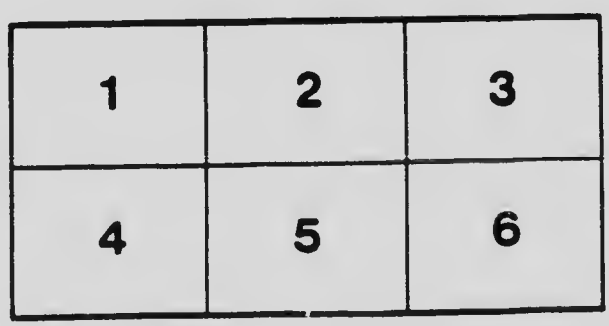

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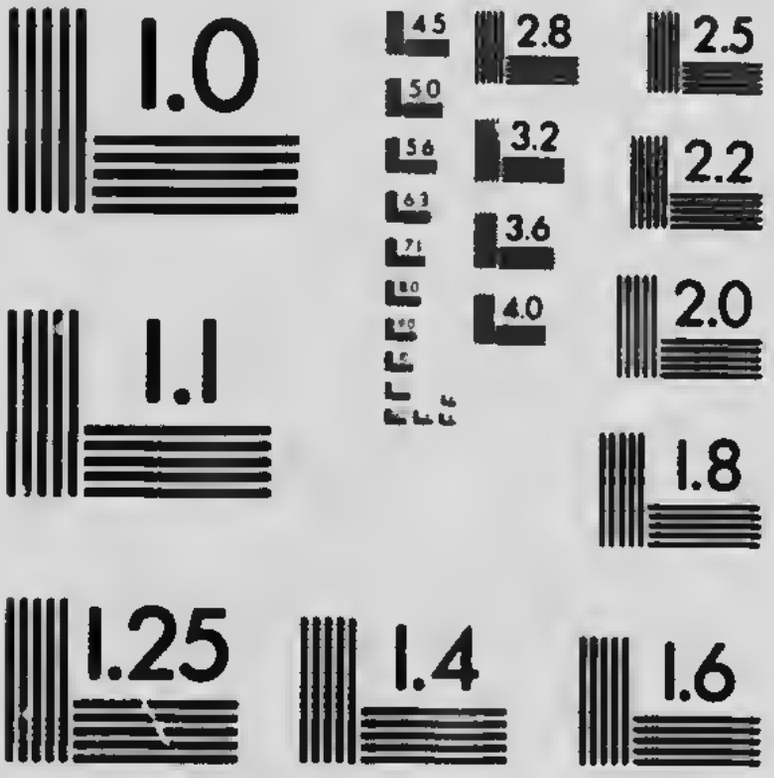

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Present and Possible Products from Canadian Woods

By

JOHN S. BATES

Superintendent, Forest Products Laboratories of Canada.

A Paper read at a Sectional Meeting of the Canadian Society of Civil Engineers, Montreal, on Thursday, April 19th, 1917

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PRESENT AND POSSIBLE PRODUCTS FROM CANADIAN WOODS.

By John S. Bates, A.M.Can.Soc.C.E.

Introduction.

The intention is to give a general survey of forest products including those actually manufactured in Canada and those which it is possible to obtain from Canadian woods by processes operating in other countries. The accompanying "Diagram of Forest Products from Canadian Tree Species" furnishes the basis for the discussion and only the more significant facts are touched upon.*

There are several general conditions which should be kept in mind by every Canadian. Canada is considered to be the third country of the world in value of forest resources; Russia is first and the United States second on the list. Contrary to popular impression forest surveys indicate that Canada's present supply of merchantable timber is only one-fifth or one-quarter of the supply still available in the United States. There is a real necessity for the extension of adequate protection of our present forests, wise utilization of the timber when it is cut and foresight in planning for natural and artificial reproduction. Trees are coming to be regarded more and more as a forest crop, and with proper system there is no reason why our forests should not be a source of expanding and permanent wealth. It is estimated that about 60 per cent. of the land area of Canada below the sixtieth parallel of latitude is non-agricultural in character and for the most part available for the growing of trees.

In the list of Canada's natural resources agricultural field crops hold first place in value of production with an estimated total of from $700,000,000 to $800,000,000 annually; forest products come second with a total of about $175,000,000 for the primary products

*For more detailed information those interested are referred to the Forest Products Laboratories of Canada, 700 University St., Montreal. These laboratories were organized in 1913 under the Forestry Branch of the Department of the Interior, and are established in co-operation with McGill University. Scientific work is being carried on to supply authoritative data on the mechanical, physical and chemical properties of Canadian woods and to furnish experimental information on industrial processes for the utilization of wood.

and this figure is considerably increased if paper and other manufactured products are included. In 1916 the exports of products from wood amounted to approximately $100,000,000, not including the minor proportion of specially manufactured wood articles, showing the place which our forest resources will take in helping to overcome the war debt. According to the census of 1911 the capital invested in timber, lumber and re-manufactures amounted to $259,889,715 in 4,999 establishments, this being the highest figure on the list. In addition the paper and printing trades accounted for an invested capital of $62,677,612 in 773 establishments.

Wood Used as Such.

By far the most important and extensive utilization of wood consists in the manufacture of lumber and other products by mechanical processes, whereby the wood still retains its identity.

Under the heading of wood used in the rough, firewood takes first place and in value accounts for about 30 per cent. of the primary wood products. Air-dry wood has a calorific value rather more than half that of coal, pound for pound. The normal annual consumption of railway cross-ties in Canada is about 20,000,000 with an average value of about 45 cents each. Half of these are used for renewals showing the tremendous destruction which is mainly due to decay rather than mechanical wear. Only about 7 per cent. of the ties receive preservative treatment indicating the scope for extension of modern wood preservation processes in the case of a number of the Canadian tree species. Treatment with creosote and other preservatives is practised very extensively in the United States and especially in Europe, with the result that the life of the tie is doubled in most cases. In order of importance the Canadian tie woods are jack pine, eastern cedar, Douglas fir, hemlock, tamarack, western larch and small quantities of other species. Hardwoods, such as birch and maple, are now coming into use, as creosote treatment successfully overcomes the low durability of hardwoods, and the ties have the advantage of high mechanical strength. Large numbers of wooden fence posts are used throughout the country, but there are no accurate figures. The fence post problem is particularly important in the Prairie Provinces where the perishable poplar and willow are the only local woods available. An investigation of preservative treatment is now being carried out. The annual consumption of round mine timber is over 53 million linear feet with a total value of $524,000, while the mines consume sawn timber to the extent of 23 million feet board measure valued at about $30[illegible] About 140 coal and ore mines in Canada use timber, the leading woods being Douglas fir, spruce, balsam

fir, lodgepole pine, jack pine and hemlock. The high humidity and elevated temperature in the mines promote rapid decay, and it is likely that preservative treatment of mine timber will be taken up in Canada, at least for timber used in permanent haulways. The demand for poles has fallen off in recent years largely on account of decrease in telephone line construction. In 1914 the returns show 283,184 poles used with a value of $660,262. The leading woods are eastern cedar, western red cedar, spruce and tamarack. Spruce and other piling is used quite extensively in Canada and forms an important export item.

The term lumber is used to include a wide range of material and constitutes the most important manufactured product. A large proportion goes directly from the saw-mill into general building and construction without passing through any intermediate wood-working factory. In 1915 the lumber cut in 3,23 mills totalled 3,842,676,000 feet board measure with a total value of $61,919,806, which includes a good deal of "structural timbers." Twenty-five kinds of wood are reported which represent about 50 distinct species. Spruce, white pine and Douglas fir account for about 75 per cent. of the total lumber cut in Canada. Hardwoods are of minor importance, representing only about 6 per cent. of the total lumber cut; birch is the leading species in point of quantity available. The term "structural timbers"* covers wood so used that its strength is a factor of first importance and includes timbers for mill construction, trestle and bridge timbers, wharf timbers, larger ship timbers, etc. The Divisions of Timber Tests and Timber Physics of the Forest Products Laboratories are now establishing authoritative data on the mechanical and physical properties of Canadian woods for the benefit of engineers, architects and others concerned with the grading of lumber and design of structures. The Canadian species in order of merit and resources are Douglas fir, western hemlock, eastern hemlock, western yellow pine, western larch, red pine and eastern larch. Douglas fir† is fully equal to southern long leaf pine as a heavy structural timber, and with the tremendous untouched resources in British Columbia is destined to become Canada's most important tree.

The rough manufactured products are too well known to require much discussion. Canada produces over three billion shingles annually, valued at nearly $6,000,000. Over half of these are made

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*The recently published Forestry Branch Bulletin No. 59, "Canadian Woods for Structural Timbers," covers this subject in detail.

†Forestry Branch Bulletin No. 60, "Mechanical and Physical Properties of Canadian Woods—Douglas Fir," now in press, gives a detailed account of tests made on Douglas fir at the Forest Products Laboratories of Canada.

in British Columbia mostly from western red cedar. About 800 million laths are produced with a value of over $2,000,000, these being for the most part by-products from slabs and edgings. Treated wood-block paving* is now used in a number of Canadian cities and throughout the world is placed in the first rank of city paving materials. Wood flour or wood meal is the fine, fluffy, absorbent fibre made by grinding wood chips in a stone mill or steel burr roller mill with a limited amount of water. It is used in the manufacture of dynamite, inlaid linoleum, oatmeal wall paper and wood plastics. Canada imports considerable quantities from Europe and the United States chiefly for the manufacture of dynamite, and there is no reason why the industry should not be established in Canada for both local and export trade. Wood wool is a fine excelsior used in Europe for surgical dressings, filtering, stuffing mattresses, and as a substitute for cotton waste.

Specially manufactured products include hundreds of different kinds of articles wholly or partly constructed of wood. In Canada this group probably accounts for 15 per cent. of the total wood cut. An economic principle underlying the proper use of wood is that each species of wood has a legitimate field of usefulness within which it should be employed. Custom, prejudice and lack of information frequently prevent the use of a species for some purpose for which it is naturally adapted. A large amount of accurate data still remains to be established, and there is a wide field for technical research in determining the mechanical, physical and chemical characteristics of Canadian woods.

Special mention should be made of the by-products of the lumber industry since they constitute an enormous amount of wood material which for the most part is now going to waste. Utilization is retarded in Canada on account of the scattered population and limited markets as well as the technical nature of many of the processes. It is estimated that the logging waste which is left in the woods represents about 25 per cent. of the original tree. Obviously the opportunities for utilization are limited, and the main problem in Canada at present is to rigidly enforce the proper burning of slash in the wet seasons to remove this serious fire hazard and leave the woods in better condition for second growth. Other losses in the forest are due to fire, insects, fungi, wind, thick growth, scattered growth, local predominance of inferior species, mature trees not up to cutting standard, inaccessible timber and land-clearing operations. These are some of the problems which

*Forestry Branch Bulletin No. 49, "Treated Wood-block Paving," discusses the subject as related to Canada.

confront the forester, and the importance of the forest protective movement is emphasized when we remember that forest fires in Canada have destroyed perhaps ten times as much wood as has been taken out by the lumbermen. The federal and provincial forestry branches and the various associations have done a great deal to safeguard our widespread forest resources and to secure the co-operation of the public in overcoming carelessness in the woods.

Saw-mill waste amounts to about 40 per cent. of the original tree, so that the finished lumber on the average represents from 30 to 35 per cent. of the tree. New developments in the utilization of wood waste are being made continually, but it is false economy to handle waste unless the by-product industries can be carried on at a profit. Effective utilization calls for a variety of chemical and mechanical processes which must be adapted to the form, species and quantity of wood waste available at any point. Slabs, edgings and trimmings represent 15-17 per cent. of the tree. Among the more common uses are fuel, laths, box shooks, small slack cooperage, small wooden articles, kraft and sulphite pulp, excelsior, wood flour, wood wool and producer gas. Sawdust accounts for another 11 per cent., and is used to some extent for fuel, producer gas, briquettes, polishing metals, insulating, packing, bedding in stables, floor sweeping compounds, composition flooring blocks, linoleum, improving clay soils, smoking meat and fish, blasting powders, wood flour, plastics, porous bricks, mixing with mortar and concrete, distillation, ethyl alcohol, oxalic acid and carborundum. Bark amounts to about 10 per cent. of the tree. It is usually used as fuel, although hemlock and oak barks are important in the tanning industry. A recent development is the use of spent hemlock bark for mixing to the extent of about 30 per cent. with rag stock in the manufacture of roofing felts. Experiments on its use in wall board, indurated pails, conduits and wall paper give promise of success. In the manufacture of special wood products a good deal of wood is lost during seasoning by decay due to poor methods of storage, and also by warping and splitting. There is a large waste in converting wood into the desired shape for the finished article. Proper co-ordination with plants making small wooden articles brings about a great economy of material. Shavings find use as fuel and to some extent for packing, bedding, drying wet land and manufacturing fibre board. Beechwood shavings are required in large quantity by vinegar factories, but this is another case where specially cut wood is usually used instead of relying on by-product wood from various plants.

Pulp and Paper Industry.

The pulp and paper industry has expanded very rapidly in Canada during the past ten years, and it appears that Canada is destined to become perhaps the leading country in the world in the manufacture of pulp and paper products from wood. This is largely because of our extensive natural resources of water-powers and suitable tree species. It is important to point out the opportunities and responsibilities for Canadian engineers in this technical industry. The consumption of paper increases so rapidly from year to year in the more highly developed countries that there is no indication of slackening development, at least for some years to come. Canada now has a total of about 90 mills, many of which are large and of modern design. The export figures for the calendar year 1916 show that pulpwood, wood pulp and paper have increased to nearly half of the total export value (approximately $100,000,000) of all forest products with the exception of the small proportion of specially manufactured articles.

The softwoods are the most important species for papermaking, spruce and balsam fir accounting for the bulk of the woods used with hemlock, jack pine, tamarack and other conifers coming into more extensive use. Poplar and basswood representing the "soft hardwoods" are valuable for making soda pulp and a variety of hardwoods such as birch and maple are used in smaller quantity. In 1915 the total reported pulpwood consumption amounted to 1,405,836 cords with an average value of $6.71 per cord. In addition, Canada exported 949,714 cords of pulpwood, which quantity has remained fairly constant for several years while the consumption of pulpwood in Canada has rapidly increased.

The groundwood process is the simplest method of manufacture, involving the wet grinding of pulpwood blocks. In 1915 this process accounted for 52.9 per cent. of the total pulpwood consumption. An important direct use of groundwood pulp is in the manufacture of wallboard, such as ordinary "Beaver Board" and the thicker "Insulite" board used for insulating cold storage rooms and refrigerator cars. Fibreware, represented by indurated pails and tubs, moulded egg cases and pressed milk bottles impregnated with paraffin, is composed mainly of groundwood pulp. Paper pie plates are cut and pressed from sheets of this pulp.

The sulphite process is the most important of the chemical processes, and in 1915 used 33.5 per cent. of the total pulpwood. The wood is chipped and steamed in large digesters with a solution of calcium (and magnesium) bisulphite containing free sulphurous acid, which dissolves most of the lignin and other non-cellulose material amounting to about one-half of the dry-weight of the wood.

Production of sulphite pulp has now reached about 1,000 tons per day, over half of which is used in the manufacture of paper in Canada. An important development is the increase in manufacture of bleached sulphite pulp for high-grade papers.

News-print paper is by far the most important manufactured product in the pulp and paper industry and is essentially a mixture of about 75 parts of groundwood pulp and 25 parts of sulphite pulp with suitable loading, sizing and colouring materials. Canadian production now totals about 2,100 tons per day which is now over half the production of the United States. Only a small proportion is needed for Canadian newspapers, so that about 89 per cent. is available for export, chiefly to the United States. Other products made by mixing groundwood and sulphite pulps are hanging paper (wall paper), the cheaper grades of wrapping paper and book paper, container board for paper boxes, liners for cars and boxes, paper for posters, etc.

Sulphite pulp in the unbleached or bleached state is used for making many papers of the higher grades, including print paper, book and writing, tissues and wax paper. Recent attention has been given to production of imitation parchment and grease-proof papers such as glassine. Sulphite pulp is well suited to the moulding of plastics, such as toys and novelties by incorporating binders. Vulcanized fibre or hard rubber substitute is usually made by treating pulp with zinc chloride and mixing with red ferric oxide, with the addition of glycerine if a pliable product is desired. Some of the paper wheels and pulleys come under this head. A sample of surgical cotton substitute from Europe turned out to be an excellent product from bleached sulphite pulp, and it is reported that large quantities are being used by Germany during the present cotton shortage. Viscose is one of the artificial silk materials which can be readily made from wood pulp. Bleached sulphite pulp is first converted to alkali cellulose by treating with strong caustic soda and then to soluble cellulose zanthate by the addition of carbon disulphide. After pressing into threads through dies or moulding into heavier articles the material is readily converted back to stable cellulose in the form of artificial silk, films or moulded articles. It is also used for sizing textiles and paper. There are several plants in the United States and undoubtedly the industry will be established in Canada. The best gun cotton is made from purified cotton, but good grades have been made from bleached sulphite pulp in England and at the present time to a large extent in Germany. Cellulose acetate is ordinarily made from cotton, and it is doubtful if bleached sulphite pulp will be used in America until the process can be improved. The non-inflammable and water-

proofing qualities of cellulose acetate made it more valuable than nitro-cellulose for aeroplane varnish, films, artificial silk and celluloid substitutes. In some industries a filter mass of sulphite pulp has been successfully used in place of cotton fibre.

Waste sulphite liquor is one of the most frequently quoted industrial wastes, as millions of gallons are turned into the rivers every day carrying half of the original pulpwood substance together with most of the lime and sulphur used. Recovery of by-products is difficult and costly, but it is safe to say that Canada will begin to practise recovery in the near future. In Europe and the United States evaporated liquor is used quite extensively as a binder for briquetting fuel and as core binder in foundry work. The tannin-like substances are separated and incorporated with true tannins in preparing sole leather. Sweden has taken the lead in recovery of ethyl (grain) alcohol, and produced in 1916 over one-half million Imperial gallons of 95 per cent. alcohol for industrial purposes, motor fuel and potable spirits. It is reported that Germany has established this process in fourteen sulphite plants in order to conserve potatoes, which are the usual source of alcohol in that country. Waste sulphite liquor contains about 1.5 per cent. of fermentable sugars which are produced from the wood during the cooking process, and these sugars are fermented to alcohol by yeast. The direct recovery of sugars and other organic matter makes available a fairly good cattle food. Recent processes aim at the precipitation of the lignin content for use as fuel, and a number of new plants are going up in Norway. Minor processes are the recovery of destructive distillation products, fertilizer and mordants for dyeing. There is also the possibility of recovering sulphur compounds which, however, do not originate in the wood

The sulphate process used 13.1 per cent. of the Canadian pulpwood consumption in 1915. This increase is a development of recent years and produces a remarkably strong flexible fibre by the combined action of caustic soda and sodium sulphide on the soft-wood chips. The value of kraft pulp is most noticeable in the brown, strong, thin wrapping papers which are now so widely used. A variety of ingenious uses for this pulp have been worked out in Europe and elsewhere. Paper twine, made by cutting kraft paper into narrow strips and spinning into a coarse strand, is now largely used for wrapping parcels and for binder twine. The threads may be assembled to produce first-class rope. By weaving there is obtained bagging material to replace burlap, carpets and matting which can be purchased in several Montreal stores, coarse cloth for upholstering furniture or even for wearing apparel, and also belting which is now used in Europe. By wrapping layers of

kraft paper on a core and impregnating with tar binder conduits are made which can be turned and threaded; these are especially useful for underground electrical conduits and acid-resisting water pipes. Kraft pulp is also used for making imitation leather for suitcases, as well as counters and heels for boots and shoes.

In Europe the sulphate process is sometimes modified to give more fully cooked sulphate pulp which can be bleached and used for higher-grade papers such as book and writing.

The spent liquor is always evaporated, incinerated and causticized for the recovery of alkalies which are used again for cooking. One Canadian mill is now recovering so-called "rosin oil" which separates from the spent liquor. Turpentine and small quantities of other light oils may be recovered from resinous woods by distilling with steam during the cooking operation and rosin soap separates from the spent liquor on cooling. This applies particularly to manufacture of kraft pulp from longleaf pine in the Southern States. Methods have been proposed for the production of methyl alcohol, acetone, acetic acid and higher oils by the destructive distillation of the evaporated liquor with simultaneous recovery of alkali and perhaps oxalic acid from the residue.

The soda process in Canada is for the most part limited to the treatment of poplar and basswood and accounted for only 0.5 per cent. of the pulpwood used in 1915. The wood is cooked with caustic soda alone to produce a short fibre which can be bleached and used as filler in some of the higher-grade papers. Soda pulp is used in conjunction with rag pulp or sulphite pulp to give bulk and smooth finish to book and magazine papers, lithographic and art papers, and to give desirable qualities to lower grades of blotting paper.

The spent liquor is treated much the same as in the sulphate process for the recovery of alkali. It would be possible to obtain the same destructive distillation products, and in case resinous goods were used, turpentine and rosin oil might also be recovered.

Distillation Industries.

The destructive distillation of hardwoods is the only important distillation industry in Canada where wood is used as raw material. There are now 11 plants in Ontario and Quebec, and the industry is well organized. It is gratifying to note that manufacture is carried beyond the stage of the crude products, where so many of Canada's industrial activities cease, and that the specially refined and derived products are produced in Canada for local and export trade. In the limited list of chemicals which are regularly

exported from Canada there are only three of much importance, namely, calcium carbide, acetate of lime and methyl alcohol, the last two of which are entirely produced by hardwood distillation. It is important to remember that practically all of the wood alcohol and acetic acid which are so essential to modern civilization are produced by the destructive distillation of hardwoods. The Canadian plants together consume over 500 cords of wood per day. Maple, beech and birch are the main species used, although oak, hickory and other hardwoods are suitable if they can be obtained. The primary distillation process is rather crude, the cordwood sticks being run into retorts on cars, and the retorts being heated externally by fire which is controlled to some extent. The crude decomposition products which are driven off go through a series of refining operations for the separation and purification of the valuable products.

The crude wood alcohol is collected at a central refining plant where distillation products are separated in accordance with market demands at the time. The methyl acetone or acetone-alcohol solvent is a mixture of methyl alcohol and acetone with smaller quantities of methyl acetate, acetaldehyde and other compounds and is a valuable solvent in the paint, varnish, leather and other industries. Methyl alcohol (wood alcohol) in the pure state (Columbian spirits) or containing more or less acetone is widely used as solvent, fuel, denaturant for industrial alcohol and in many chemical industries. Formaldehyde is produced by oxidation of methyl alcohol vapour with air in the presence of heated copper gauze, and is in strong demand at the front for disinfecting purposes.

The acetic acid distilled from the wood is recovered in the form of gray acetate of lime, and before the war America exported over half of the production to Europe for the benefit of foreign chemical industries. The main peace uses are for the production of acetic acid by distilling with sulphuric acid and in turn the manufacture of white lead, iron and aluminum acetates used as mordants in dyeing, and a variety of other acetates. Methyl acetate solvent is made from acetic acid and methyl alcohol. Acetic anhydride is another derivative of acetic acid and its production in Canada has been developed since the outbreak of war for the manufacture of aspirin in Montreal and elsewhere. It is also used for the manufacture of cellulose acetate which is becoming of more and more importance. The war has brought about a very radical change in the disposal of acetate of lime on account of the tremendous demand for acetone as a solvent for gun cotton in the manufacture of cordite, which is the most important British propellant explosive. Canada has played a large part in the furnishing of

this solvent not only by hardwood distillation but also by developing new chemical processes on a commercial basis. By decomposing acetate of lime in suitable retorts acetone is the main product and the higher ketones and ketone oils are refined for use as solvents in the artificial leather industry and elsewhere.

Hardwood charcoal is the other valuable product and is mainly used as household fuel and for manufacture of charcoal iron. The wood gas is of rather low heating value and is burned under the retorts. The hardwood tar is also used as fuel at the plant in most cases as the constituents have not the inherent value of the more widely-known coal tar; however, the recovery of certain by-products has important possibilities. The various creosote oils which are obtained in the course of separating the wood alcohol and acetic acid from the tar are at present of minor value, but recent investigations by the Forest Products Laboratories of Canada indicate that they are suitable for the flotation of Cobalt and other Canadian ores. So-called beechwood creosote is a standard article in the drug trade and is made by chemical treatment of hardwood creosote oils.

Destructive distillation of resinous woods is a much different proposition and aims mainly at the recovery of turpentine, pine oil and pine tar oil together with softwood charcoal. The industry has had a more or less checkered career in the Southern States where the very resinous "lightwood" of the longleaf pine is available. The wood is destructively distilled in retorts designed somewhat differently from hardwood retorts in order to give better temperature control. The uses of turpentine are well known and pine oil is valuable in the drug trade and for flotation of ores. The crude tarry fraction is large in quantity, and as "pine tar oil" commands a fairly good price for impregnating ropes, staining shingles, etc. The yields of methyl alcohol and acetate of lime are much smaller than in the case of hardwoods and by present methods recovery has not been found profitable. Experiments have indicated that the resinous stumps of western yellow pine in British Columbia compare very favorably with southern pine in yields of distillation products, and the old red pine stumps of Ontario contain a good deal of rosin and some turpentine. When the industry becomes more highly developed it will no doubt be established at certain points in Canada.

Wood waste of various kinds can be used in place of coal for the generation of producer gas, and this method of utilization is practised in Europe and to some extent in the United States. The increased efficiency of the producer and gas engine over the boiler and steam engine is a well-known advantage in the handling of

fuels. In Canada wood waste occurs in such large quantities and is so easily used as fuel directly under steam boilers that there is not so much occasion for installing the more complicated large-scale gas producers. In line with the manufacture of producer gas it is important to mention the destructive distillation of wood waste modified to yield the maximum amount of wood gas. A number of centres in America are now using wood gas for heating and illuminating purposes and as motor fuel.

The steam and solvent process applies to resinous longleaf pine in the Southern States. The selected wood waste is hogged or chipped, steamed to drive off most of the turpentine and pine oil and then extracted with gasoline or other volatile solvent for the recovery of rosin. The extracted wood is used in the manufacture of composition flooring blocks and is also suitable for manufacture of pulp. The resinous wood material in Canada is limited in quantity and not very high in quality, so that economic recovery of products is a more difficult problem.

By steam distillation of the leaves and twigs of certain trees which contain essential oils, products are obtained for the drug trade. Most of the cedar oil is produced by distilling the waste cedar wood in pencil manufacture, and this particular species (Juniperus virginia) does not grow commercially in Canada. Ordinary eastern cedar provides a small amount of cedar-leaf oil, and spruce oil is of some importance. A number of the essential oils which are well known in the drug trade are supplied from European tree species. Birch oil is mainly oil of wintergreen, which is now made synthetically.

Minor Industries.

There are a variety of other processes for recovering products from trees, only a few of which are of importance in Canada at present.

Of products which are taken directly from the living trees maple sap holds quite a large place. The maple sugar industry in Canada furnishes products worth over two million dollars per year, over half of which comes from the province of Quebec. Calcium bi-malate has been recovered from the "sugar sand" in boiling down the syrup, and is considered by the MacDonald College authorities to be superior to cream of tartar or other acid materials used in baking powder. Malic acid can also be produced from the malate of lime and is a high-priced chemical. Canada balsam and spruce gum are well-known products which are obtained from balsam fir and spruce respectively. Some of the fruits, nuts and

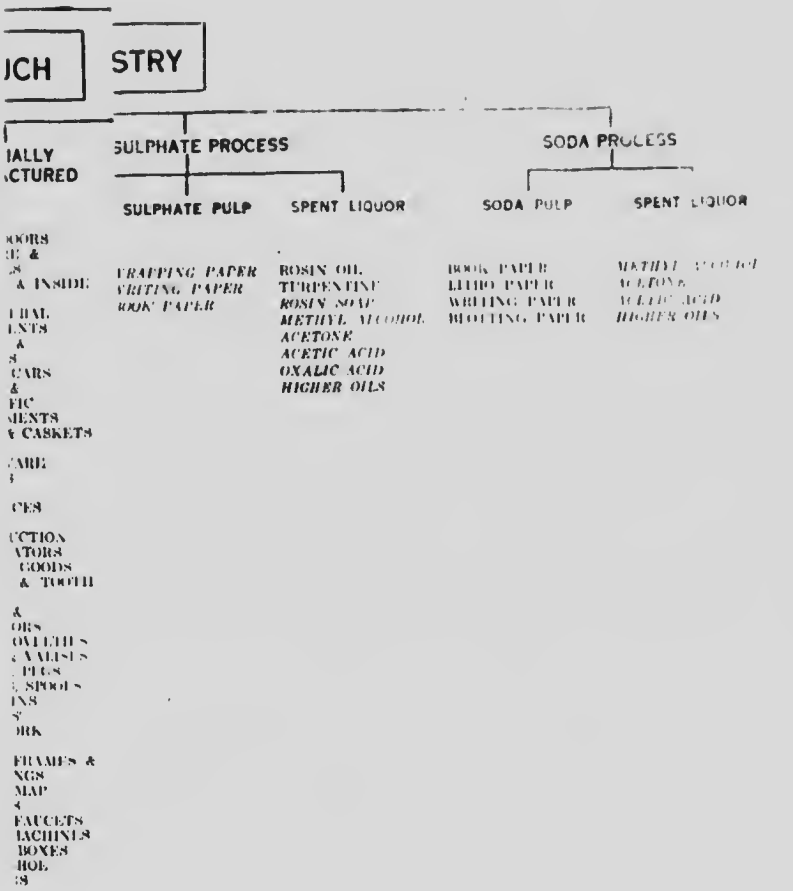
flowers come from forest trees, although it is not intended to include the whole fruit industry, for example, under this head. The naval stores industry of the Southern States provides the bulk of the turpentine and rosin used throughout the world and involves the "chipping" of longleaf pine trees. Experiments are now being carried out on western yellow pine in British Columbia with some prospect of commercial success.

Solvents are used in various ways to extract valuable products from certain kinds of wood material. In Canada hemlock bark is used directly in the tanneries, and at one plant in New Brunswick for the manufacture of concentrated tannin extract. Oak bark and chestnut wood are of minor importance owing to the limited range of these species in the southern sections of Canada. The recovery of potash from wood ashes was at one time the main source of potash in Canada, but for many years the cheap potash salts from Germany have overshadowed all other sources. Since the outbreak of war there has been some revival of potash recovery in Canada owing to the great advance in prices. Hardwood ashes are the richer for treating, but in any case wood ashes should reach the land as fertilizer. The extraction of resinous woods with volatile solvents and the separation of the turpentine and pine oil from the rosin by distillation is not a promising industry for Canada on account of the limited supply of sufficiently resinous woods as already explained. This also holds true of extraction with weak alkali solutions whereby turpentine and pine oil are distilled with the steam, the rosin recovered from the solution in the form of soap by "salting out" with more alkali and the extracted wood cooked with the strengthened alkali to produce paper pulp. Dye woods are of but little importance in Canada. The extract of black oak is used partly as a tanning material and partly as a dye, while walnut and butternut extracts give a brown colouring material and the flowers of sumac a red dye which is at least used locally throughout the country. The laboratory of the United States Forest Service has made an interesting discovery that western larch contains from 6 to 8 per cent. of water-soluble material which is mainly galactose sugar. Various products including table syrup, ethyl alcohol and mucic acid which may be used as a constituent of baking powder can be manufactured therefrom. It may be that a small industry can be established in western Canada.

Hydrolysis of sawdust or hogged wood-waste is carried out by dampening with a certain proportion of dilute sulphuric acid and steaming under pressure for a short time. Part of the wood substance is thereby converted into sugars, most of which can be fermented by adding yeast to the neutralized water extract with re-

covery of ethyl alcohol (grain alcohol). The yield from softwoods is about 20 U.S. gallons of 95 per cent. alcohol per ton of dry wood, and it is estimated that the cost of production can be reduced to 15-20 cents per gallon. Two plants are operating in the United States, each consuming several hundred tons of wood waste per day. Undoubtedly the industry will be established in British Columbia or at other large saw-mill centres in Canada when the economics of the process are more definitely established and when Canada joins the other civilized countries of the world who have given their chemical industries the necessary factor of tax-free industrial alcohol. Cattle food as a substitute for hay can be recovered by removing the acidity from the hydrolyzed wood mass and in some cases mixing with waste molasses.

By heating softwood sawdust at moderately high temperatures with a strong solution of caustic soda and caustic potash a large proportion of the wood is converted into sodium oxalate. The valuable product, oxalic acid, can be recovered by precipitation of the extract with lime and treatment of the calcium oxalate with sulphuric acid. One plant has been established in the United States, but it is doubtful if the industry will assume large proportions on account of cheap production of oxalic acid by other chemical methods, especially in Europe.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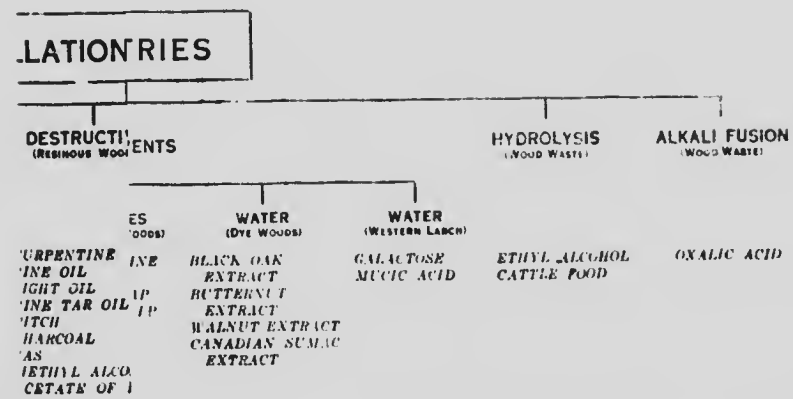
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EXTRACT
WALNUT EXTRACT
CANADIAN SUMAC
EXTRACT
GALACTOSE
MUCIC ACID
ETHYL ALCOHOL
CATTLE FOOD
OXALIC ACID

DIAGRAM OF FOREST PRODUCTS FROM CANADIAN TREE SPECIES

(Products indicated in plain type are now being manufactured in Canada; products indicated in *italic type* are those which it is possible to obtain from Canadian woods and in some cases represent industries which should be established)

TR

WOOD USED AS SUCH

ROUGH

FIREWOOD
CROSSTIES
MINE TIMBERS
POLES
PILING
FENCE RAILS

ROUGH SAWN

LUMBER
STRUCTURAL TIMBERS

ROUGH MANUFACTURED

SHINGLES
LATHS
OUTSIDE FINISH
BOXES & CRATES
BARRELS
SHIP & BOAT TIMBERS
TANKS & SILOS
VENEER
EXCELSIOR
WOOD PAVING BLOCKS
WATER PIPE
WOOD FLOUR
WOOD WOOL

SPECIALLY MANUFACTURED

SASH & DOORS
FURNITURE & FIXTURES
FLOORING & INSIDE FINISH
AGRICULTURAL IMPLEMENTS
VEHICLES & SUPPLIES
RAILWAY CARS
MUSICAL & SCIENTIFIC INSTRUMENTS
COFFINS & CASKETS
HANDLES
WOODENWARE
PATTERNS
LAUNDRY APPLIANCES
MACHINE CONSTRUCTION
REFRIGERATORS
SPORTING GOODS
MATCHES & TOOTH PICKS
PULLEYS & CONVEYORS
TOYS & NOVELTIES
TRUNKS & VALISES
DOWELS & PEGS
SHUTTLES, SPOOLS & BOBBINS
PLUMBERS' WOODWORK
BRUSHES
PICTURE FRAMES & MOULDINGS
SHADE & MAP ROLLERS
BUNGS & FAUCETS
SEWING MACHINES
TOBACCO BOXES
BOOT & SHOE FINDINGS

BY-PRODUCTS

LOGGING WASTE

TOPS
STUMPS
BRANCHES
CULL LOGS
LEAVES
TWIGS
ROOTS

SAW-MILL WASTE

SLABS
EDGINGS
TRIMMINGS
SAWDUST
BARK
CULLS

MANUFACTURING WASTE

SEASONING WASTE
SHAPING WASTE
SAWDUST
SHAVINGS
CULLS

DISTILLATION INDUSTRIES

DESTRUCTIVE (HARDWOODS)

CRUDE WOOD ALCOHOL

METHYL ACETONE
METHYL ALCOHOL
FORMALDEHYDE

ACETATE OF LIME

ACETIC ACID
ACETIC ANHYDRIDE
METHYL ACETATE

ACETONE
METHYL ETHYL KETONE
WHITE KETONE OIL
YELLOW KETONE OIL
KETONE RESIDUE

CHARCOAL
GAS
HARDWOOD TAR
CREOSOTE OILS
BEECHWOOD CREOSOTE

DESTRUCTIVE (RESINOUS WOODS)

TURPENTINE
PINE OIL
LIGHT OIL
PINE TAR OIL
PITCH
CHARCOAL
GAS
METHYL ALCOHOL
ACETATE OF LIME

PRODUCERS (WOOD WASTE)

PRODUCER GAS

STEAM & SOLVENT (RESINOUS WOODS)

TURPENTINE
PINE OIL
ROSIN
EXTRACTED WOOD

STEAM (ESSENTIAL OILS)

CEDAR OIL
SPRUCE OIL
HEMLOCK OIL
PINE NEEDLE OIL
BIRCH OIL

MAPLE
MAPLE SY
MAPLE SU
MALIC AC

TREES

PULP AND PAPER INDUSTRY

GROUNDWOOD PROCESS

GROUNDWOOD PULP

- WALL BOARD
- FIBREWARE
- PIE PLATES
- NEWSPRINT PAPER
- HANGING PAPER
- WRAPPING PAPER
- BOOK PAPER
- CONTAINER BOARD
- LINERS
- POSTERS

SULPHITE PROCESS

SULPHITE PULP

- PRINT PAPER
- WRAPPING PAPER
- WRITING PAPER
- BOOK PAPER
- BAG PAPER
- TISSUE PAPER
- PAPER TOWELLI
- WAX PAPER
- GREASEPROOF PAPER
- IMITATION PARCHMENT
- PLASTICS
- *VULCANIZED FIBRE*
- *SURGICAL COTTON*
- *VISCOSE*
- *GUN COTTON*
- *CELLULOSE ACETATE*
- *FILTER MASS*

WASTE SULPHITE LIQUOR

- *BINDERS*
- *TANNINS*
- *ETHYL ALCOHOL*
- *CATTLE FOOD*
- *FUEL*
- *DISTILLATION PRODUCTS*
- *FERTILIZER*
- *MORDANTS*

SULPHATE PROCESS

KRAFT PULP

- WRAPPING PAPER
- *PAPER TWINE*
- *ROPES*
- *BAGGING*
- *CARPETS*
- *CLOTH*
- *BELTING*
- *CONDUITS*
- *IMITATION LEATHER*

SULPHATE PULP

- *WRAPPING PAPER*
- *WRITING PAPER*
- *BOOK PAPER*

SPENT LIQUOR

- ROSIN OIL
- TURPENTINE
- *ROSIN SOAP*
- *METHYL ALCOHOL*
- *ACETONE*
- *ACETIC ACID*
- *OXALIC ACID*
- *HIGHER OILS*

SODA PROCESS

SODA PULP

- BOOK PAPER
- LITHO PAPER
- WRITING PAPER
- BLOTTING PAPER

SPENT LIQUOR

- *METHYL ALCOHOL*
- *ACETONE*
- *ACETIC ACID*
- *HIGHER OILS*

MINOR INDUSTRIES

DIRECT FROM TREES

MAPLE SAP

- MAPLE SYRUP
- MAPLE SUGAR
- *MALIC ACID*

GUMS

- CANADA BALSAM
- SPRUCE GUM

NAVAL STORES

- *TURPENTINE*
- *ROSIN*

FRUITS NUTS FLOWERS

EXTRACTION WITH SOLVENTS

WATER (BARK & WOOD)

- TANNING SOLUTIONS
- TANNIN EXTRACTS

WATER (WOOD ASHES)

- POTASH

VOLATILE SOLVENTS (RESINOUS WOODS)

- *TURPENTINE*
- *PINE OIL*
- *ROSIN*
- *EXTRACTED WOOD*

ALKALIES (RESINOUS WOODS)

- *TURPENTINE*
- *PINE OIL*
- *ROSIN SOAP*
- *PAPER PULP*

WATER (DYE WOODS)

- *BLACK OAK EXTRACT*
- *BUTTERNUT EXTRACT*
- *WALNUT EXTRACT*
- *CANADIAN SUMAC EXTRACT*

WATER (WESTERN LARCH)

- *GALACTOSE*
- *MUCIC ACID*

HYDROLYSIS (WOOD WASTE)

- *ETHYL ALCOHOL*
- *CATTLE FOOD*

ALKALI FUSION (WOOD WASTE)

- *OXALIC ACID*