THE UTILIZATION OF SAWMILL WASTE

BY

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Note: This thesis will contain most of the important uses to which sawmill waste may be put, particularly in the Pacific Northwest. It will not contain, however, every possible phase of wood utilization, for that is a story that would well make volumes. Many of the ways of utilization that are described herein are not at the present time being practiced in the northwest, but there are possibilities that such may be done.

It just isn't human nature to make the most of the things we have in abundance. The red glow in the sky at night from large burners, spells WASTE. Many far-sighted men have been advocating, preaching, and calling for help in the protection and utilization of our forests. Today we are beginning to wake up and take notice of what they are saying, for we know now that the depletion of our forests can not go on forever. Quoting the exact words of S. T. Dana, Forest Economist, he says that the pinch on our pocketbooks is at last beginning to convince even those not versed in higher mathematics that it is a physical impossibility to continue indefinitely removing from the forest three or four times the material grown. This may be borne out by the fact that we pay as much as $65 per thousand board feet for Douglas fir flooring at the point of production. We have cut, burned, and willfully destroyed our forests without providing for their replacement, and now we are near the trail's end as to the supply of virgin timber.

The United States is not the first country to face a timber shortage. Western Europe had one and pulled thru. Asia Minor and China each have had one and failed to pull thru.
Saving in the utilization of our timber was recognized as a vital part of forest conservation when we saw two roads ahead of us, one that lead the way of China and Asia Minor and the other the way of Western Europe. From the economic situation in the United States and from the amount of research and education that is being carried on, and which, from all indications, will be carried on in the future, judging from the past few years, it is by no means likely that we will fall in the group with China and Asia Minor.

It is worth pointing out that the United States is the first country where the exhaustion of timber in one section could be readily met by the cutting of forests 2,000 miles distant. Our transportation system has largely concealed the ultimate outcome of the exhaustion of old-growth timber. Because of our transportation system, we have practically pooled all of the old-growth stumpage in the United States and maintained our enormous use of forest products with no other ill effect, from the standpoint of current consumption, than constantly higher freight bills. From many standpoints this is a blessing. On the other hand, it is dangerous because it permits practically a nation-wide depletion of high quality timber before any very serious local effects, in any part of the country, may be experienced. In other words we are in danger of coming up short, almost overnight, against a depletion of virgin timber so serious as to cause disastrous public and industrial consequences.
It might be that the railroads can help us solve this wood-waste problem. Transportation ought to make it possible for local mill or woods waste to reach the plants and markets for box material, pulp, and fiber products, small dimension stock, and the like. An official of an important New England railroad recently proposed that low grades of lumber be given lower freight rates in order that the railways may get the benefit of the traffic. Newspapers can be shipped cheaper than books and other higher classes of reading material, why is it not possible to ship low-grade lumber at a cheaper rate? If this proposition is sound from the standpoint of the railroad, it is doubly sound from the standpoint of timber conservation.

It has been figured that out of a log at the mill, there is 53 per cent of mill waste, 6.7 per cent of seasoning waste, and 40.3 per cent goes into unplanned lumber. Of the mill waste, bark comprises 13 per cent, saw-kerf 13 per cent, slabs 12 per cent, and edgings and trimmings 10 per cent. These figures are just for the log, not mentioning what is left in the woods. That there is ample room for utilization, is clearly shown by these figures.

There are really no questions about what we should do in regard to wood waste. In fact there are only two things we can do. One of these is to grow more wood, and the other is to use more effectively what we have. We have, in round numbers, less than 135,000,000 acres of virgin forests that must be cut
in such a way as to maintain the productivity of the land. And there are more than 81,000,000 acres of wholly idle and 235,000,000 acres of partially idle forest lands that need to be put to work. At the same time we must see that more than a third or a fourth of the 24 billion cubic feet of wood removed from the forest each year is actually put to some beneficial use.

It is a curious fact that until a comparatively few years ago almost no thorogooding study was made of a material that is so widely used and enters into our daily life in so many different ways as does wood. Highly paid chemists and engineers were employed to investigate steel, and concrete, and oil, and rubber, and a hundred other products, but wood was apparently taken for granted. Yet wood, being more complex, more variable, and less efficiently utilized than any of these, was actually in greater need of investigation. This need has always been recognized by the Forest Service, but not until the establishment of the Forest Products Laboratory, was it possible to undertake the work in an effective way. Since then, the progress that has been made constitutes a fascinating story of achievement.

What to do with short length lumber: There is hardly an industry in America where certain items are not sold at a loss. The drygoods merchant realizes that the remnant of the bolt is just as useful for some purposes as the balance of stock is for others, and he therefore appeals to his customers thru
advertising and other means, offering these remnants at a discount. As a result the thrifty housewife absorbs this surplus quantity which is as unavoidable in the textile trade as short lengths are in the sawmill.

The leather industry, welding industry, and in fact all industries, where odd, short pieces occur, take these pieces and weld or melt them together in some way so as to make a greater value out of the product. These industries work it out in such a way that the public is induced to buy the surplus quantities of small stock.

The waste of short lengths, lengths less than eight feet, occurs because most consumers prefer long lengths or because they have difficulty in getting short lumber adapted to their particular needs. The building trade is accustomed to buying long lengths, despite the fact that fully one-third of the lumber must eventually be cut into short pieces for its intended use. The wood-fabricating industries also prefer long material, altho less than one-third of their lumber is used in lengths of eight feet or more. It might almost be said that the common demand is for long lengths to be cut into short lengths. Part of this preference for long lengths undoubtedly comes from trade custom, but some of it is due to practical difficulties and to slowness on the part of the lumber producer in catering to markets for short lengths. While it may be possible in some isolated instances to dispose of short lengths at the same price as longer lengths, it is generally found that
the consumers will insist on a reasonable discount because of
the various drawbacks which operate against the economical use
of this class of lumber. By end matching short length lumber,
these objections may be overcome in some cases, but not all
stock lends itself to this process. It will be noted that when
an order is sent in to a mill it will specify the maximum
amount of short length lumber that shall go to make up that
order. The buyers just don't seem to want short length material
no matter how badly they cut it up when they get it.

It has been found by a study made by the Forest Products
Laboratory, that 64 per cent of the retail dealers buy not
more than five per cent of their lumber in short lengths; 86
per cent buy not more than 10 per cent in short lengths; 95
per cent buy not more than 15 per cent in short lengths; 99
per cent buy not more than 20 per cent in short lengths. This
presents a problem that has no simple or easy solution; other-
wise it would have been solved long ago.

The most feasible solution, as the situation presents
itself at present, is to cut to size at the mill. This is
being practiced with increasing frequency as the requirements
for the products such as step ladders, refrigerators, caskets,
coffins, incubators, core stock, and sectional houses make
themselves felt.

It is quite evident that a user of short lengths cannot
afford to buy shorts of random length. It can readily be seen
that if a manufacturer has use for material in lengths of 3\frac{1}{2}
feet and is required to buy mixed four and six foot lengths and cut them back, his waste is excessive. A frequent objection to short lengths is the handling costs. This however can be removed by bundling the stock.

It seems that special efforts on the part of lumber producers toward educating the trade in the possibilities of short-length utilization would be well worth while. An example of the obstacles to be removed is the common and insistent preference of customers for 16-foot lengths, almost without regard to the purpose for which they are intended. With large industrial concerns lumber is often one of the less important purchases and one with which the purchasing agent is not thoroughly familiar. He frequently fails to specify his requirements to the best advantage, and he may or may not be receptive to inquiries and suggestions. There are always those who will gladly fill his orders without question, and the dealer who must compete will often withhold valuable suggestions rather than risk a sale.

The following figures will give some idea of the amount of short length material used annually in the United States. The figures are taken from U. S. D. A. Cir. 393, 1926.

Millwork (shop lumber)----------1,000,000,000 bd. ft.
Woodenware manufacture--------100,000,000 " "
Crating automobiles and trucks---60,000,000 " "
Piano boxes---------------------25,000,000 " "
Shade and map rollers----------68,000,000 " "

SCHOOL OF FORESTRY
OREGON STATE COLLEGE
CORVALLIS, OREGON
Boxes and crates------------------3,800,000,000 bd. ft.
Billboard panels and signs-------- 30,000,000 "  "
Beehive manufacture---------------- 15,000,000 "  "
Motor car manufacture--------------- 37,000,000 "  "
Tanks, vats, and silos------------- 195,000,000 "  "
Coffins and caskets---------------- 185,000,000 "  "

It would not be a hard matter to fill several pages showing the possibilities in using short length lumber. The above totals 5,545,500,000 board feet annually. This goes to show what short length lumber, that is lumber cut into short lengths in the finished product, amounts to when once it is figured up. It might be interesting to know that the non-wood industries use 330,000,000 board feet yearly. The bulk of this is used for boxing, crating, blocking, and skids. It affords a good outlet for short lengths to say the least.

When our timber like Port Orford cedar (Chamaecyparis lawsoniana) sells for $100 per thousand in the log, we will most likely start to use short length lumber more. In the case of Port Orford cedar, it often happens that nearly half of the lumber in the yard is of short length. In these cedar mills, all the rotted and short pieces of boards are sent to a remanufacturing plant within the mill, where the pieces are ripped and trimmed from six inches to eight feet long and from one inch in diameter to all odd and even widths and thicknesses. All this short material is bundled for shipment. The time cannot be so far off when we will be treating our more common
species in a like manner.

Lath: Lath affords a most excellent method of using mill waste--slabs. To be sure metal lath is on the market, but wood lath has its good points that are not easily displaced by a substitute. In the year 1922 there were 2,940,714,000 lath cut, valued at approximately $4.50 per thousand or a total of $13,233,213.00.

Trimmings: Trimmings are necessary, but they need not be a waste. Most trimmings can be used up as fuel and this is generally done, especially where the mills are close to fuel users. The trimmings of kiln dried material are of special value as kindling wood and bring a good price, particularly in the eastern states.

The possibilities of trimmings are in the manufacture of pulp, rayon, cellophane, firtex, and cellulose products, a few of the cellulose products herein mentioned. Of course the time is not economically ripe for the utilization to a close degree, but little by little it is bound to come about. It is starting in a few places now. Excelsior, for example, may be made from trimmings of some species. Square edged as small as 1"x1\frac{1}{2}"x6" may be used.

Edgings: There is not a great deal of waste here, but what there is may be worked up in the same manner as trimmings and also hog fuel.

Bark: The bark of most of our important lumber species has little commercial value other than for fuel. Some of the bark is suitable for use in tanning. The principal bark for
this purpose in the Northwest is found on the western hemlock and tan bark oak trees. In the East chestnut oak bark and eastern hemlock bark are both used for tanning. It has been estimated that the annual production is well over one million cords. Some of this is used direct in tanning and the balance is first made into extract and used in that form. Practically all of the bark used for tanning purposes is peeled in the woods, but especial attention is directed toward the possibility of mechanically peeling the saw logs at the sawmill.

The newest use for barks of various sorts is in the manufacture of certain kinds of paper, in which it takes the place of more expensive materials. Among these papers is roofing felt, used in making asphalt shingles. Some mills are now using several hundred tons of tanbark weekly in the production of roofing felts, and others are working upon its use in boxboards and similar products.

The Japanese often specify that the bark be left on the log of Port Orford cedar (Chamaecyparis lawsoniana). This stringy bark of the cedar lends itself very well to the manufacture of novelties and useful gifts, which are shipped back to the United states. Thus we help the Japanese pay for the logs they buy from us.

Bark is sometimes ground and used as a substitute for wood flour for certain purposes. The central section of Douglas fir bark, when ground, resembles ground cork, and can probably be substituted for that product for some uses.
Bark can be used as an insulating material, and is used to some extent also as a sound deadener.

Masonite: At last the time has come when we can take wood apart and put it back together again better than it was in the first place, and with the use of NO chemicals—a pure physical process.

In the spring of 1924, after many months of experiment, Mr. Mason hit upon the idea of exploding wood. It occurred to him that wood, being plastic when subject to heat and moisture and this plasticity probably being due to change in the lignins under those conditions, it might be possible to soften the lignins and blow the fiber apart with the same steam that had been used to soften the wood. So in the old shed adjoining the saw-mill of the Wausau Southern Lumber Company at Laurel, Mississippi, he built his first "gun" consisting chiefly of a piece of old shafting three inches in diameter and fifteen inches long. A hole was bored in the end of the shafting and enlarged inside in cylindrical form to a dimension twice the size of the neck thru which the boring was made. The outside of the muzzle was tapered to a ground valve joint and a valve inserted. The gun chamber was then filled with chips and water and the valve placed at the breech opening. Two gasoline torches were directed against the side of the gun until the temperature inside rose to 480 degrees, indicating a pressure of 600 pounds. A bar was then placed against the firing pin and a sharp blow with a hammer on the other end of the bar knocked the pin loose.
and allowed the valve to blow out. The experiment proved to
be a success.

The Mason Fiber Company was ready for operation in June,
1926, with three guns at the plant. Mill waste is used to load
the guns. The waste is transmitted to the hog where it is cut
into chips and screened before being fed into the guns. Saw-
dust has not proven to be a satisfactory material. About 200
pounds of green chips are charged into each gun, the valve is
closed, and for from 10 to 15 seconds the chips are steamed,
thus softening the lignins of the wood. The steam is then
turned on to a pressure of 1,000 pounds for from 3 to 5 seconds
before blowing them from the gun at a velocity of 4,000 feet
per second. The chips are exploded into fiber as they pass the
ports on their way into the wooden stock chest.

Only about one-third of the mill waste ever reaches the
guns. The steady stream of slabs, edgings and sawdust that
comes in from the mill first goes into a hog where it is cut
into chips, and afterwards screened to substantially the same
size as used in an ordinary paper mill. The remaining two-
thirds goes into the furnaces as fuel. After the chips are
shot from the guns and evolve a moss-like fiber, water is added
in the stock chest so it can be drawn out to the refiners.
These machines are somewhat similar to a Jordan engine in prin-
ciple, except the material enters at the large end and is dis-
charged from the small end.

The refined stock then passes to the press rolls. Here
the sheet of fiber forms to a thickness of about two inches. It then passes thru the rollers and is reduced to three-quarters of an inch in thickness. After this the sheet is automatically cut into twelve-foot lengths and is fed by a triple feed to racks before it is placed in a press.

Four presses are required to handle the product. Each press contains twenty-one steam heated platens. The wet sheets are drawn in between the platens on wire cloth, and the press closed. Each press is capable of exerting a pressure of 2,000 tons. In making insulation board seven-sixteenths of an inch in thickness, the time in the press is about fifty minutes. Presdwood, one-eight of an inch in thickness, requires but twenty-five minutes.

Each charge of the press produces approximately 1,000 square feet of board and when the press is discharged back into the empty rack, the boards are ready for the market except for cooling and trimming.

This process has several distinct advantages over the process of making wood pulp for paper. In the first place there is very little wood wasted, while around 50 per cent of the wood is wasted in the cooking process of paper making. In the second place it requires very little time from start to finish; one hour being about the average time from the time the mill waste leaves the mill until it is made into Presdwood (a commercial product of the Masonite process). In the pulp wood process it takes 7 to 14 hours just for cooking. In the third place the
slow laceration of fibers entailed in the mechanical grinding process is avoided, and this process is expensive both in power and machinery.

The chief Masonite product, Presdwood, possesses many unusual qualities which have won for it a wide variety of uses. Automobile doors, radio cabinets, desk tops, card tables, concrete forms, advertising signs, show cases, china closets, wallboard and paneling are just a few of its uses; in fact its uses range from doll houses to bridges and flumes. Bricks have been pressed from the fiber and heavy lumber has been produced. The product, according to Mr. Mason, has a tensile strength of from 4,000 to 5,000 pounds per square inch, equal to many woods with grain. Since this product has no grain, its tensile strength is equal in all directions, whereas in ordinary wood the strength across the grain is much less than with the grain. Being a wood product, the board is subject in a limited degree to moisture. However, its resistance is such that the small absorption that does take place does not affect its hardness appreciably.

One of the big things for which Masonite Presdwood may be used and is used, is a base on which to plaster. It is used instead of lath and has important advantages over lath. It acts as an insulator and as a sound deadener. The lath does not compare in this respect. In order to show the adhesiveness between plaster and Presdwood, note the following test made by Robert W. Hunt Co., Engineers, for the Mason Fibre Company. For these tests pieces six inches square were used, a one-half inch
thickness of Wood Fibre Plaster being applied to both faces. After drying out for one week, wood blocks were bonded to the plaster surface. The specimens were pulled apart with the following results:

<table>
<thead>
<tr>
<th>Test Number</th>
<th>Dimensions of Bonded Surface</th>
<th>Area of Bonded Surface</th>
<th>Load Per Square Foot of Bonded Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6&quot; x 6&quot;</td>
<td>36&quot;</td>
<td>1,000#</td>
</tr>
<tr>
<td>2</td>
<td>6&quot; x 6&quot;</td>
<td>36&quot;</td>
<td>1,120#</td>
</tr>
<tr>
<td>3</td>
<td>6&quot; x 6&quot;</td>
<td>36&quot;</td>
<td>1,080#</td>
</tr>
</tbody>
</table>

On the above three tests the failure occurred thru the insulation material, no failure taking place between the plaster and the insulation.

Masonite Presdwood is actually a better product than Nature's own material; better in four ways. It is grainless, has greater moisture resistance, is much denser, and is far tougher. Yet it contains no foreign substance, not even a chemical binder. It is genuine wood--and nothing else--wood torn apart and put together again.

Advantages of Masonite Presdwood: Masonite Presdwood won't crack, check, split or splinter. It is highly resistive to wear and moisture, and shows minimum contraction and expansion. It can be used on any woodworking machinery; planer, sander, shaper; and because it contains no grit or foreign substance it does not damage tools. It may be sawed like an ordinary board. It comes in convenient size--four feet wide by twelve feet long. Also smaller sizes. Requires no paint for protection, yet takes
any finish; lacquer, paint, stain or varnish.

Thus, the advent of exploded wood may have a far-reaching effect upon forest utilization and the practice of forestry throughout the country. The manufacture of Masonite need not be confined to sawmill waste; tree tops and slashings unsuited for lumber present an abundance of ammunition for the guns. Slightly decayed and deformed trees, or trees under logging dimensions can be utilized in the exploded wood process.

Another thing that may be expected of the process is a possible reduction of the forest rotation. Trees from twenty-five to thirty years old are choice cannon fodder in the Mason process. Thus, the value of cutover land, if immediately restocked, is increased materially.

Synthetic lumber is an achievement worthy of more than a passing thought. It may have a great economic influence on the lumber industry. Further, it may open the door to a new and more rapid method of utilizing waste in the making of paper.

The price of Masonite varies as to the kind and amount purchased. Seven-sixteenth inch, size 4 x 8-9-10-12 feet sells for $50 per thousand from one to 3000 square feet. In carload lots, $40 per thousand. One-eighth inch Preswood, size 4 x 8-9-10-12 feet sells for $75 per thousand from one to 3000 square feet. A correspondingly lower price is given on any kind of Masonite purchased, depending on the amount purchased.

**Balsam-Wool:** Balsam-wool is made from living balsam, spruce and pine trees, the woods of which even when in a thoroughly
dry condition, weigh over 20 pounds per cubic foot or more than five times that of the finished balsam-wool made from them. This great reduction in weight is brought about by cementing the individual fibers together after they have first been picked apart from the natural wood, so that in their rearranged condition they extend in all three cubical dimensions, rather than in only two dimensions as occurs in forming a sheet of paper. In fact, the first steps in the manufacture of balsam-wool are not unlike those practiced in paper making.

The sawmill waste is first freed of foreign particles, (no sawdust is used) and then cut into small chips, which are run into a steel digester and cooked in the presence of an alkali, until the cementing material binding the fibers together is loosened. The partially cooked chips are then mechanically beaten so that the fibers are knocked apart and the wood becomes a mass of individual fibers floating in water. In this condition the individual fibers are then treated with a fire-proofing compound so that they will not burn if exposed to flame. They are then formed into sheets or laps and the moisture content reduced to air dryness, after which they are subjected to a very violent beating, which knocks the fibers apart in air and causes them to form a cloud of individual fibers. In this condition they are picked up by a large fan and blown thru distributing hoods against a moving screen. These distributing hoods are so designed that the fibers are deposited upon the screen in a continuous and uniformly thick blanket six feet wide. As the fibers
pass from the distributor hoods to the screen they are blown thru an atmosphere of cement in a highly atomized condition, which causes the fibers to cement themselves together when they strike the screen. The traveling screen then carries the blanket of fibers thru a dryer when the water is evaporated and the fibers dried. When the blanket emerges from the other end of the drier, the fibers are thoroly dry and cemented together in an endless blanket about six feet wide and one and one-half inches thick. At this stage, two sheets of tough kraft paper coated on the inside with a thin film of water- and moisture-proof asphalt are pressed against the blanket of wood fibers, and thoroly cemented to this blanket. This makes the blanket of increased strength, water and moisture resistant, and renders it absolutely impos-sible for any air currents to pass thru it. The final step in the manufacture of balsam-wool consists in trimming and slitt-ting the blanket into such widths and lengths as are desired, after which the blanket is rolled up into bundles of fifty pounds each and is ready for shipment.

Balsam-wool has many good qualities and uses. It is an efficient heat insulator, for the "wool" form retards the circ-ulation of air in the air cavities. It is a good sound deadener. It is water-proof. The water-proof film of asphalt with which the paper coverings are lined protects the wool from moisture and thus assures its high insulating efficiency thruout the life of the building. The asphalt coating also keeps dampness out of the building. It is fire-resistant. In the manufacturing
process the wood is chemically treated to make it fire-resistant. It will char while exposed to flame but it will not smolder or burn after the flame is removed. It is vermine proof and sanitary, for it contains no animal matter and will not attract or harbor rats, mice or vermin.

It is interesting to note that one-half inch of Balsam-wool is equal to $1\frac{1}{2}$ inches white pine, 95 layers of building paper, 8 inches of brick, 17 inches of stucco, or 17 inches of plaster for insulating purposes--keeping cold out and warmth in.

**Rayon:** The actual invention of artificial silk is somewhat obscure, credit being given to an internationally known chemist named Reaumur, and to DeChardonnet, who secured the first patent in 1884.

Observation of the fact that the silkworm feeds on cellulose in mulberry and oak leaves led to the rayon industry of today, as the basis of all rayon fiber is cellulose. In attempting to compete with the silkworm, and to duplicate its process, experiments were concentrated on the same ingredient that the silkworm uses, cellulose.

The result, rayon, is like silk in some respects, but has many differing characteristics, due mostly to the fact that the silkworm produces an animal fiber, whereas the cellulose fiber is purely a vegetable product.

There are four processes now in use to greater or less degree in the production of rayon, namely: Nitro-Cellulose, Cupro-Ammonium, Cellulose Acetate, and Viscose. These differ basically
in the solvents and methods used in converting cellulose to liquid form for transforming it into threads or filaments.

The first named process, Nitro-Cellulose, invented in 1884, never proved to be a success because the filament was inflammable and explosive. The Cupro-Ammonium process, invented in 1900 by Bronnert, has fallen into disuse until now only five per cent of the world's output of rayon is made in this way. The Cellulose Acetate method has been used more extensively for other purposes than for making threads, and produces less than one per cent of the rayon now used.

The Viscose process, altho the newest method known, is now the most extensively used and has overcome many of the difficulties of the former processes.

The first Viscose patent was taken out by Cross & Bevan in 1892, and 1902 an inventor named Topham perfected an apparatus for forming textile fiber from a solution of cellulose, twisting it, and at the same time coiling it into a cylindrical package. This was a radical change from any of the methods then in use, and proved so superior that it is now used almost universally.

In the manufacture of rayon there are seven distinct steps between the preparation of the cellulose and the final packing of the finished yarn. These seven major steps are as follows:

1. Making and purifying cotton or wood pulp for cellulose base.

2. Mercerizing, consisting of caustic soda treatment, forming alkali cellulose.
3. Treatment of alkali cellulose with carbon bisulphide, forming cellulose xanthate.
4. Mixing of cellulose xanthate with caustic soda liquid to form cellulose solution.
5. Spinning cellulose solution into threads.
6. Reeling threads into skeins and finishing.
7. Preparation of skeins for textile mills.

Spruce sulphite wood pulp and pulp manufactured from cotton are used very largely, and the method of procedure is the same with either. The sawmill waste of hemlock, white fir, and spruce present raw material for the manufacture of rayon.

The whole general procedure in preparing the cellulose sheets is similar to that used in pulp and paper making, but the chemical formulas used for the manufacture of rayon produce a much purer form of cellulose.

In mercerizing the pulp, the large sheets are cut to twelve-inch squares and soaked in a solution of caustic soda for about twenty-two hours. The excess liquor is then forced out by hydraulic presses, and the sheets are torn into small particles by revolving knives and kept in especially constructed containers, at an even temperature, for about forty-eight hours.

This product, now called alkali cellulose, is placed in a revolving churn with a measured amount of carbon bisulphide, and the mixture is slowly revolved for two to three hours, forming the cellulose xanthate. This is a plastic substance, light orange in color, and can readily be dissolved in water.
The cellulose xanthate, with a weak solution of caustic soda, is placed in a machine with rapidly revolving blades, which thoroughly beat and mix it into a uniform mass. This operation, called the mixing, is the final process in converting the cellulose to the liquid form called "Viscose."

The word "Viscose" was derived from the word "viscous," meaning adhesive and glutinous, and is a correct designation of the Viscose Solution, which closely resembles molasses in color and consistency.

The solution, after mixing, is in an immature state and before it can be spun into threads, it must be aged by standing in large vats or tanks at an even temperature. Before leaving the ageing cellars for the spinning room, it must be very carefully filtered to remove all dirt or foreign matter.

The secret of forming the filaments of thread is that the Viscose Solution is strongly alkali and hardens upon coming in contact with acid, thus reverting the cellulose to a solid form by neutralizing the alkali.

The mechanical part of the operation, simply stated, consists of forcing the Viscose thru a plate containing fourteen or more holes, which is immersed in an acid bath. The Viscose, on leaving the plate, is immediately hardened or reverted by the acid and drawn away from the plate before it has time to merge or run together again.

The holes in the plate or cap thru which the liquid is forced are from two to five one-thousandths of an inch in diameter and, in fact, are invisible to the naked eye unless held
before a strong light.

The Viscose is conveyed in pipes from the ageing cellar to the spinning room, first being fed to a pump which forces an exact amount per minute thru a filter; then thru the cap and into the reverting bath where the filaments are hardened. The filaments are taken as they come thru the cap into the bath, twisted together, and wound upon the revolving spool. If, for instance, it is desired to spin a thread having ten thousand yards to a pound, the pump would have to force ten pounds of Viscose Solution, containing one pound of cellulose, thru the cap in a hundred minutes.

Rayon has become an important factor in our present day life. It is better than silk in that it will not turn yellow. Rayon stands up even better than silk. A test was made with women's underwear made from silk and rayon. The test showed that the rayon still intact after the silk garment had started to go to pieces. Of course rayon by itself is not as strong as when combined with cotton, silk, or wool.

Rayon does not have the same water-resisting qualities as silk, wool and cotton, and if it is subjected to any undue strains while wet, the threads are in danger of being torn apart. Water at any degree of temperature from ice-cold to boiling hot has no permanent deteriorating effect on rayon, so that when it is again dry, rayon regains its full original strength, but must be carefully handled while wet.

The most commonly recognized form of rayon is the knitted
fabric used in sweaters, scarfs, women's underwear, hosiery, etc.

The comparative world's production of cotton, wool, silk, and rayon for the year 1923 is as follows:

- **Cotton** --- 9,000,000,000 pounds
- **Wool** --- 2,600,000,000 "
- **Rayon** --- 97,000,000 "
- **Silk** --- 87,000,000 "

The United States produced 35,400,000 pounds of the 97,000,000 in 1923.

The manufacture of rayon is a costly and intricate process. It cannot be manufactured at a profit in small quantities, so that the initial undertaking must be on a large scale. It never was and probably never will be possible to start with the value of a shoestring and wind up with a fortune.

**Cellophane:** Cellophane, like rayon, is manufactured from pure cellulose, by the Viscose process, and here too we have an outlet for wood waste. To secure the cellulose in the soluble state, known as viscosé, it is first necessary to treat the wood pulp with caustic soda, shred it, and then treat with carbon bisulphide. The reaction ensuing produces a chemical combination of the sodium cellulose and carbon bisulphide, known as sodium cellulose xanthate which is mixed with a weak solution of caustic soda, placed in a machine with rapidly revolving knives and thoroughly mixed into a uniform mass. This operation converts the cellulose to the liquid form, viscosé.

Cellophane is produced in continuous sheets, as a result of
exuding the viscose thru narrow, flat openings into an acid coagulating bath. After passing thru many refining baths it eventually goes on a dryer similar to those of a paper machine, and is wound up in rolls.

Cellophane is manufactured in six thicknesses, from approximately .00083 inches to .0068.

Cellophane is supplied in sheet form, standard stock size, approximately 36 x 40 inches and 34 x 40 inches. It may be had cut to any desired size within these limits.

The following are just a few of the uses of Cellophane as a package or article wrap: cards of novelty jewelry, stationery, toys, hypodermic needles, books, fish lines, fine glassware, disinfectants, tennis balls, candy boxes, cakes, fruits, bakery goods, and as a sanitary wrap for surgical instruments.
Sausage Casings: It may seem strange, but when we eat the casings of sausage, we are many times eating wood for a large part of our casings are made of cellulose, the same thing of which rayon, cellophane, and paper are made. Last year many thousand dollars worth of such casings were shipped abroad.

Pulp and Paper: The process of paper-making is an industry that we cannot overlook when it comes to using up sawmill waste. The largest sawmills are beginning to run a pulp mill in conjunction with the sawmill. Other sawmills prepare their waste in the form of chips which are shipped to the paper mills.

There are four commercial processes of making paper pulp. They are known as the groundwood, the sulphite, the sulphate, and the soda processes. Each is especially adapted to the manufacture of certain grades of paper or to the pulping of certain woods.

In general, news, cheap magazine, and cheap catalog papers are made mostly of groundwood. The stronger and better grade papers, in all the producing regions, are made by the three chemical processes—sulphite, sulphate, or soda.

In brief, the manufacture of paper is as follows: In the case of the chemical process, the wood is chipped up, put in a digester and there cooked with chemicals and steam under pressure for 7 to 14 hours. After this it is thoroly washed, screened, mixed in a beater where fillers and coloring matter are added, and finally run thru the press and drying rolls, coming out as paper. This is very brief indeed, but the idea is to show in a
way that the pulp and paper industry is a means of using up sawmill waste. Just to cite a few examples; there is a sawmill at Dalles, Oregon which makes chips of its white fir mill waste and ships this would-be waste to the Salem paper mill. The Long Bell people of Washington are running a pulp mill in conjunction with their sawmill. In the South, there are several pulp mills operating on southern yellow pine mill waste.

Sawdust and Shavings

Shavings and sawdust are marketed in larger quantities and for a greater variety of uses than is generally supposed. Dealers in the Chicago district alone dispose of upwards of 12,000 cars, or approximately 360,000 tons annually. While the volume of sawdust and shavings consumed in the industries is in the aggregate large, it represents but a fraction of the amount of such materials available at sawmilling operations and wood-working plants. The existence of shavings and sawdust in great abundance does not mean that there is always suitable material available for users of such stock. On the contrary shortages of sawdust and shaving are quite common during the periods of greatest use of those commodities. Portland, Oregon has had this experience.

Sawdust and shavings users demand much greater refinement of stock than in former years. Specialization in the use of these items is rapidly reaching the point where the average run of sawmill and factory stock has little commercial value. Shavings of one species, such as white pine, soft yellow pine,
spruce, and other light-colored softwoods have a very ready sale. Maple sawdust is in good demand. For some uses sawdust or shavings must have no species in mixture that leach and dis-color products with which they come in contact.

Considerable sawdust is graded for size to meet the requirements of many industries. A large part of the dry hardwood sawdust sold is either sifted or marketed in various approximate size grades direct from the factory. Softwood sawdust is seldom sifted. Grading of sawdust at the point of origin is commonly only very roughly done, and the product is designated chiefly by type of machine at which it is made as resaw dust, sander dust, etc. The latter is often improperly called wood flour.

Grades of sifted sawdust are designated by size as 8 mesh, 20 mesh, 40 mesh and so forth. The most common uses for sifted stock are in fur dying and cleaning, plating work, as a filler for composition flooring, plaster, stucco, tile, concrete, and a variety of moulded products. Some packers require sifted sawdust for meat smoking use.

The outlets for sawdust and shavings are increasing in number but the volume of material required to supply these new demands as yet scarcely compensates for losses due to changing conditions in industry. For example, the use of sawdust for ice house use is falling off sharply due to electric refrigeration. Milk deliveries in cities are being made more and more by electric and gas driven trucks in place of horse drawn ve-
vehicles, thereby curtailing the use of shavings for stable bedding purposes. On the whole, however, growth of the sawdust and shavings industry is about normal.

**Fuel:** Most of the sawdust and shavings produced is used for fuel, and practically all of it is consumed at the points of production. The use for fuel will continue to be the chief outlet for such stock until it commands a price for industrial and other purposes sufficiently high to enable factories and mills to use other forms of fuel or electric power for plant operation.

Dry sawdust and shavings can be burned quite readily with no radical changes in the fuel chamber. Green sawdust and shavings, however, require for best results considerable modification of the combustion chamber and proper mixture of the material with larger forms of wood waste. About 50 per cent of hogged fuel mixed with green sawdust or shavings prevents fuel from packing and provides proper draft for good combustion.

The actual fuel value of a given weight of bone dry wood or bark is nearly constant regardless of the nature of the material or species of wood, and is usually assumed to be about 8000 British thermal units per pound. Average coal has a fuel value of about 13,000 British thermal units per pound. The bulk of sawdust consumed as fuel, however, is green and its fuel value is thereby greatly reduced.

Mr. F. M. Simonton of the Monks Burner Sales Corporation, Portland, offers the following comments on the subject of sawdust
burners: "The sawdust and hog fuel burner is here to stay. There are now more than 4000 burners in Portland and 3000 in Seattle with the number increasing steadily each month. More than 275 units, 200 cubic feet each, of sawdust and hog fuel are burned daily in Portland during the winter months. At an average delivered price of $4.50 a unit, the people of Portland are spending more than $1200 a day for sawdust and hog fuel during winter months. These figures represent only a small percentage of the total figures for sawdust and hog fuel consumed in the Pacific Northwest.

"A sawmill cutting 100,000 feet in eight hours normally produces 50 units of sawdust a day--and can produce with the installation of proper hog equipment, 50 more units of hog fuel. Determined largely by fuel prices in the larger cities, less freight and handling charges, the mill nets from 75 cents to $1.25 a unit for its sawdust. There are several instances of sawmills contracting for their entire sawdust output to fuel companies at a price that will return them $25,000 a year for a product that in some cases costs them that much to dispose of in their burners.

"The use of sawdust and hog fuel is spreading rapidly from residential heating purposes to include industrial plants and it is entirely probable that sawdust and hog fuel will soon become the greatest selling heat unit in Oregon and Washington. An exceptional opportunity awaits the sawmills which will cooperate with the sawdust burner manufacturer and fuel dealer in furnish-
ing and delivering fuel for residential and industrial sawdust and hog fuel burners.

"Few people realize the heat value of sawdust and hog fuel. A unit of this fuel, at an average delivered cost of $4.50, is equal to a ton of coal at $8 to $14 a ton."

The following will show the amount of shavings which is often produced in a mill. Kiln-dried longleaf finish, in the rough, has an average weight of 3400 pounds per thousand board feet. One-inch stock surfaced on one or two sides to 13/16 inch weighs 2600 pounds, which shows a reduction in weight of 800 pounds or 23.5 per cent. Assuming the average cubic volume of 1000 board feet of one-inch stock to be 83 1/3 cubic feet, the amount of shavings produced is 19.59 cubic feet, which weighs 800 pounds. Rough 1- by 12-inch, air-dried common boards weigh 3500 pounds per thousand board feet, but when made into stock, S 1 S or S 2 S to 13/16 inch they weigh 2800 pounds, a reduction of 20 per cent. This indicates that the solid content converted into shavings is 16 2/3 cubic feet, and weighs 700 pounds.

Assuming one-fifth of the cut to be finishing grades and the remainder common grades, the average solid content of 1000 board feet of rough lumber converted into shavings would be 17.45 cubic feet for each 1000 board feet worked. Since the space occupied by shavings is equal at least to two and one-half times that of the solid wood from which they were made, the gross volume of loose shavings per 1000 board feet would be, approximately, 44 cubic feet per thousand board feet.

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Briquettes: The use of sawdust and shavings in the manufacture of fuel briquettes has not developed to any great extent in this country. The principal factors necessary for success in fuel briquette production are: a large and constant supply of cheap raw material, low production costs, and a good market for the briquettes at a fair price. Such conditions are found only in especially favored localities. In regions where fuel is relatively high priced and climatic conditions are such that only a small amount of heat is required during the greater part of the year, the manufacture and sale of sawdust briquettes may be found profitable. The most promising fields for the waste wood briquetting industry are the Pacific Coast region, the southwestern states, and probably Florida.

A common type of wood waste briquette is about 3½ inches in diameter and of varying length up to 12 inches. Under sufficient pressure such briquettes hold together without added binders. Other briquettes of similar type have a core of wire or of rope which in a measure prevents them from falling apart.

An improved briquetting machine makes a briquette of sawdust or of any other waste wood material under a pressure sufficiently great to destroy the natural elasticity of the wood. Briquettes of this type are heavy, hard, hold together without an added binder, and do not readily break in handling.

A special type of wood briquette is made in small quantities for automobile tourist use. Such briquettes are heavily impregnated with inflammable substances to facilitate combustion. Fire
lighters comprise another form of sawdust briquette. So far as we know, no fire-lighters of sawdust are produced in this country, but reports from Europe indicate that their manufacture is quite an industry.

In the process of making briquettes, the hogged fuel and sawdust are conveyed to a retort where the moisture is removed, after which it is conditioned and then put thru a secondary grinding process. The next step is the mixing with a binder at which point further conditioning takes place. The material is pressed thru a briquette press, after which it is ready for the second retort. In the secondary retort, the lighter oils and creosote are recovered, leaving the active elements of the binder with physical structure sufficient to withstand any condition that might be encountered while they are being consumed, thereby making a sootless, smokeless fuel. The products used in the binder are furnished by the retort, which is equipped with a condenser. Gas is also produced which can be used for heating the retort; in some cases the gas might be sold commercially.

**Steamboat Use:** Sawdust is reported to be an ideal fuel for small steamboat use. The sawdust is fed to the furnace under steam pressure and perfect combustion is reported to be attained. It is said that one cord of sawdust, under the conditions used, equals in efficiency two cords of wood as a steam producer. Steamboat boilers fired with sawdust are said to maintain a constant steam pressure, varying less than two pounds in a forty-five mile run.
Stable Bedding: Sawdust and shavings find extensive use for bedding horses and cattle, particularly in cities and at large dairy farms. Probably three-fourths of all the shavings marketed are for these purposes. Softwood species are used exclusively for stable bedding. Altho the demand has fallen off in the cities, an increase in the demand for shavings by dairy-men should, however, be sufficient to offset any loss in city use.

Absorbents: One of the most widespread uses for sawdust, and to a limited extent for shavings, is for sprinkling on floors for absorbent and decorative purposes. Some of the more common places which use sawdust in this manner are meat and fish markets, hotels, abattoirs (public slaughter houses), machine shops, garages, factories and warehouses. Sawdust is also sprinkled about entryways on rainy days to keep them dry and to prevent slipping.

Composition Products:

(a) Floors: Sawdust is an important ingredient in quite a number of flooring compounds. The mineral base of most of these substances is magnesium oxychloride. Probably the most common filler is wood, chiefly in the form of sawdust. There is considerable variation in the type, kind, grade and proportion of sawdust used in making composite flooring. Chiefly, however, hardwood of rather fine mesh is used. The proportions of sawdust in the mixture may vary from four per cent to seventy per cent and more.

(b) Concrete Products: Sawdust and shavings are used
to some extent as fillers in various types of concrete and concrete-like products. Concrete of these types is light and porous, holds nails and screws well, and has fair insulating qualities. One concern uses mineralized sawdust (sawdust treated with iron compounds) in making a light weight concrete. About one-third to one-half of the weight of the material is sawdust. The product is said to be highly wear-resistant, fire-resistant, a non-conductor of sound, and more comfortable to walk on than concrete. It can be sawn, nailed, screwed and polished. Sawdust-concrete floors are sometimes laid where it is desired to attach wooden construction by means of screws and nails.

(c) **Cast Products:** The number of products made by casting mixtures containing sawdust is increasing. Burial vaults are made of sawdust concrete. Tile, fire brick, shingles, and plumbing ware have also been cast. The cast products are said to hold nails well, can be sawn, are waterproof, and fireproof up to 2600°F. Other cast articles are refrigerators and floor marble. A very beautifully mottled wall and floor tile has a high percentage of shavings in its composition. It is very successfully used for bathroom and other interior purposes.

(d) **Stuccos and Plasters:** There are several composition stuccos and plasters on the market that use sawdust as fillers. The resulting mixtures are lighter and more porous than ordinary stuccos and plasters. They can be nailed without damage, and are said to have better insulating qualities than the ordinary product. The chance for development along these
lines are not very promising.

(e) Gypsum Compositions: Sawdust is used in the manufacture of a number of commodities of gypsum. Sawdust decreases the weight of the products, makes them more porous, increases their insulating qualities, softens the material so that it can be nailed and sawn, and lessens the cost of the finished articles. The following are typical gypsum products in the manufacture of which some sawdust may be used: interior partitions, floor insulation, wall insulation, wall boards, cast products of a variety of kinds and roofing material.

(f) Clay Products: In the manufacture of porous clay bricks and tile, it is necessary to mix with the clay a substance which will be consumed during the burning and leave the finished product filled with fine cavities or pores. For this purpose either sawdust or finely chopped straw is used. Hollow clay tile for partitions is made light and porous by adding 25 to 35 per cent sawdust. In the burning process the sawdust burns out, and the resulting product is soft and porous. The use of sawdust in the manufacture of clay and gypsum products is probably decreasing, because of the rather general use of "bubbling" compounds for purpose of expanding the mass to lighten its weight and increase the porosity.

(g) Moulded Articles: Sawdust and shavings ground to the proper fineness are used in making doll heads, radio horns, display novelties, insulators, jewelry cases, thermometer backs, tiles, furniture ornaments, and so forth. For radio horns fi-
brous sawdust of PortOrford cedar is particularly desirable. The wood particles are mixed with a suitable binder, placed in moulds of the desired froms and subjected to heavy pressure. The binders commonly used are ox blood, starch, glue, flour, and aluminum sulphate.

**Wood Flour**: The name wood flour is applied to a number of different kinds of finely divided wood. Commercial wood flour is produced by specially made mills of which there are several types. Wood flour is made chiefly from white pine shavings and sawdust. The present requirements of industries using the bulk of wood flour production are for light colored, light weight, non-resinous, fluffy, and highly absorptive stock. Upwards of 15,000 tons of shavings and sawdust are converted into wood flour annually. The linoleum and dynamite industries use over 75 per cent of the total volume of wood flour consumed. Phonograph records are made of about 60 per cent wood flour.

**Plating Industry**: The plating industry uses considerable sawdust for drying and polishing their products, after removal from the plating solution. For this purpose a coars sifted sawdust, Plater's stock, of about eight mesh is used. Metals which have been cleaned in a pickling bath are also dried and polished by tumbling in sawdust; greasy pieces made on automatic machines, washed jewelery, etc., can be cleaned, dried, and polished by agitation in a tumbling barrel or otherwise. Heavy machinery is often cleaned of greases and oil by the use of sawdust. For these uses dry sawdust is, of course, essential. The kind or
types of sawdust are not so important, except that the material shall be highly absorptive. Aluminum ware is cleaned and polished by contact with sawdust after passing thru a solvent solution. Sawdust is used to some extent for polishing wire nails.

**Packing:** This is one of the most common uses for sawdust and shavings. Practically any clean and dry stock is suitable for packing use. Not only fragile articles, but many kinds of canned goods are packed and shipped in sawdust and shavings. The insulating properties of the material are of value in cold climates, preventing the freezing of liquids during transit, and the absorbing properties are of value when shipping liquids like ink, which might do a good deal of damage if the containers were to break. In the packing of miscellaneous lots of canned goods, sawdust is very convenient, since all the irregular interstices are filled up and the cans prevented from bumping each other. Also sawdust absorbs moisture and prevents cans from rusting in transit or storage. Shavings are quite extensively used for packing in between and around blocks of building stone in transit.

**Shipment of Grapes and Other Fruits:** The shipment of grapes from California is now regularly made in sifted sawdust, and experiments with the shipment of other fruits have been very successful. For this use, however, only coarse dust is employed, since the finer grades tend to pack and make the removal and cleaning of the fruit too difficult. About 4,000 tons of sawdust are consumed annually by the grape packers.

**Leather Working:** A considerable quantity of sawdust is
used at tanneries in operations where it is necessary to moisten the hides for stretching. Moistening by means of wet sawdust is very satisfactory since the moisture is evenly distributed over the surface and the stretching is done with a minimum of loss from tearing. Considerable amounts of sawdust are also used as absorbents in and about tanneries, and in smaller amounts for other purposes.

**Heat Insulation:** Dry sawdust is a good insulator. Experiments show that when filled in between studding it is the equal of any of the common commercial insulating materials. It is quite extensively used in ice house construction, for refrigerator cars, storage houses, etc. It may also be used in dwellings of the cheaper types in regions where sawdust is plentiful.

**Floor Sweeping Compounds:** The manufacture of floor sweeping compounds is a well established industry, and there are a number of companies regularly engaged in it. In most of these compounds, sawdust, sand, and oil are used in varying proportions, depending upon the particular use to which the compound is to be put. If it is to be used upon highly polished floors, the sand may be left out entirely, since it is liable to scratch the surface. It is probable that the most common sweeping compound is the homemade variety, which consists of ordinary damp sawdust.

**Nursery Practice:** Sawdust and shavings are used in many operations in the production of nursery stock and live plants.
The most common uses are for packing about baled trees and shrubs, and about the roots of baled trees, for heeling in use, and in packing small stock and live plants. For the latter use a long stringy sawdust is very desirable.

Protection of Fresh Concrete: Reports from dealers in sawdust indicate that the use of sawdust for this purpose is becoming popular. The sawdust is spread in a layer three or four inches deep over the fresh concrete, and thoroughly wet down. It thus forms a protection and at the same time provides some of the moisture which is needed for the proper setting of the cement.

Wall Paper: Sawdust is added to the finish in the production of oatmeal wall papers and produces the distinctive surface of this kind of paper. In velvet or raised wall papers, sifted and colored sawdust is sprinkled over the properly sized surface of the paper to produce the desired effect.

Lettering and Decorating: Decorative lettering of all kinds is produced in a manner similar to that employed in the manufacture of raised wall papers. The designs are worked out in glue size and then sprinkled with colored sawdust. Floral emblems, plaques, and cards are the most common articles decorated.

Railroad Signal Rockets: These rockets are composed of greases and sawdust pressed into a tube.

Stuffing Pincushions and Dolls: There are still many toys of various kinds made with sawdust stuffing.

Fireworks: Sawdust and wood flour are used in various kinds of fireworks which are intended to burn for a time, rather than
to explode. The sawdust is mixed with the color-producing and inflammable matter, in a manner similar to that employed in making signal rockets.

Circus Rings: The circus ring that does not use sawdust would be a novelty.

Football Fields: Where sawdust is close to the fields it is often used.

Moth Repellent: Port Orford cedar and some other cedars furnish sawdust for this purpose.

Coloring Clay Pipes: Clay pipes are colored black by packing in sawdust and heating to red heat in a muffle.

Roofing Paper: Small quantities of sawdust are reported as being used in the manufacture of roofing paper.

Fire Extinguisher: Sawdust is effective as an extinguisher of oil, gas, and lacquer fires. The sawdust remains on the surface of the liquid and smothers the fire. It is probably more effective if mixed with soda. For this purpose sawdust will probably always be of minor importance only.

Food from Wood: Willstaetter, in 1913, found that thru the action of hyperconcentrated hydrochloric acid, transformation into soluble carbohydrates, and eventually into glucose, could be brot about. With these laboratory results as a basis, a technical process has been evolved thru which 100 parts of dry wood of any kind can be made to yield 75 per cent of a crude foodstuff containing 80 per cent of pur carbohydrates. This product proved to be of high nutritive value and equal to any
other foodstuff of starchy consistency, and is particularly adapted for hog raising.

**Ethyl Alcohol:** The manufacture of ethyl alcohol from sawdust and other mill waste was carried out upon a commercial scale for a number of years. Sawdust and shredded waste of almost any species is suitable, and it is not necessary to remove the bark, tho it is not desirable to have a large percentage of bark present. The wood is placed into a rotary digester, and treated with dilute acid at high temperature, which converts the cellulose into fermentable sugar. These sugars are then separated out and fermented into alcohol, which is distilled and rectified in the usual manner, making a product which is the equal of grain alcohol produced by any of the other commercial processes, and superior to some. One ton of dry sawdust or other wood waste will yield from 12 to 20 gallons of 188-proof alcohol. Often times mills are in secluded spots where, due to their location, the sawdust is not worth much aside from fuel. In a case like this the sawdust would not cost over 30 or at the most 50 cents per ton, in which case a gallon of alcohol could be produced for about two cents.

No great stretch of the imagination is required to look forward to the day when ethyl alcohol derived from wood will be one of our important motor fuels. Already, as the supply of gasoline promises to become more restricted, alcohol, which is a more efficient fuel, will come to be used in small proportions as a substitute. It is estimated that from material now wasted
at the mill some 300,000,000 gallons of alcohol could be produced annually. While this falls far short of the consumption of gasoline, it could be increased many times by utilizing small, inferior second-growth trees and low-grade material now used for other purposes. It is well within the realm of the possible that the time will come when one of the specific purposes for which trees are grown will be the production of alcohol. Who knows but that some day we shall rely upon successive crops of trees to act as the medium thru which the sun's energy is converted into power for running our automobiles!

It looks as tho there are possibilities in the lumber industry yet. Much of the waste that has taken place formally had to be, because the time was not ripe to do anything much about it, but now things are beginning to ripen, and research going on, waste will be at a minimum.

The wood now left after longging operations (16% of the tree) opens up still wider possibilities in the lumber industry. Much of the tree left in the woods could be brot to the mill and made to yield a profit by close utilization of the sawmill waste.

The time cannot be far off when the mill burners will be history. Some mills have already abandoned their burners. It will be a losing porposition to make use of them. It costs from five to ten dollars per day to keep a burner going. If some of the mills discard their burners and start converting an expense into a profit, others will have to follow or lose out, for they will not be able to keep up with competition.
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