BENT TIMBER SHIPS AND UNIVERSAL WOOD BENDING MACHINERY. TWO PRIZE MEDALS AWARDED AT THE INTERNATIONAL EXIBITION, PHILADELPHIA, 1876

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Bent Timber Ships and Universal Wood Bending Machinery. Two Prize Medals Awarded at the international exibition, philadelphia, 1876 by John W. Griffiths

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JOHN W. GRIFFITHS

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Trieste

BENT TIMBER SHIPS

AND

UNIVERSAL WOOD BENDING

MACHINERY.

Two Prize Medals Awarded

AT THE

INTERNATIONAL EXHIBITION,

PHILADELPHIA,

1876.

JOHN W. GRIFFITHS, Manufacturer,

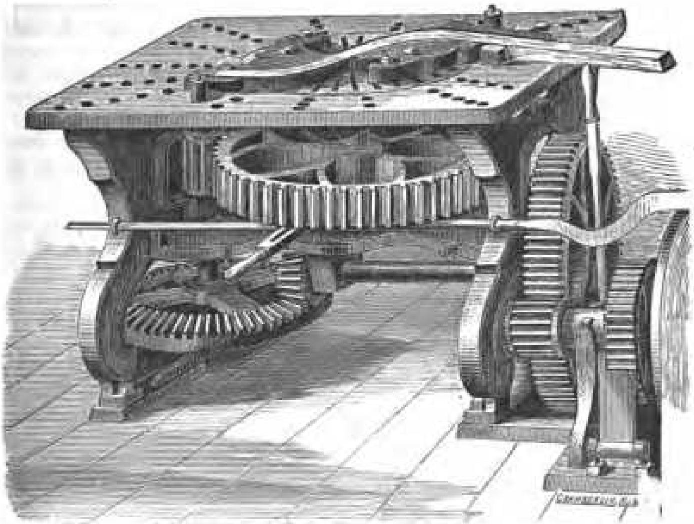
P. O. Box 5125, New York.

During the International Exhibition, Section B 10, Column B 74,
Machinery Hall, Philadelphia.

No. 8 BENDING MACHINE.

PRIZE MEDAL AWARDED

AT THE



Centennial Exhibition,

1876.

This Machine is adapted to Bending Wood for Agricultural Implements, Wheelwright Work, Building Cars, Making Funiture, Civil Architecture, Boat Building, and other trades.

BENT TIMBER SHIPS

AND

UNIVERSAL WOOD-BENDING MACHINERY.

THE STRUCTURE AND GROWTH OF TREES.

On examining a section of the stem of an oak or other timber tree, we observe the following parts: First, the pith or its remains in the centre; secondly, the bark on the outside; thirdly, a mass of wood between the two, made up of concentric layers known as the annual rings, which are intersected by a series of ray-like lines or silver grains, passing in direction from the centre to the circumference.

The medullary sheath is a layer of vascular tissue, immediately surrounding the pith. Its integrity is highly necessary to the life of the young tree.

The medullary rays are of a fibrous growth, at right angles to the pith, and are like a series of cross partitions formed at intervals from the root to the apex of the tree. These rays or grains afford the media of communication between the pith and the bark. Their growth is outward from the first layer of wood, and they constitute the woof of the tree, as the grains running from the top to the root may be said to form the warp. This interweaving of horizontal with vertical growths of fibres gives strength and beauty to the wood. In proportion as the medullary rays are strong and irregular in growth, the wood is difficult to work, and particularly to split. These rays may be considered as a series of *fastenings*, by which the outer and the inner annual rings are more firmly united across the vascular system. As the tree enlarges new rays are formed at intervals between the primaries, and grow outward in slightly divergent course, through the inner to the outer bark, from limb to root. In the oak they are very distinct, and to the fibres growing in large assemblages the floral appearance and peculiar beauty of this wood is due.

The bark forms the covering of the tree. It may be considered as composed of two structures united in one, viz: the outer part which is cellular, and the inner which is vascular or woody, and which forms a link in nature of substance between the wood and its covering. The inner part of the bark consists of several layers of small interlaced bundles of woody fibres, connected by loose cellular tissue. On its inner surface it is smooth, being opposed to the smooth wood, and is covered by a semi-fluid, called *cambium* or formative fluid. Its meshwork formation permits the medullary rays to pass through it and maintain a connection with the cellular or outer part of the bark and an electrical communication with the atmosphere. The more apparent use of the bark is to give protection to the wood, but if the bark did not clothe the tree there would be no *cambium*, and without this fluid there could not be a deposition of fibre; and thus it is that the presence of bark is essential to the growth of a tree. The bark contains a large number of air vessels, and not only conveys refuse matter from the leaves to the soil, but is also a depositary of elaborated secretions. This is seen in the oak bark yielding tannin, the cinchona bark producing quinine, and the fir tree emitting turpentine.

The wood is the most important formation of the tree. We find it constituting nearly the whole body of the trunk, and its structure arranged in a very systematic manner. The cross section of a stem shows a series of circles around the heart, increasing in diameter, and separated by wider intervals as the bark is approached. Thus the trunk is composed of numerous zones inclosed within each other. Between these zones, or annular layers of fibre, are situated the capillary tubes or vessels forming the circulating system of the tree. Next we observe the medullary rays passing in straight radiating lines across the zones from the pith to the bark. Splitting always takes place more freely in the lines of the rays and capillary circles; but the radiating fibres of the rays, passing through a stick of timber in almost every direction, nevertheless bind the zones very closely and firmly together.

Wood is formed by the instrumentality of the green leaves during the growing season, which is the one of most light and heat, and passes down in a fluid condition toward the root, between the inner bark and the wood growth of the previous year, perfectly enclosing the latter. To the leaves there is brought by the action of the roots and through the capillaries of the trunk a supply of *sap*, which is constantly evaporating into the air. This sap consists of water, with some carbonic acid, saline matters and a little ammonia. From the air surrounding the leaves abundant stores of carbonic acid are drawn into their pores to become food for vegetation. The sun's light, acting on the carbonic acid in the presence of the green matter of the leaf, decomposes it—an effect not otherwise attainable—and by this means brings into existence those compounds of carbon and water which are known as sugar, starch, gum, and which are products depended on to sustain not only vegetable, but animal life. The visible tree and the invisible atmosphere are composed almost entirely of the same substances. Elementarily, they are almost identical. From one to five per cent. of the tree, its organic or mineral portion, its ash, comes from the soil; the remainder, the main bulk of the wood, 95 to 99 pounds in a hundred of its weight, has the same constituents as the air. For proof of this we consume the wood, when all but its ash dissolves into gases, and, rising upwards, is converted into air. The coloring of the wood is influenced by the constitution and action of the bark in depositing coloring matter in the cellular tissue at the time of formation.

The roots of trees are composed of nearly the same tissues with the stem, viz., woody fibre, ducts and cellular tissue. The chief functions of the roots are, to sustain the tree, and to absorb from the soil and supply to its stem all the fluids and substances in solution which enter its circulating systems. Effete and deleterious substances are also emitted by the roots. Although the sap ascends the capillaries of the trunk from the roots, it flows still more copiously between the wood and the bark. If the bark be stripped from a tree, the circulation of the sap is greatly diminished thereby, soon ceases, and the tree will gradually perish. The growth of the tree depends in large measure upon the health and vigor of the roots. At the butt, the largest grains and the greatest growth is found on that side of the tree which has the largest root or roots, and the heart lies nearest that side of the tree which has a deficiency of root extension and vigor.

The leaf is the structural type of the entire tree, representing, as it does, in its composition every organization, growth and particle which is found in the stem, and none other. Thus, there is cellular and vascular tissue inclosed on each side by a cuticle. The surface is commonly marked by a number of ridges, which are called veins, and which consist of woody tissue, spiral vessels and cellular tissue, and they are retained in their position and the intervening spaces filled up by cellular tissue. The tissues of the veins are brought in close proximity in the *petiole* (which is a small stem supporting the blades of the leaf), and having passed through it into the stem of the tree, one part enters the bark, whilst the other traverses the wood and penetrates to the medullary sheath, at the centre of the trunk. Thus, every leaf is in direct communication with the stem, and not only so, but each leaf is a prolongation of the very spinal vessels and wood of the stem. The similarity between the leaf and the stem of the tree may be carried yet further, for not only do the same structures enter into the composition of both, but in both there is a double set of vessels, one of which conveys the fluid from the root to the leaf, and the other carries it back again from the leaf to the root. The leaf is the laboratory of life. Its power resides in the green matter, termed *chlorophyll*, which serves the important purpose, under the action of the sun's light and heat, of decomposing air and water, throwing off oxygen gas and commencing organic operations. The decomposition of carbonic acid is the starting point of life and growth. The oxygen thrown off produces a gaseous current outwards, which is compensated by the substitution of a stream of fresh carbonic acid from the air; thus the aliment of the tree is recruited. This action of the leaf will not take place in the night or in darkness, nor will it occur when the leaf acquires the orange and red tint of Autumn. When the leaf is *green* in color is its time of vigor; then it absorbs the red and allows the yellow and some blue rays of the solar light to pass through; but the green color having faded or changed with the season, or from any cause, these active rays are more or less cut off, and the functions of the leaf are altered or cease althogether. The first effort of growth in the green leaf is the formation of soluble starch or dextrine, characterized as the most important body in organic chemistry. The thickening of the sap by the dextrine serves to solicit fresh supplies of fluid from the soil; other changes and alterations in the plant food occurs, and under the influence of these causes the circulation extends, and the tree expands and grows. The chemical action of the dextrine itself is remarkable. It possesses the power of changing into starch, sugar, gum, cellulose and woody fibre, all these being primary compounds of carbon with water, nearly in the same proportions. The oils and acids, and other secondary bodies found in trees are derived from these compounds by combinations and processes peculiar to the nature of each particular kind.

The living tree holds communication with the earth and water beneath, and the air and sun above it, by means of roots, bark and leaves without, and the system of circulation within its trunk. Its healthy growth depends upon the presence and normal action of all its members. Its fluids and deposits will be imperfect if wanting in any essential ingredient, or deprived in any degree of necessary light, heat and electricity. A healthy growing tree undoubtedly produces the strongest and most durable wood of its kind, because its fibre and grain has been formed under natural influences. If a tree be denied water and the necessary mineral food to its roots, or be stripped of its leaves, or peeled of its bark, it will gradually and surely perish, as by starvation. If all these things be done to it simultaneously, it will immediately cease to live *as a plant*, and become timber. When a tree is felled, the root circulation is cut off; fluids will no more ascend the stem, as the force of ascension resides in the roots, but the bark and leaves will continue their functions until their powers are exhausted. The juices will flow into the stem for a while from the leaves of the top and branches, but this circulation soon becomes sickly and poisonous to the tree, and causes untimely decay. If, however, when a tree is felled, it is also cut off from the top, not only the upward, but the downward or vascular circulation very soon ceases. The only circulation left is that between the pith and the bark, but this will not cease until after the bark has exhausted its powers upon the fluids within its reach and sown the seeds of premature dissolution throughout the wood of the tree. The *plant life* of a tree should be completely destroyed at the time of felling it for timber, or changes injurious to the lasting qualities of the wood will take place. Imperfect formations are the most unstable and the first to decay. The felled tree should be immediately converted into timber, with every fibre and tissue of bark removed from it.

THE CONSTITUTION OF WOOD.

The matter of woody fibre consists of two constituents, *lignine* and *cellulose*. These bodies have the same proportion of carbon, but differ slightly in their combining numbers of atoms, of hydrogen and oxygen. Lignine is not identical in composition with any other substance, while cellulose is composed of the very same elements, in like proportions, though differently grouped, as starch, dextrine, and tragacanthine—substances of a glutinous or gummy nature.

The structure of the fibre is invisible to the naked eye. With the aid of the microscope it is found composed of spindle-shaped *cellules* or minute elongated cells, the one growing from the other in continuous line, and joined together laterally on all sides, with companion lines of cellules arranged in such order for strength that the extremities of the cells overlap and break butts, so to speak, in the most mechanical manner. The walls of the cellules are of *cellulose*, a substance endowed with skin-like toughness, while the interior, insoluble and fixed matter of the fibre, is *lignine*. As the bark envelopes and adheres to the wood of a tree, so does a membrane of cellulose contain and cohere to each separate atom of lignine, of which there are many in a fibre. And as the cellules with their contents build up the fibres, so do the fibres in turn, by aggregations, construct with their vascular tissues the woody layers of the tree. The annual layers of fibrous growth are like so many skins that may be split circularly from root to branch into an indefinite number of veneers, in some kinds of wood, as thin as paper, and yet every veneer will have several thicknesses of fibre arranged and conjoined to the utmost advantage for strength, solidity and structural coherence.

Fine linen fibre offers a beautiful illustration of the chemical properties of cellular lignine. It is white, tough, tasteless, insoluble in water and innutritious. Strong sulphuric acid converts it in the cold state into a tough mass, resembling a solution of dextrine, a name given to the mucilaginous fluid of vegetables. By warming the mixture, the lignine will be charred; by boiling, it will be converted into a solution of grape sugar, which may be purified, filtered and dried. Cotton fibre, on the other hand, presents us with a specimen of nearly pure cellulose, with little to distinguish its reactions from those of linen. Both bodies have the same general properties, they may both be made into paper in the same way, they both dissolve in cold sulphuric acid into dextrine, and they both may be made to yield gun-cotton.

From the simplest vegetable, consisting of a single cellule, with one side adhering to the moist wall, and the other exposed to the rays of the sun, we may learn the principle upon which vegetable and also animal bodies are constructed. The cell wall is everywhere complete. No microscope can discover any palpable apertures in it, but it nevertheless allows some elementary bodies to pass through it to the interior, or is porous. Its porosity is the same which belongs to all masses of matter, and which is due to the unseen spaces existing between the atoms. Through these unseen interstices such bodies alone pass as have a natural attraction for the bounding membrane; and such alone into the interior as have a similar relation to the fluid, solid, or gases which may occupy it.

The tallest tree and the strongest wood are alike formed and built up of infinitesimal elementary *cellules* or membranes, filled with woody matter. These cellules with their contents are grouped into fibres, the fibres are united into layers, and the layers are disposed over each other, forming *grains* or annual rings of growth. Between the grains, or layers of solid wood, a system of capillary tubes exists, through