THE KEOKUK AND HAMILTON BRIDGE.

We publish herewith a full page engraving of the road and railway bridge over the Mississippi at Keokuk, Iowa, designed by Mr. J. H. Linville, C. E., and erected by the Keystone Bridge Company, of Pittsburgh, Pa. It is a work of the highest engineering skill and most solid construction, and of great magnitude, as the following dimensions will show:

Commencing at the west or Keokuk end of the bridge, the spans are located as follows: Pivot span, total length of one truss, center to center of end posts, 376 feet 5 inches; opening under each arm of 160 feet measured on the square; 2 spans, 253 feet 6 inches; 8 spans varying in length from 148 feet $4\frac{3}{16}$ inches to 161 feet 7 inches; total length, backwall to backwall on bridge seats, 2,192 feet. It is a through bridge built on a skew of 17° 15', with a distance between the two trusses of 21 feet 6 inches. It carries a single line of railway track and two tramways for local traffic, the track being placed in the center between the tramways. On each side of the bridge, outside of the trusses, are footwalks 5 feet wide protected by light and substantial iron lattice railings.

We are indebted to *Engineering* for the engraving, which is made from photographs taken on the spot.

Correspondence.

Acoustics of Public Buildings.

To the Editor of the Scientific American:

There are few things more provoking than the inability to hear a public speaker distinctly, when that inability arises from the fact that the building has been constructed with little or no regard to good acoustic effect. We are inclined under such circumstances to blame the architect; but unfortunately the architect is often compelled to consult the wishes of those who come not to hear, but to see. In no public buildings are the simplest laws of acoustics more neglected than in our churches. This arises in a great measure from the fact that, at the present day, an effort is made in church building to imitate in architectural effect the large churches of the middle ages. The fact that these grand old structures were not erected to be filled with a single voice, but to raise a monumental pile for great ceremonials, seems to be entirely forgotten; and many of the churches of today are built with a high apsis, in which is placed the speaker's desk instead of the high altar of earlier days. The nave is lofty and, by its groined arches and hooded windows, gives ample opportunity for the sound of the speaker's voice to be echoed and re-echoed from its numerous surfaces until it falls upon the ears of the audience in indistinct and unintelligible sounds. When these great errors in church architecture have been committed, the question arises: Is there any remedy by which the acoustic properties can be improved? Plain and parabolic sounding boards have been introduced, but with very indifferent results. Drapery has been festooned about the sides and bases of the arches with no better (and with very unsightly) effect; and until quite recently, no really successful method has been devised by which the difficulty could be overcome. The Rev. Joseph P. Taylor, formerly rector of St. Paul's Church, Brunswick, Me., ascertaining that his audiences were greatly troubled to hear him distinctly, on account of excessive reverberation, gave the subject careful investigation and study, and conceived the idea of overcoming the difficulty by the introduction of screens of very fine wire beneath the ceiling, at a proper angle and at such a distance from the pulpit as would best intercept the sonorous wave, and thus prevent its striking the reflecting surface with sufficient force to cause echo. The same device was subsequently employed by Mr. Taylor in the Brown Memorial Church, Baltimore, where a very bad echo or reverberation existed; and the testimony of prominent men connected with the church is that the cure is complete. The Asylum Hill Congregational Church, of Hartford, Conn., is a fine gothic structure, built of Portland stone after the style of architecture of the middle ages. It has an apsis of 17 feet depth and 52 feet hight. The point of the arch of the nave or clerestory is 54 feet above the floor of the audience room, and is ornamented with hooded windows. The organ gallery, at the end of the church opposite the apsis, extends over the vestibule to the front of the central tower, and is some 25 feet deep. When this church was completed, its architectural effect was beautiful, but it was found impossible to understand the speaker in some parts of the audience room. A parabolic sounding board was introduced, back of the speaker's desk which was situated in the apsis. The effect of this contrivance was to benefit the hearing directly in front of it, but was of little or no service to those sitting in the side seats. Subsequently an organ was purchased and put in the apsis, nearly filling it, and the speaker's desk was placed on a platform extended some 8 feet in front. The front of the organ gallery at the opposite end of the church; was provided with a skeleton gothic window, that is, one with the frame and tracery, without any glass. (The organ gallery is unoccupied.) This was done to break the column of sound which was found to vibrate in this gallery independently of the great column of sound in the audience room. These changes improved the hearing qualities of the church, but in certain localities the old difficulty remained, and some of what would ordinarily be the best sittings in the house were very undesirable, from the great difficulty of distinctly hearing the words of the speaker. Various devices for overcoming this difficulty have been suggested, and investigation of them has been made. The one which was regarded with most favor by the society's committee was the introduction of wires to be used at points of greatest reverberation. Mr. Taylor was invited to examine the audience room of the church and decide as to the ability of his method to accomplish the end desired. The diagnosis of the case was interesting. A speaker was placed in the desk and the two or three persons composing the audience distributed themselves within the limits of greatest reverberation. The effects of the speaker's voice at different angles and at different elevation was carefully noted, and the source of the reverberatory waves traced out. This having been done, the mode of applying the remedy was decided upon. There is no undeviating rule that can be laid down, but every case must be examined and the remedy introduced in accordance with the peculiar circumstances involved. In some cases, the wires are strung across the groined arches high up in the nave. In others, they are placed across the arches leading to the transepts. In the Asylum Hill Congregational Church, it was found necessary to separate or divide the groined arches and hooded windows of the clerestory from the audience room below. The wires are of very small gage, and do not disfigure the church in the least. A stranger would not notice them unless his attention were particularly directed to them. The result of the experiment is most satisfactory, and the hearing is equally good in all parts of the house, provided that the preacher speak with sufficient strength and distinctness for an audience room so large. Mr. Taylor's patent is entirely different from the plans of some who have made use of wires to overcome acoustic defects. These have usually consisted of wires of large gage, distributed from four to eight feet apart, being very unsightly and producing but indifferent results. His plan is what he terms a "break sound." The wires are so placed as to receive the sound wave before it reaches the reflecting surfaces which cause the reverberation. The sound impinges against the wires; its force is broken, and it has no power to produce an echo or reverberation from the surfaces beyond, nor is the sound reflected back by the wires to the audience. It is simply broken, and its force is taken up by the wires which, by inaudible vibrations, convey it away. If a sounding board or sonorous reflector were placed in the same position, an unpleasant reflection of sound would be the result; and if drapery were used, the sound would be dead and muffled. Having made trials of all these devices, we can say that the wires alone accomplish the end sought, and they are adapted to all kinds of public buildings where difficulty in hearing is experienced. I have given you a full and lengthy account of our experiments because I am aware that there are many public buildings and churches in the country which are beautiful in their architecture, but have acoustic defects that sadly eclipse other attractive features, and I am also aware that the SCIENTIFIC AMERICAN is a paper to which people look for such information.

Hartford, Conn. J. M. ALLEN.

The Relative Attraction of the Earth and the Sun.

To the Editor of the Scientific American:

It appears that I have not been explicit enough in my communication on the above subject, published on page 245 of your current volume, and have used too few words in disposing of Captain Ericsson's iron ball floating in a bath of mercury: consequently he labors under the impression that I do not understand his apparatus. I understand it only too well, so well indeed as to know that even the attraction of the rising or setting moon can never affect such an arrangement, which, according to Captain Ericsson's ideas, it ought to do, if only its sensitiveness were slightly increased. In order to show this, we will take Captain Ericsson's data, given on page 164: Mass of sun$=$314,760, the earth being 1. As the mass of the moon is 0·0125 or the 80th part of that of the earth, the sun's mass surpasses that of the moon: $314{,}760 \times 80 = 25{,}180{,}800$ times; and the force of gravitation being inversely as the square of the distance, and directly as the mass, the sun's attraction is relatively equal to $25{,}180{,}800 : 400^2$, nearly 157 times that of the moon. The attractive force on Captain Ericsson's iron ball is, according to his calculation, for the sun equal to 748·6 grains, and thus for the moon $748{\cdot}6 : 157 = 4{\cdot}9$ grains. If, therefore, the arrangement were only a little improved, so that the ball were movable by a little less than 5 grains, in place of 8, the moon would affect it. But that this can never be the case, with any contrivance of this kind, however delicately it may be constructed, even if it could be moved by a single grain, is due to the fact that the circumstances are totally different in the cases, first where the ball and the bath in which it floats are both affected by changes in the direction of gravitation, and second, if the ball alone is acted upon by some mechanical contrivance. The cause of the ball being always balanced under various conditions of gravitation, as I stated on page 245, is that the attractions of the sun and moon act simply in such a way as to shift the center of terrestrial attraction towards them, according to the law of composite forces. This shifting of the center of attraction induces changes in the ocean level, and thus is the cause of the tidal waves. Therefore the rising or setting sun or moon, in shifting the earth's center of attraction eastward or westward, will not only act on the floating iron ball, but change equally the level of the mercury, and so keep the ball at rest; while, according to Captain Ericsson's ideas, it should slide over the unaffected mercurial surface, as down an inclined plane, towards the side on which the sun or moon is situated.

Surely the lunar attraction is not neutralized by centrifugal force, because the earth does not revolve around the moon, and any lunar attraction therefore must manifest itself to its full amount.

That the solar attraction is, for the greater part, neutralized by the centrifugal force of the earth in its yearly orbit, is evident from the fact that, notwithstanding that the attraction of the immense solar mass surpasses that of the moon on our earth's surface 157 times, the solar tidal wave is smaller than the lunar tidal wave; but the existence of the solar tide wave is a better argument in proof of the effects of solar attraction than can be drawn from any such experiment as the one in question.

The amount of this solar attraction, manifested in the solar tidal wave, enters, as is well known, into the calculation of the times and relative hights of the spring and neap tides; it has been laid down on geometrical principles that the change in the moon's gravity, due to the sun's action, is expressed by the formula $\frac{M}{D^3} \times y(1 - 3\cos^2.\Phi)$ in which M is the sun's mass, D its distance expressed in the earth's radii, y the distance of the particle from the center of the earth, and φ its elongation from the sun as seen from the earth's center. The same formula is applicable to the moon; and as $y\ (1 - 3\cos.^2\varphi)$ may be taken equal for both, we find, if we call the moon's mass and distance m and d, that their attractions, in regard to raising the tidal wave, are as $\frac{M}{D^3} : \frac{m}{d^3}$, showing that the power to raise the tides is in direct proportion to the mass, and inversely as the cubes of the distances. If now we give the quantities the proper values, taking, for simplicity's sake, the moon's distance as unit, we have $\frac{314{,}760}{400^3} : \frac{0{\cdot}0125}{1^3} = 2\frac{1}{2}$, showing how many times the moon's attraction surpasses that of the sun.

This calculation gives results perfectly in accordance with the observation that the mean hight of the solar tidal wave is to the lunar as 3: 7, while the whole theory of the tides (aqueous and atmospheric) proves that the solar attraction on our rotating and revolving globe is only neutralized by the centrifugal force when we consider the earth as a whole, but that this is by no means the case for the different particles in its mass, especially not for those near or upon its equatorial surface. P. H. VANDER WEYDE.

New York city.

Solar Attraction and Centrifugal Force.

To the Editor of the Scientific American:

With surprise I read the communication of Captain Ericsson (page 291, current volume), in which he concludes that Dr. Vander Weyde does not understand the principle of his apparatus for showing the neutralization of solar attraction and centrifugal force. Though Captain Ericsson, in his communication of March 14, proved to be master of the subject, he evidently overlooked one point, or else he would not have mentioned the experiment with the iron globe.

Though solar attraction does balance the orbital centrifugal force while the sun is rising, it will not do so three hours afterwards, when a pendulum will be slightly deflected towards the sun, while the floating globe will not move. True, the globe is attracted towards the sun somewhat more than it is repulsed by centrifugal force, and consequently would move towards the sun, if the mercury were not under the influence by virtue of which its surface leaves the true horizontal direction, rising slightly at the side nearest to the sun. If the mercury only were attracted, not the iron, the globe would seek the lowest level and retreat from the sun. These two tendencies upon the globe will perfectly balance each other, and in no position of the sun can any result be obtained by the experiment. To prove my assertion of the inclination of the level of liquids when the sun occupies an angular position, I refer to the solar tidal wave. The water in a straight line with the sun being higher than that at right angles, there must be an inclined level at intermediate points of the ocean.

As the experiment does not show a difference between solar attraction and centrifugal force when it actually exists, it cannot demonstrate a neutralization of those forces.

In addition to what was said on the question, it may be interesting to state that the moon, though much smaller than the sun, by her nearness causes about three times greater variations of gravity during her apparent diurnal motion, than the sun, as may be found by repeating Captain Ericsson's calculation, with reference to the moon.

Philadelphia, Pa. HUGO BILGRAM.

Drying Peat.

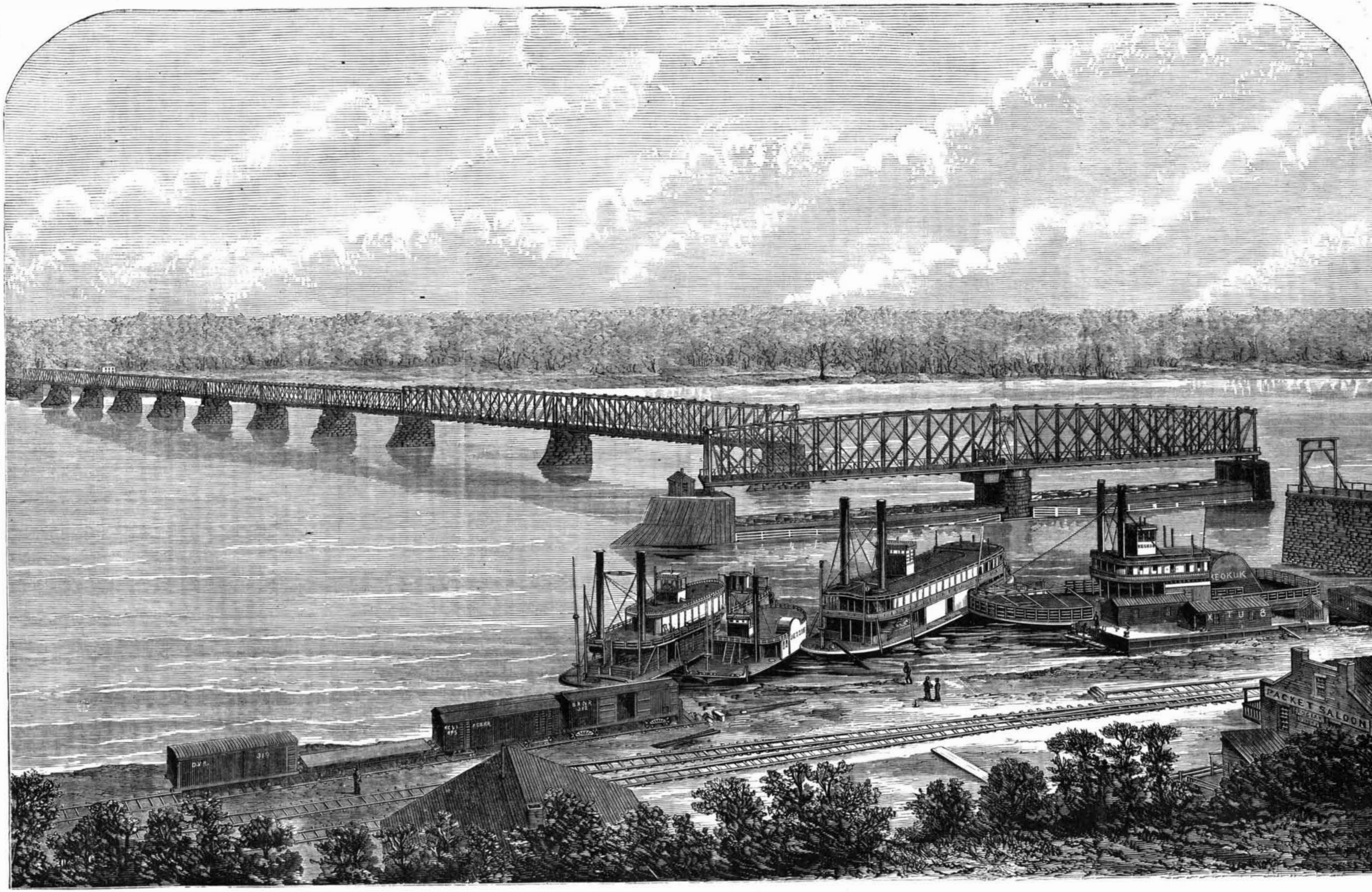
To the Editor of the Scientific American:

A kiln of condensed peat has recently been dried by evaporation in forty-eight hours, upon the principle and system for which a patent was obtained through your agency. The heat requisite was carefully noted from a thermometer in constant use during the process, and found to average only 85°. Two other appliances, embraced in my system, could not be used at this time, but, when used, will shorten the time to thirty-six or forty hours only. The important question of artificially drying peat is therefore solved, at the same time preserving economy of labor and fuel, and the system is susceptible, as to quantity, of almost indefinite extension.

Rome, N. Y. W. E. WRIGHT.

TURPENTINE.—Venice turpentine is obtained from the larch, and is said to be contained in peculiar sacs in the upper part of the stem, and to be obtained by puncturing them. It is a ropy liquid, colorless or brownish green, having a somewhat unpleasant odor and bitter taste.

Oil of turpentine is the most plentiful and useful of oils. It is obtained in this country from a species of pine very plentiful in the Carolinas, Georgia and Alabama. The tree is known as the long leaved pine (*pinus Australis*), and is found only where the original forest has not been removed.



ROAD AND RAILWAY BRIDGE OVER THE MISSISSIPPI, AT KEOKUK, IOWA.