THE MYSTERY OF MUSICAL SOUNDS. How They Are Produced and How They Are Heard.

From the New York Times.

son Medical college Dr. Henry C. Chapman talked of the voice in speech and singing and told some interesting fundamental facts, among which were those touching the creation of sound and how it is received.

Drawing a violin bow across a bell produces sound. Practically, what occurs is this: The air intervening between the sounding instrument and the ear is thrown into vibration by the pendulum motion; the tympanic membrane is thrown into vibration, and, through the medium of the little bones in the ear, this vibration is ultimately communicated to the acoustic nerve.

Take a long rod, hold it to the head. scratch the end furthest from the ear, and you hear. The rod is in vibration and communicates that vibration to the ear. Whatever the medium-air, earth-the cause of any sound is that this tympanic membrane is thrown into vibration by the instrument which causes that sound. The English word "sound" implies a cause of the sound and the hearing of that sound-both cause and effect-the effect of the sound

being our hearing.

If a particle of air hits the tympanic membrane very gently the sound is a faint one, but if that particle of air pounds the tympanic membrane a loud sound is produced, and the loudness of sound simply depends upon the force with which the tympanic membrane is

The pitch of the sound has nothing to do with its loudness, because a lowpitched sound may be delivered to the tympanic membrane very gently, and high-pitched one very forcibly.

Sound two organ pipes, one of which produces a sound an octave above the other. The air from both strikes the tympanic membrane with the same force, but there is a difference in pitch The air is issuing out of one pipe twice as rapidly as from the other. It is preclsely as if there were two pipes full of water-if it took one minute to empty the long pipe it would take one-half minute to empty the short one.

The air vibrates twice as rapidly in the short as in the long. The long pipe emits 256 puffs of air in a second, with a corresponding number of vibrations in the tympanic membrane. When the brain is shaker up at that rate it recognizes that sound, but when the short pipe sounds (which emits 512 puffs a second) the intervening air and the tympanic membrane go at the same rate, and that is pitch.

WHAT PITCH IS.

Pitch is the rate of vibration, the rate at which the tympanic membrane is bent in and out. By a certain instrument we determine the number of vibrations per second issuing from any pipe. One pipe corresponds to C of the piano (256 vibrations per second). The C below that has 128 vibrations per that 32, the C's above the middle C go 1,024, etc., on up to the highes notes.

subject. Suppose a string of the length of the E string of the bass viol. When the bow is drawn across the string the latter is drawn into vibration, and according to the force of the bow sbtroke we have the loudness or the lowness. The E of the bass viol (the lowest string used) goes 43 times in a second, and the tympanic membrane vibrates that number of times. Halve that may differ in quality; that is, the funstrong and it will double its vibrations. because there is just one-half the quantity of matter to be moved. Bridging it at one-third its length, the third will go three times as fast as the original string, when struck, four times as fast.

Bridge a string giving out a certain fundamental note, and the sound goes case the fundamental is associated with one way in halves. The ear catches the lower overtones, and, in the other the not due to the fundamental note, case associated with the higher overand also, eventually, the note due to tones. Strip the piano and violin of the half of the string is going as a their overtones, and the note issuing whole another portion is going as from the one would be the same as halves, you hear the fundamental note, from the other, supposing the sounding and you hear the octave above that- board is the same. one-half the string goes simultaneously with all the string.

A series of instruments called resonators, to be applied to the ear is of great value in the study of acoustics. One resonator is designed to catch the first octave above the fundamental strument. What kind? note; another, to catch the third octave above. Using eight resonators one E above that, the G above that, and

'Have the E string of the bass viol or sider in the first place what can it do the corresponding string in the violin or piano thrown into vibration and we hear the note due to the vibration of the string as a whole. While it is vibrating as a whole it can vibrate in s the octave above the fundamental. While the string vibrates as a whole, and at the same time in halves, it can also be vibrating in quarters, which will give the twelfth above the fundamental, or G. By applying the corresponding resonator to the ear one will hear that overtone, and by putting the successive resonators to the ear one will get even eight or nine overtones

from the fundamental note. Suppose, when the fundamental note it the half and the quarter; then the ear takes cognizance of the fundamental note, the octave above, and the octave above that; but supposing that when the fundamental note is sounded there are perceived simultaneously with it yet other notes. In the first case we have the first overtone and another overtone associated with the fundamental, and in the second case we have the fundamental associated with the third and with the fourth overtone. That is what distinguishes all musical

instruments from each other. Sounding the E of the bass viol or any note at all of a flute or of a piane. though those notes have the same loudness (that is, the tympanic membrane is struck with the same intensity), and, though the rate of vibration is the same (in the case of the middle C of the plano 256 to the second), any one appreciates the difference in the sound not because of any difference of intensity or because of any difference in pitch (because the note is the same).

What is the difference? The difference is due to the fact that the quality of the note is different; that is, if the fundamental note in the one case is accompanied with certain overtones, in another case it will be accompanied with different overtones. If | and is cut into a series of puffs. A con- | he must change the length of that fifth |

the note is the same in pitch-that is In a recent lecture before the Jeffer- if the rate or vibration is precisely the same from the various instruments and the tympanic membrane is struck with the same force-the difference cannot be one of intensity or pitch, but a difference of quality; and the difference of

quality consists in what overtones are

What kind of an instrument is it? It is a culmination of pipe with a memated with the fundamental. If brane. There are different kinds of inthe overtones associated with the fun- struments of that sort. The ordinary damental are not the same the charac- instrument which the French use in



HERMANN H. KOHLSAAT.

Comparatively a young man, he is salesman and bakery owner, and now quite the leading figure in Chicago journalism, being the owner and editor of the fact, by all odds, the most agressive, Times-Heral? and Evening Post. Mr. clear-headed and high-minded newspaper Kohlsaat has been a carrier, cash-boy.

that is what constitutes the difference | ment of this kind. between all musical instruments.

In listening to the large orchestra with its violins, violoncellos, trombones, tubas, and drums no one fails to recognize the difference in the character of the sounds produced by any one of those instruments. Though the loudness of the note may be the same, the pitch may be the same, the difference in those instruments lies in the quality-not one has the same set of over-tones accomsecond, the C below that 64, C below panying it. The difference in quality lies in the facts already illustrated strings, because each resonator is adapted to vibrate to its particular string | air is driven up. and no other.

The sound given out by an organ pipe is a composite one. One highly educated French musician could hear the overtones up to the fourth, fifth and sixth. This was because his ear was highly ed-

Sound may have a different pitch according to the rate of vibrations and damental note may be the same, but the fundamental note in one case may be accompanied by the twelfth octave, or the octave above that; while, on the other hand, the fundamental note may be accompanied by only the fifth or sixth or seventh octave, and therein the violin differs from the piano. In one

THE HUMAN VOICE.

The practical application of the foregoing to the voice lies in the fact that

The voice is greatly modified by the character of the throat and the nose, may hear the octave above the funda- showing that resonance must play a mental note; the octave above that, the part in influencing the character of the sound. In considering what kind of an instrument the larynx is one must con-

An ordinary male bass voice sings 64 little higher, and sometimes a little lower. The tenor voice begins a little larger. halves, which will give the note which higher up and exceeds the bass in range by a few notes. Some tenors can take high C. The range of the female con-

1.024 vibrations. The average feminine voice can, talk faster than the ordinary male voice.

The larnyx, if split down through the singing to be a thin, elastic edge which, thrown into vibration, causes the sound we hear. The air is forced up from the being heard, there is associated with lungs and through the windpipe; and as that air passes over that edge it throws it into vibrations. It is that little to-and-fro motion of our vocal membranes that causes the air to pass out in that way.

Air never makes any sound when there is a steady blast Breathing is one thing, and the voice s another. You can breathe without giving rise to any voice; but there is

no voice without breathing. The larnyx is constructed of elastic tissue, susceptible of stretching and few in number-while, if they are tightshortening, and is really not a vocal cord, but a vocal membrane, The larnyx is a pipe with a membrane, and a resonating cavity surrounding it.

Why is not the larnyx-comparable to a wind instrument, as an organ? An organ pipe of a given length will emit 64 vibrations a second. The lowest male voice makes a note of 64 vibrations a second. If the human larnyx is anything like an organ pipe then the larnyx of that particular specimen would have to be as long as that organ pipe. The larnyx has lungs like the bellows; it has a trachea; but the organ pipes do not produce sounds by two membranes.

When an organ pipe sounds, the reason is that the air enters the chamber

The French theory years ago was stringed instrument, and therefore they called this vocal membrane a cord.

of the larnyx, it is a membrane. In the lowest bass violin of the orchestra the E string gives about 43 vibrations in a second, and there are bass voices can sing as low as that, but if that edge in the larnyx were working like a string, the larnyx uld have to be about four feet long, (the length of the string). Therefore the larnyx cannot be a stringed instru-

vided into separate pulsations.

an organ.

ter of the note never is the same; and tuning up their pianos is an Instru-

THE HAUTBOY.

The most curious of all the wind instruments is the hautboy. Here you have the pipe with the keys and the double reed, just as in the larnyx, a membranous expansion here and a membranous expansion there. We have the fundamental note through the whole length of the pipe. If we were to drive the air up and let the air come out at the end and have the reed vi-

Of all instruments, the hautboy is nearest to the larnyx, and the resemblance is proved in a case where the eration, in the fact that when an opening was made in the windpipe and the reed of the hautboy player inserted, the persons so operated on could read the service of the Church of England.

Therefore, the larnyx is not an organ, any more than the hautboy is a windpipe. It is not a stringed instrument because it is not long enough to correspond with the E string of the base violin, and it is, therefore, a reed in strument; in other words, it is a vibrating membrane associated with the pipe,

The available part of this larnyx only extends about one-fifth of an inch in the male and one-eighth of an inch in the female. Why do we have a memtrane here, which is a little more than half an inch in length? It is not the whole of that membrane which is active. How can we get different kinds of sounds out of a pipe associated with ly and without clinkers. a membrane? In other words, if the bass voice is to emit certain notes, and the tenor to emit certain higher notes, how can that be accomplished by such an instrument as this? In two ways: lengthening the instrument or by seasons.

In the organ pipe, if you want to get octave above, you halve the pipe and if you want the octave below you lengthen the pipe. In the human being, the larnyx is, at birth, of a certain vibrations, and can sing 256 per second; | size, and, as the individual becomes an but about there it stops. He may go a adult, the larnyx ultimately arrives at a certain size and cannot get any

Fine bass voices generally have fine large larnyxes. In the great bassos of old they were broad shouldered, sixtralto includes some of the notes of foot men with very large larnyxes, both tenor and bass, The soprano sings Tenor and bass differ in size of larnyx. We can get a higher note out of a given pipe by overtones, but never can get a lower note, because the pipe cannot be made lower. A voice can sing so low middle, shows the part involved in and no lower; so high and no higher, because the length of the larnyx will not permit any greater range.

> tightening up that larnyx. How is that done? If the two mem branes of the larnyx are in a relaxed condition the note emitted will be of a low character-that is, the vibration ened, the note emitted is higher in pitch. That is just what the singer does when he ascends from the lowest notes up into the higher ones; he is continually pulling on certain muscles that tighten that membrane. Bass notes are emitted when the membrane is relaxed. When, in passing from a lower to a higher note, the listener observes something moving in the singer's throat, it is the muscles moving and tightening the parts of the larnyx If a man can have only one-fifth of

an inch to act upon, (and he can sing,

as we know, two octaves), a person

who has the compass of two octaves

action is only one-fifth of an inch.

every time he sings one of those sounds

can emit 240 different sounds. If his

ightening it.

A string of a certain length can be made an octave higher by tightening. The violinist tightens the string; and every time the string is tightened it is made higher. Lowering the tension lessens the height of the pitch. Therefore, though you cannot change the initial shape of the larnyx-either male or female-you can change the note by

tinuous draft of air makes no impres- of an inch one-two-hundred-and-for- the "braky" hadn't finished yet. He sion upon the ear, but that air as it tieth. Every good singer who can sing continued: passes up through the pipe must be ditwo octaves can tighten his vocal membrane by the twelve-hundredth of The larnyx has nothing like that. It produces the sound through the vibrathe skill with which the singer can do tion of membranes. It therefore is not

that. It was said in the last century by a great authority in music that a certain | it as the shadow of the train we had that the larnyx acted as if it was a cantatrice could not only emit 240 just brought in." sounds, but she could emit 1,200. Any one of these great singers, taking an There is no such thing as a vocal cord aria beginning with one of these low notes and running right up for over two octaves-very nearly three octaves -is sounding not only the three octaves, and sounding ten intervals between the three octaves, thus contracting her little vocal membranes by so slight a variation as the two-thousandth part of an inch. The effort is so slight you cannot see the muscles of her throat vary.

Why cannot you sing a-e-i-o without changing your larnyx from the shape of emitting "u?" When you say "u" the shape of your mouth is so adapted that it resounds to that one sound; but if you change the shape of your mouth slightly you get the first overtone, and have the vowel "o; change the shape of your mouth again, and you get the vowel "a;" again, "e;" again, "I"-in other words, the vowels are each a successive octave over and above the fundamental note.

The fundamental note of the larnyx is always the same in the pronunciation of the vowel, but changing the shapes of the mouth causes it to resound with these particular overtones. Further, when the sound, a--e-lpasses up and out through the throat and nose, then we have those sounds modified so as to give rise to the various sounds, n, l, p, etc. As they go through the nose, they are known as nasal. When the back of the throat Is cut off by the palate and the voice ascends through the nose, we get the head tones. On the other hand, with other conditions, we get the falsetto.

COAL FROM THE RIVER.

Extent of the Industry That Has Developed Near Sunbury.

From the Philadelphia Inquirer. Many thousand tons of coal have already been dug out of the bed of the Susquehanna river in the vicinity of Sunbury and Northumberland during under kiver the past five years, and still there Of the sycamores, jack oaks, swamp ash cems to be no daminution of the supply. This is at a point from fifty to sixty miles below the mines of the Luzerne region and from sixty to seventy miles distant from the Lackawanna fields. So important has the river coal mining industry become in the neighborhood of Sunbury that Ira Dissinger has several steamboats at work scooping up the dusky diamonds, and other persons living near monds, and other persons 'living near' there frequently have as high as forty barges at work at one time. The big Kinglisher gittin' up and skootin' out o' iam constructed across the river beow Sunbury has dammed in Immense quantities of this fuel that would otherwise have been washed down stream eward Harrisburg.

The steamers engaged in this work ire accompanied by big flatboats or Intoo the worter, like he don't know how sand barges, upon which the fuel is deposited as it is blosted from the river bed by a series of elevator buckets, but the flatboats or barges owned by individuals work in a more primitive manner. Two or three men man each barge and scoop the coal up with long-handled wire nets, which allow the mud and sand to escape as the operator raises the scoop to the surface of the water to deposit its contents on his barge. Then a couple of boys pick the pebbles and sticks from Corn bread and 'dock greens-and little brating between, we would have exact- tents on his barge. Then a couple of with the violin strings. The resonators by what we have in the human larnya boys pick the pebbles and sticks from enable us to single out the particular. The hautboy player drives the air among the coal, throwing them back down, whereas in the human larnyx the into the stream. Cold weather does not stop the work, but is rather favorable to it than otherwise, as the river is low and when frozen over oles are cut in the ice and the miner does not have to bother with an unwelldy boat.

The coal is found in beds contain ing from fifty to one hundred tons each, and is most frequently encountered in the eddies, where the particles find lodgment to a depth of from five to six feet. As the workman scoops up the fuel other coal fills into the depression he has created, so that he an frequently work for weeks and sometimes even months at the same bed. The coal consists of all sizes. anging from broken and egg down to suckwheat, but chestnut and pea sizes are by far the most plentiful. It is free from slate, because the latter being heavier than the coal, lines bed of the stream farther up the state. The coal is rounded like pubbles, as the result of the action of the water, and its having been relied down the bed of the river, and burns very free-

The beatmen find ready sale for it in the local market at \$3 per ton. It is estimated that at least 10,000 tons were mined in this manner during the past season, and these figures were largely You can either get the different notes exceeded during some of the preceding

BROKE THE RECORD.

the Blonde Braseman Told a Good Story When He Tried.

Rallroad club met Tuesday evening in the usual place and after a short business session the boys drifted into "shop" conversation, says the Missoula Silverite. Several stories of remarkable time made on different occasions were related and when the blonde brakeman got the floor he saw he was expected to break the record. And he did.

"Speaking of fast runs," said he why that little Montana Union line lays over everything I ever saw. No Dutch clocks or anything else to hold a man down there. I worked for that road when Bob Smith was dispatcher and when he told the boys to 'wheel 'em' we all knew what it meant. One day we were going north and were delayed in various ways until we reached Stewart. Bob wired the con, at that point that he wanted our train to get over to Garrison as quick as God would let us. We had a clear track when we started and it wasn't long before the telegraph poles looked like a picket fence. The biggest burst of speed was reserved for the homestretch-from Deer Lodge to Garrison, eleven miles. We didn't stop at Deer Lodge but as we approached that place the engineer sounded the whistle as usual—and you may take my head for a football if the 'Slow' sign in the Garrison yards wasn't passed by our train before that whistle

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"Well, we put our train away and were resting ourselves, when we an inch, and the nicety in singing is glanced up the track and saw a dark streak approaching at a lightning gait. We were astounded for an instant but as it slowed up we readily recognized

NO USE.

A Washington correspondent gives the

Post this story of a German publisher in St. Louis: "There had been a big fire directly opposite the office of his paper the night before. A magnificent building was destroyed, with all its contents. The streets in the vicinity were filled with people, who so checked the thoroughfares as to almost prevent the firemen worknig. It was the cevnt of the season, in a news sense, and the papers were naturally filled with articles telling the whole story. The publisher of the paper in question, on reaching his office the next morning, looked over the papers of his contemporaries first and then, lighting a fresh cigar, tilted back in his chair, took up his own paper to read what he felt sure would be the best report of all. To his amazement there was not a line concern-ing the fire in his paper. When he suffi-ciently realized the fact that no mention had been made of the conflagration he dashed upstairs to his city editor, and bursting into the door exclaimed: 'Why in -- didn't we have a story of the fire?" The city editor, who was a German with-out a great deal of experience in this country, looked up calmly and replied: 'Vat vas re uze of brintin' anythnig about it? Everybody in town vas dere to see de whole ting for hisself.'"

DOWN AROUND THE RIVER.

Noontime and Junetime, down around the Have to fuse with 'Lizey Ann-but lawzy!

I fergive her!
Drives me off the place, and says 'at all 'at she's a wishin'.

Land o' gracious! time'll come I'il get
conugh o' fishin'! Little Dave, a'choppin' wood, never 'pears to notice.

Don't know where she's hid his hat, cr

keerin' where his coat is. Specalatin', more'n like, he ain't a-goin' And guessin' where, say twelve o'clock, a feller'd likely find me.

Noontime and Junetime, down around the rivert Clean out o' sight o' home, and skulkin'

and eilum-Idies all so jumbled up, you kin hardly Tired, you know, but lovin' 4t, and smilin' jes' to think 'at 'Any sweter tiredness you'd fairly want to driuk it.

1 o' fishin'-tired o' fun-line out slack and slacker-

All you want in all the world's a little more tobacker!

hearin Snipes on t'other side, where the County Ditch is, Wadin' up and down the alge like they'd rolled their britches! Old turtle in the root, kindo'-sorto drap-

it happen!
Worter, shade, and all so mixed, den't
know which you'd orter
Say, th' worter in the shadder-shadder

Somehody hollerin'-way round the bend Upper Fork-where yer eye kin jes' ketch the endin'
Of the shiney wedge o' wake some mus'rat's a-makin'

Dave a-shinin Crost the rocks and mussel shells, a-Impin' and a grinnin'. With yer dinner fer ye, and a blessin

from the giver, Noontime and Junetime down around the -James Whitcomb Riley



are like owls They look don't think In diagnosing disease the don't go back to the starting point. When a man gets sick, nine dent sicknes

lected disorder. Most frequently the original and exciting trouble is a disordered digestion. If that is corrected nature will in the majority of cases do the rest. It is easy for a man to avoid sickness if he will keep a watchful eye on his digestion and resort to the right remedy the moment he feels

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JARDWARE AND PLUMBING. Gunster & Forsyth, 327 Penn. Cowles, W. C., 1907 N. Main ave. IARNESS AND SADDLERY HARDWARE.

Fritz, G. W., 410 Lackawanna, Keller & Harris, 117 Penn. HARNESS, TRUNKS, BUGGIES. E. B. Houser, 133 N. Main avenue.

Arlington, Grimes & Flannery, Spruce and Franklin. Scranton House, near depot.

HOUSE, SIGN AND FRESCO PAINTER. Wm. Hay, 112 Linden. HUMAN HATE AND HATE DRESSING. N. T. Lisk, 223 Lackawanna

LEATHER AND FINDINGS. Williams, Samuel, 221 Spruce. LIME, CEMENT SEWER PIPE. Keller, Lucher, 813 Lackawanna, MILE, CREAM, BUTTER, ETC.

Scranton Dairy Co., Penn and Linden. Stone Bros., 308 Spruce. Mrs. M. Saxe, 146 N. Main avenue.

MILLINERY AND DRESSMAKING. Mrs. Bradley, 206 Adams, opp. Court House. MILLINERY AND FURNISHING GOODS.

Brown's Bee Hive, 224 Lackawanna, MINE AND MILL SUPPLIES. Scranton Supply and Mach. Co., 131 Wyo.

MODISTE AND DRESSMAKER. Mrs. K. Walsh, 311 Spruce street, MONUMENTAL WORKS,

Great Atlantic \$3 Pants Co., 319 Lacka-wans ave. PAINTS AND SUPPLIES. Jiencke & McKee, 206 Spruce street, PAINTS AND WALL PAPER.

PAWNBROKER. Green, Joseph, 107 Lackawanna

PIANOS AND ORGANS. Stelle, J. Lawrence, 308 Spruce. PHOTOGRAPHER. H. S. Cramer, 311 Lackawanna ave, PLUMBING AND BEATING.

Howley, P. F. & M. F., 231 Wyoming ave. REAL ESTATE Horatio N. Patrick, 226 Washington. RUBBER STAMPS, STENCILS, ETC.

Scranton Rubber Stamp Co., 538 Spruce National Roofing Co., 331 Washington. SANITARY PLUMBING

W. A. Wiedebusch, 234 Washington ave. STEAMSHIP TICKETS. J. A. Baeron, 215 Lackawaana and Priceburg.

STEREO-RELIEF DECORATIONS AND S. H. Morris, 247 Wyaming ave,

TEA, COFFEE AND SPICE Grand Union Tea Co., 103 S. Main, TRUSSES, BATTERIES, RUBBER GOODS Benjamin & Benjamin, Franklin and

UNDERTAKER AND LIVERY, Raub, A. R., 425 Spruce, UPHOLSTERER AND CARPET LAYER

C. H. Hazlett, 226 Spruce street. WALL PAPER, ETC.

WATCHMAKER AND IEWELER. Rogers, A. E., 215 Lackawanna, WINES AND LIQUORS.

Walsh, Edward J., 22 Laskawanna. WIRE AND WIRE ROPE. Washburn & Moen Mfg Co., 119 Frankite