onto a second grate, which slopes in the reverse direction from the opposite wall, and also extends half way across the furnace; from this it falls onto the last grate, which reaches entirely from wall to wall. Above each grate a large number of tuyeres admit hot air to the incandescent mass of rubbish (which, from its nature, tends to become matted on the grates) and help to keep it in active combustion. Each grate consists of a set of water tubes which terminate at the lower end in a water pipe and at the upper end in a steam pipe. The several water pipes are connected together and are fed at the bottom by a small donkey pump.

The steam and gases are led to a horizontal tubular boiler which is mounted a few feet distant from the furnace. The steam which collects in the steam pipes is carried into the steam drum. The gases are conducted by a flue into the lower part of the combustion chamber. They are then drawn through the tubes and pass through a suction fan and a cyclone dust separator, finally escaping to the stack.

It was necessary in designing the furnace to provide that the gases should pass out of the smoke stack free from smoke and dust, and it was this consideration that governed the arrangement of this part of the plant. It was decided to use both the "induced" and the "down draught" system in the furnace, and, consequently, a fan, driven by a direct-connected engine, was placed midway, as shown, between the auxiliary boiler and the smoke stack. The air is drawn in at the top of the furnace and passes down through the three grates. The heat of the gases was too great to admit of using a fan at the exit from the bottom grate; but by using the second boiler the temperature was lowered to 750 degrees, and another 100 boiler horse power was realized. The furnace consumes from 1 pound to 1½ pounds of rubbish per square foot of grate surface per minute. The boilers furnish sufficient steam to run the 20 horse power fan engine, the 5 horse power engine for running the sorting table and the feed pump, and steam at 70 pounds pressure is continually being blown away through a 3½ inch steam pipe.

The cyclone dust separator consists of an inner and outer cone and a set of four spiral vanes which divide the space between the cones into four spiral passageways. As the furnace gases are blown through these they acquire a whirling motion, and the centrifugal effect drives the heavy particles of dust to the outer wall, where they pass through a narrow slot into the dust box, which, by reference to the engraving, will be noticed just below the separator. That this apparatus is remarkably efficient is proved by watching the top of the smoke stack, which is free from smoke and dust and gives no indication that the furnace is at work.

The refuse which is brought to this plant, which is located near the foot of East Eighteenth Street, is gathered in the surrounding district. It would not pay to cart it from distant parts of the city. If the plan proves financially and otherwise successful, it is intended to establish similar plants at various points to be subsequently determined upon. Our thanks are due to Commissioner Waring, of the New York Street Cleaning Department, and to Mr. L. Colwell, the designer of the furnace and boilers, for courtesies extended during the preparation of the foregoing article.

"PAPER AND REFUSE" CARTS AND BALING PRESSES.

Carbide of Silicon in the Manufacture of Steel.

The American Engineer and Car Builder, referring to the patent issued recently to Alfred E. Hunt, Benjamin Talbot, and Percival Roberts, on the use of carbide of silicon in the manufacture of steel, adds: Carbide of silicon is made by passing an electric current through a cove of sand mixed with coke. The finer and better grade is used as an abrasive, but there is produced considerable material which is not valuable for that purpose and can be sold cheaply. It has been used experimentally at Pencoyd. It is split up and gives both silicon and carbon to the molten steel. It quiets and solidifies the metal and may become useful in the manufacture of castings and other specialties when solid metal is desired. It has the advantage over ferro-silicon, with 10 to 12 per cent of silicon, because the silicon in the carbide is concentrated, the carbide containing about 70 per cent of silicon and 30 per cent of carbon.

PROF. DE MAIN WOOD AND HIS ORCHESTRAL GUITAR.

THE ORCHESTRAL GUITAR.

It is not often that the gift for music and the gift for practical mechanics exist in the same individual; but it must be admitted that the really wonderful instrument which we show in the accompanying illustrations proves that this rule, like many others, has its exceptions. Generally speaking, the attachments which are occasionally fitted to guitars, harps, and other stringed instruments are not a musical success—whatever may be their mechanical merit; but after listening to the vox humana and mandolin effects, as rendered by Prof. Wood, of Muncie, Indiana, in this office, we are free to confess that he has achieved a brilliant success in the problem which he set out to accomplish some 15 years ago.

In naming it the orchestralguitar the inventor has aptly described the difference between his instrument and the ordinary guitar. The various attachments which have so completely changed the appearance of the instrument enable the player to combine the tones of the guitar, the mandolin, and the zither and to rival the finest vox humana effects of the organ or the violin.

There are in all four special attachments, as follows: 1. A subfinger board with four additional bass strings. 2. A mouthpiece for fingering the first string of the guitar. 3. A mandolin attachment. 4. A voice attachment.

On the neck of the guitar is fastened an extra piece of rosewood, the back of which is fitted in the same way as the ordinary finger board. The extra strings are strung along the under side of this board and they are fingered by the thumb of the left hand. It is thus possible to produce a chromatic scale of the bass notes without a multiplication of strings, as in the regulation subbass guitar. The boxlike structure, E, attached to the base of the guitar is the mandolin attachment. Of all the novel parts, this is the only one that is purely mechanical, the movement of the pickers being controlled by clockwork. The powerful driving springs are placed within the body of the instrument and firmly secured to the floor as shown in Fig. 3.

The controlling mechanism is contained within the box, F, from which a small shaft extends forward over the sounding board and carries at its outer end a little wheel armed with a series of steel wire pickers, C. The wheel with its pickers is housed in the half round cover shown in the engraving. Above the cover is a little lever, B, by which the clockwork is started or stopped. When the mechanism is started the wheel and pickers, which are located just above the first guitar string, begin to rotate at a regular speed. Normally they are kept clear of the string by a spring; but when the player wishes to produce the mandolin effect, he presses the little button, C, and brings the pickers down upon the string, keeping it there as long as he wishes to use the tremolo effect. The attachment, A, is merely a handrest which is used in manipulating the above described parts. To give the pickers the desired resiliency they each contain a spring coil between the striking point and the point of attachment to the wheel. It will be seen that as the speed of the wheel is uniform, the number of strokes may be determined to a nicety by depressing the button, C, for a longer or shorter time, one stroke only being made, if desired. The result of this mechanism is an

excellent reproduction of the mandolin effect, the tremolo being very perfect.

The fingering of the first string is not done by hand, but by the mouth, or rather by an attachment worked by the mouth. This consists of an L shaped piece of rosewood, L, the longer arm of which slides upon a steel bar, K, which is rigidly attached to the guitar. The smaller arm extends across the strings and carries a wheel, I, which is thus capable of being moved up and down the finger board and pressed down upon the first string in the same way as the finger in ordinary playing. The movements of the wheel are controlled by a small brass rod which slides in a roller bearing in the bracket which carries the wheel, the rod itself being carried by a mouthpiece, as shown in the engraving. To prevent the metallic sound which would result from the first contact of the brass wheel and the string, a small damper, J, is provided, which normally hangs a little below the bottom of the wheel. When the wheel is depressed, the damper deadens the string before the wheel comes in contact with it, but rises as soon as the wheel is down in place. In raising the wheel the damper is again automatically dropped, holding the string quiet until the wheel is clear.

Undoubtedly the most successful and ingenious device is the voice attachment, by which Mr. Wood secures the sympathetic effect which is sought for in the vox humanastop of the organ. Amongthe stringed instruments the violin alone has hitherto been capable of producing this exquisite effect, and the greatest credit is due to the mechanical ingenuity of the inventor that the same result should have been obtained on a guitar. The variation in the tone is produced by varying the tension in the string, the latter result being obtained by means of the lever, F, and a small bellows situated beneath the neck of the guitar, Fig. 2. The lever is pivoted on the pin, G, on which is also a small loose sheave or pulley. Above G, and attached to the lever, is another small pulley. The string is led over the second and under the first mentioned pulley before being carried to the tuning peg. The further end of the lever is linked to a small bellows, which is blown by means of a rubber tube, H, which leads to the

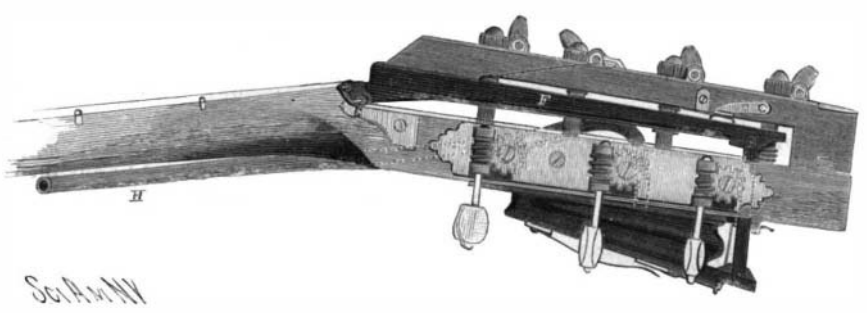

Fig. 2.—THE "VOX HUMANA" ATTACHMENT.

mouthpiece already mentioned. Now it will be seen that as the air is blown in or exhausted from the bellows the long arm of the lever will be raised or lowered. This will alternately tighten or slacken the string and produce a variation in the tone answering to the shake in the voice of a singer. By means of a flexible stop the string is brought to rest in the midposition of its length answering to the normal tone.

This most ingenious device produces results which must be heard to be fully appreciated. The throat is brought into intimate union with the guitar string, and the breath literally plays upon it as it would upon the vocal cords themselves, producing the voice effect with remarkable range and reality.

This instrument is the first and only one of its kind that has ever been made, and is unique also in the fact that there is only one person in the world who can play it.

Joseph's Canal in Egypt.

How many of the engineering works of the nineteenth century will there be in existence in the year 6000? Very few, we fear, and still less those that will continue in that far-off age to serve a useful purpose. Yet there is at least one great undertaking conceived and executed by an engineer which during the space of 4,000 years has never ceased its office, on which the life of a fertile province absolutely depends to-day. We refer, says Engineering, to the Bahr Joussuf—the canal of Joseph—built, according to tradition, by the son of Jacob, and which constitutes not the least of the many blessings he conferred on Egypt during the years of his prosperous rule.

This canal took its rise from the Nile at Asiut, and ran almost parallel with it for nearly 250 miles, creeping along under the western cliffs of the Nile Valley, with many a bend and winding, until at length it gained an eminence, as compared with the river bed, which enabled it to turn westward through a narrow pass and enter a district which was otherwise shut off from the fertihzing floods on which all vegetation in Egypt depends. The northern end stood seventeen feet above low Nile, while at the southern end it was at an equal elevation with the river. Through this cut ran a perennial stream, which watered a province named the Fayoum, endowing it with fertility and supporting a large population. In the time of the annual flood a great part of the canal was under water, and then the river's current would rush in a more direct course into the pass, carrying with it the rich silt which takes the place of manure and keeps the soil in a constant state of productiveness. All this, with the exception of the tradition that Joseph built it, can be verified today, and it is not mere supposition or rumor.

Until eight years ago it was firmly believed that the design has always been limited to an irrigation scheme, larger, no doubt, than that now in operation, as shown by the traces of abandoned canals, and by the slow aggregation of waste water which had accumulated in the Birket el Querum, but still essentially the same in character. Many accounts have been written by Greek and Roman historians, such as Herodotus, Strabo, Mutianus, and Pliny, and repeated in monkish legends, or portrayed in the maps of the middle ages, which agreed with the folk lore of the district. These tales explained that the canal dug by the ancient Israelites served to carry the surplus waters of the Nile into an extensive lake lying south of the Fayoum, and so large that it not only modified the climate, tempering the arid winds of the desert and converting them into the balmy airs which nourished the vines and the olives into a fullness and fragrance unknown in any part of the country, but also added to the food supply of the land such immense quantities of fish that the royal prerogative of the right of piscary at the great weir was valued at £250,000 annually. This lake was said to be 450 miles round and to be navigated by a fleet of vessels, and the whole circumference was the scene of industry and prosperity.

Killing Germs in Books.

Science takes the well-thumbed volume, dear to our ancestors, forgets all the pathos in it and finds instead germs. And most people would confess that sentiment comes a little dear when it carries typhoid or diphtheria along with it.

Such, at any rate, is the opinion of the authorities of the New York Public Library. When the reservoir is removed from Bryant Park, and in its place is a splendid library, there will be a free lending department, as well as the reading rooms and reference library. Every inhabitant of New York of good character will be able to borrow books free of charge, and the Public Library authorities have been for some time considering how the dangers inevitably resulting from circulating volumes in every part of the city may be avoided. Preventive measures are naturally out of the question. It would be as impossible to discover whether every volume lent would be used by persons free from diseases as to prophesy where such diseases were about to break out. The measures taken must be corrective, and the question resolved itself into an inquiry as to whether a satisfactory disinfectant could be found.

For some time Dr. John S. Billings, director of the library, has been experimenting in order to discover a perfect disinfectant. Last year Mr. Horton, under Dr. Billings' direction, conducted a series of experiments in the latter's laboratory in Philadelphia. A number of old Patent Office reports were inoculated with bacteria, and in a short time the books were full of germs of measles, scarlet fever, smallpox, and other diseases.

Trials were then made of various germ-destroying substances, and as a result of the experiments Dr. Billings says that he has a perfect disinfectant in the gas formaldehyde. The volume is placed in a glass or metal box with a saucerful of a solution of formalin in water, and left for an hour or two. At the end of that time the vapor has penetrated into every particle of the book and not a live germ can be found.

The process will be used in the circulating department of the New York Public Library, and the patrons of the institution may ease their minds of any fear that the volumes they borrow may bring the dreaded germs of diphtheria or typhoid fever into their houses.

Bibliophiles, too, will be glad to know that the formalin will destroy the Croton bug, responsible for the ruin of so many fine bindings in this country. The traditional book worm is now a rarity in America, but the Croton bug has taken its place, and the collector of Le Gascons or Groliers has in Dr. Billings' discovery a preventive of the ravages that the insect's passion for morocco and calfskin causes.

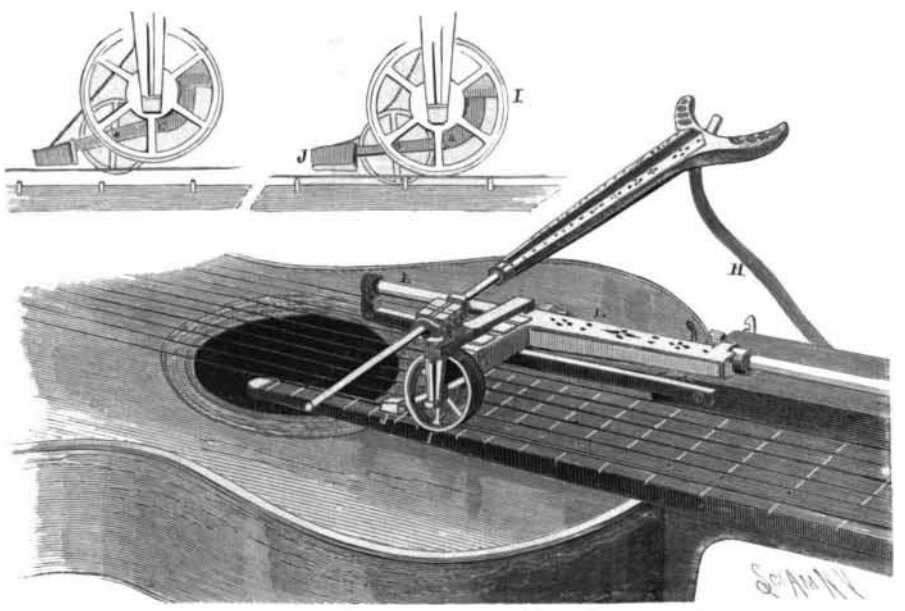

Fig. 1.—MOUTHPIECE AND FINGERING MECHANISM.

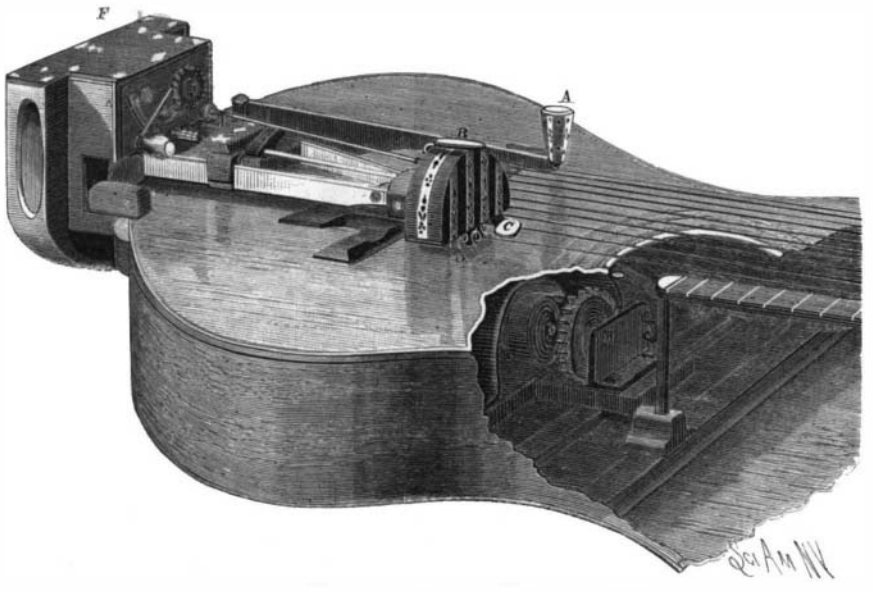

Fig. 3.—THE MANDOLIN ATTACHMENT.

King Menelik's Library.

As most people know, some of our most valuable old manuscripts, especially Bible manuscripts, have come from Abyssinia. How many more rich finds may yet come out of that region one can only surmise. It is interesting to learn from La Naturaleya, Madrid, that "at the time of the Mohammedan invasion of Ethiopia, in the sixteenth century, the Abyssinians placed all their Ethiopian manuscripts in Debra-Sina, one of the islands on Lake Zonay, and here they remained carefully guarded by the inhabitants, who looked upon the books as tutelary deities. Not long ago the negus sent an expedition to conquer these holy islands, and has built in his capital, Addis-Ababa, a library for the reception of the manuscripts thus recovered. In ancient times Ethiopia was a great center of learning, and some of these manuscripts have doubtless extreme value."

It is exactly two hundred years since the cities of France have been lighted at night, though Chief of Police La Reyaie had caused lanterns to be used regularly in Paris thirty years before. In the edict issued by King Louis XIV in 1697, ordering the innovation, he says: "Of all the arrangements made in our good town of Paris, there is none whose usefulness is clearer and more generally admitted than that of the lanterns which light the streets; and as we believe it our duty to care no less for the safety and convenience of the other towns in our kingdom, we have determined to establish the same system in them and to provide the means for continuing it forever." The system consisted in hanging a lantern with a lighted candle in it across each end of a street, and one across the middle of the longer streets.