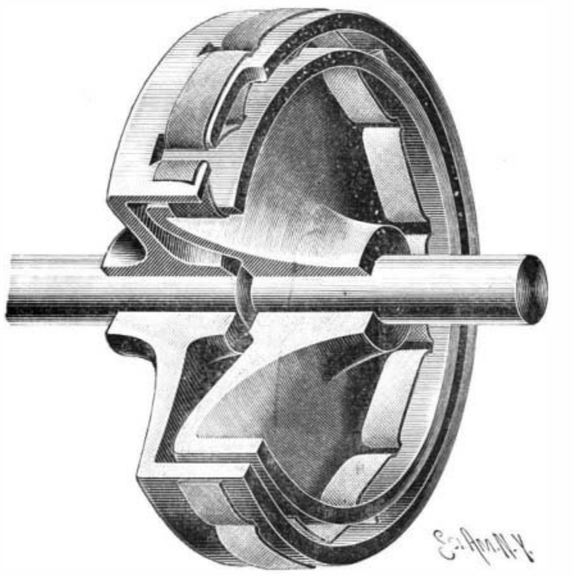
there are 19 flumes whose length aggregates 1,965 feet.

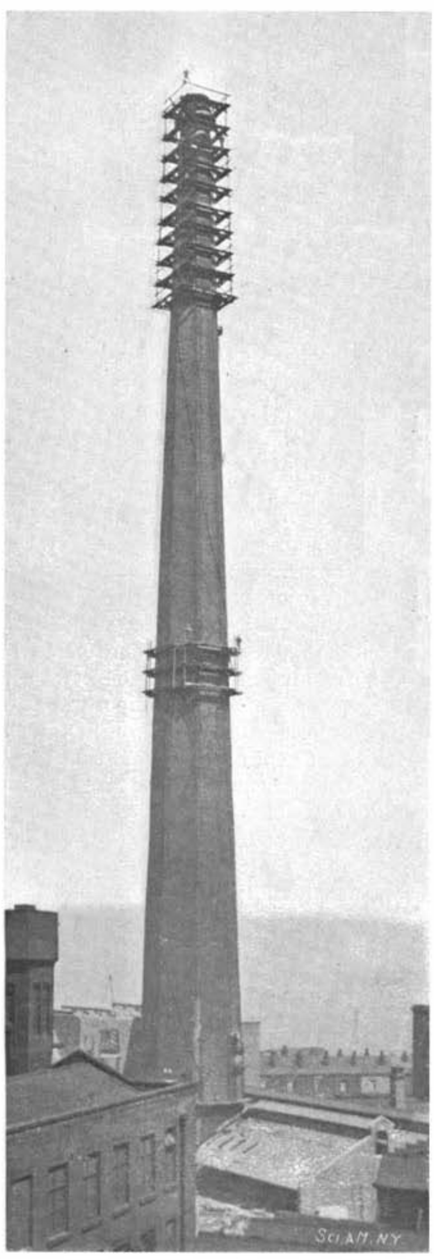
But the most striking feature of the ditch is the manner in which it is carried over the numerous gulches which scar the sides of the great extinct crater. Some of these gulches are very deep, and their sides are nearly perpendicular. To cross them pipe lines are used, not stretched across on trestles, but following the less expensive and more stable method of dropping into the gulches and allowing the water to



THE ZODEL FLEXIBLE COUPLING.

flow on the principle of the inverted siphon. Of these siphons there are twelve along the line of the ditch, all built of quarter-inch pipe, 44 inches in diameter. Their aggregate length is 4,760 feet, or nearly one mile. The largest of them crosses Maliko Gulch, a gash in the slope of the volcano which stretches nearly from the summit to the sea, and which is 350 feet deep and less than a quarter of a mile wide. Across this gorge it seemed next to impossible to carry a siphon, but Engineer E. L. Van Der Neillen, who planned the ditch and carried it successfully to completion, succeeded in doing the work. A photograph taken a week before the completion of the ditch is published with this article.

The completion of this great canal, which has been named the Lowrie Irrigating Canal, after the gentleman who conceived it and pushed it to a successful finish, marks a new era in Hawaii. By it have been demonstrated the possibilities in bringing water from distant spots in the rain belts, of which each of the islands boasts, to the comparatively dry regions which constitute a great portion of the area of many of them. The Lowrie Canal cost $250,000, but it will mean rich returns to the stockholders in the plantation which it supplies with water; and other plantations all over the group will doubtless emulate the example of the enterprising manager of Spreckelsville and put in similar irrigating canals. WADE WARREN THAYER.



SECOND TALLEST CHIMNEY IN ENGLAND—HEIGHT, 367½ FEET.

THE ZODEL FLEXIBLE COUPLING.

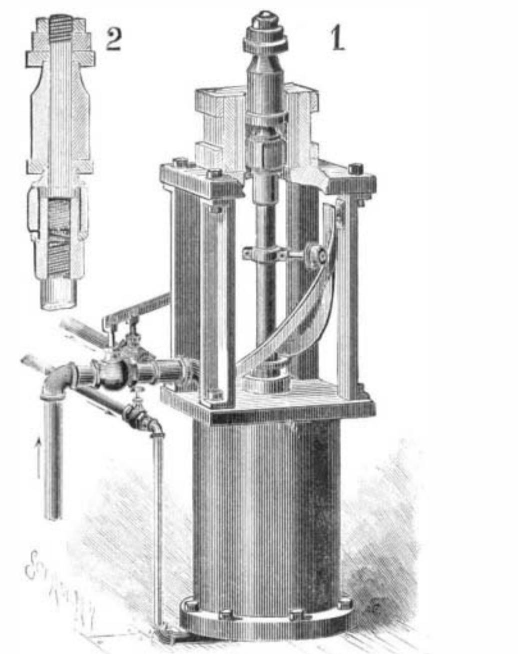
The firm of Escher, Wyss & Company, of Zurich, Switzerland, made a fine exhibit at the Paris Exposition of engines, refrigerating machinery and paper-making machines. Among the novelties which were shown by them was the Zodel flexible coupling, which is extensively used on the Continent for the direct coupling of dynamos, turbines, etc. Two disks provided with flanges are secured to the ends of the two shafts which are to be coupled. The flanges, one of them lying inside the other, are perforated by a series of slots through which is threaded a leather or a cotton belt, so that the short stretches of belt lying between the flanges have a nearly tangential position, so that they effectively transmit the tangential driving effort without waste tension in the belt. The Engineer, from which we derive our information, states that the coupling appears to work smoothly, and the belt is said to have a long life in it.

A SIMPLE METHOD OF BROACHING BRASSES AND BEARINGS.

The brasses or bearings used on car-journals are ordinarily turned on an engine-lathe—a process which requires no little time and some skill. A machine has been patented by Mr. Jason A. Baker, of 1505 Liberty Avenue, Houston, Tex., which forms these brasses and bearings at a single stroke, and which is so far automatic that the operator has merely to control certain water and air-pressure valves.

The machine comprises a cylinder containing a piston driven on the down-stroke by water-pressure, and on the up-stroke by air-pressure. The piston-rod at its upper end carries a broaching-head comprising two circular cutters separated by a collar, so that first the lower cutter and then the upper cutter passes through the brasses on the down-stroke of the piston. The brasses or bearings are therefore cut, contrary to the usual method, at a single stroke. A centering-ring is employed to hold and center the brasses while they are cut. In addition to its reciprocating movement, the broaching-head has a turning motion imparted by an arrangement consisting of an arm secured to the piston-rod, which arm carries a roller traveling on a spirally-arranged track. When the piston moves down, the roller in traveling on its track turns the broaching-head. If it be desired to reverse the movement of the piston-rod, the arm is adjusted so that the roller travels under a second track extending in a direction opposite to that of the first.

The upper end of the cylinder is connected with a water-supply pipe, and the lower end of the cylinder with a valved air-pressure pipe. An outlet pipe leads from the water-supply for the escape of the water from the cylinder, the valves of these two pipes (serving respectively to regulate the inflow and outflow of water) being controlled by a common lever. The motor employed is actuated solely by water-pressure.



A MACHINE FOR MAKING BRASSES AND BEARINGS.

THE BUILDING AND REPAIRING OF TALL CHIMNEYS.

The building and repairing of tall chimneys offer engineering problems of considerable magnitude. One of our engravings represents the repairs to the second tallest chimney in England, and our other engraving shows the novel staging used in the construction of a chimney built by the Plume & Atwood Manufacturing Company, at Thomaston, Conn. The latter chimney is 150 feet high, 15 feet in diameter at the base and 9 feet at the top. It is built of red brick with an inside flue of firebrick which reaches quite to the top. The staging was designed by Mr. J. M. Chatfield, of Thomaston, and is held in place by two bands which are made in eight sections. Each section, which is 38 inches long, is constructed of two parallel pieces of iron 38 inches long, 3 inches wide, and a quarter of an inch thick, fastened horizontally 9 inches apart, to five wooden uprights or staves 18 inches long and 1¼ inches thick which come into direct contact with the chimney. To each end of the flat iron pieces is riveted one leg of a piece of angle iron; the opposite legs, at right angles with this band, are fitted with long bolts connected with the adjoining section in like manner. The bolts are threaded throughout their entire length, 30 inches, and serve to hold the section together, and tighten or loosen the band around the chimney, allowing the space between the sections to decrease or increase as the band is moved up or down the chimney.

To each section in the upper band is bolted a wooden bracket. The upper end of the bracket is 10 feet long and extends below the lower band. Blocks prevent the uprights from moving sideways; these blocks are fastened to the band, forming a groove in which the upright slides as the band is moved up and down. The horizontal members of the brackets extend out 5 feet at right angles to the uprights and are raised a few inches above the upper band. On these eight brackets rest the planks of the staging proper. The bands are raised and lowered by means of eight screws, one in each section; each screw is 9 feet long and is fastened at the upper band by a collar held between two pieces of angle iron which are bolted to the upright of the bracket. At the lower band the screw, which is threaded 6 feet of its length, passes through a nut held between two other pieces of angle iron which are bolted to the flat iron pieces in that band. The upper band is tightened around the chimney by means of the bolts; the lower band is then loosened by the same means and the screws turn the nuts at the lower band and press against the top pieces of angle iron and raise the lower band to the desired position. That band in turn is then tightened and the upper one is loosened and the screw is reversed, causing the nuts to press against the lower pieces of angle iron, thereby raising the upper band, to which the brackets and staging are fastened, to its proper position, which is about 6 feet above the lower band. This band is then tightened, and the staging is then ready for use.

Our engraving also shows the neat device by which material is hoisted. The crane arm is bolted to one of the sections in the upper band. The workmen obtain access to the staging by means of an iron ladder which is built into the chimney as the work proceeds.

Mr. James Smith, the well-known steeplejack of Rochdale, near Manchester, England, a description of whose *modus operandi* for the felling of tall chimneys by underpinning was published in the SCIENTIFIC

A NEW STAGING FOR BUILDING CHIMNEYS.

AMERICAN a few weeks ago, recently completed the restoration of a chimney at Bolton, which is second in height to the famous Townsend stack at Glasgow, the tallest chimney in the world. This chimney was erected in 1843, but a few years elapsed before it was extended to its present height.

It is a massive substantial octagonal structure 367½ feet in height, with a circumference of 127½ feet at the base, and 34 feet at the top. About 1,000,000 bricks and 120 tons of stone were employed in its erection. The reason for the chimney being of such extreme height is due to its connection with a large chemical manufactory, since it was found necessary to dissipate the noxious chemical fumes into the atmosphere at a high altitude so as not to cause any inconvenience to the densely populated district below.

From the date of its erection the chimney had undergone no repairs whatever beyond the slight extension, which is a sufficient testimony of the substantial nature of the structure. Generally speaking, from twenty to thirty years is the average life of a chimney before it requires renovation. The hot air and gases that pass upward through the shaft, and the elements, play havoc with the masonry, and if the internal heat is very great, the stack will bulge at the weakest points, so that the work of repair has to be carried out with skill and care.

The overhauling of this chimney presented many difficulties that are not generally encountered in the repairing of chimneys. There was its great height, and also its shaky condition near the summit, to be considered. Under normal conditions, it would have been possible to have inclosed the shaft in scaffolding from top to bottom, but in this instance the erection of such an immense staging would have occupied several weeks. It was therefore decided by the steeplejack to carry out the work from the top, which, by the way, is his general method of procedure, since it is more convenient, more expeditious, and cheaper than the customary method. To accomplish this the stack was laddered from the bottom to the top, with a series of ladders each about ten feet in length, of the minimum weight consistent with the maximum strength. This part of the work is carried out with astonishing celerity. An iron dog is driven firmly into the masonry at the base of the chimney, and the lower end of the first ladder firmly lashed thereto. The steeplejack then climbs this ladder and drives another iron dog into the masonry, to which he attaches the top of the ladder; this dog also constituting the support for the lower end of the second ladder, which in turn is climbed, and the process repeated until the summit is gained. A platform was then built round the top of the chimney, from which all operations were conducted.

Upon close examination the stack proved far more decayed than it appeared to be from the ground below. From a point a little above halfway a wide crack extended to the top of the structure, while much of the masonry in the upper portion was in a crumbling condition. It also appeared that at some time the structure had been struck by lightning.

The only possible repair to the upper portion of the stack was by belting. Successive stagings were erected below the uppermost platform from which to carry out this work. At the corners of the building large heavy iron flanges were let deeply into the masonry and secured in Portland cement. These flanges were then connected by heavy iron tie-rods, by screwing up the nuts of which the brick work was drawn closely together and further opening of the cracks prevented.

When the topmost platforms were erected it was found impossible to haul up the materials from the ground to such an altitude at one lift, owing to the action of the wind on the line and its loads. Three other temporary platforms were therefore constructed nearly half way up, to which the materials were first conveyed, and thence hauled to the upper platforms.

The crack in the side of the stack was successfully repaired by the men working from seatboards suspended from the platform above. In addition to repairing all the defects in the crumbling masonry, and installing lightning conductors, the shaft was repointed from top to bottom, and subsequently two or three coats of linseed oil were applied to the whole structure as a temporary protection against the weather. The work of restoration occupied no less than eight months, and the task constituted the record contract for chimney repairing ever placed in Great Britain.

The Water Supply of Lake Nicaragua.

We are in receipt of an article by Prof. Angelo Heilprin, in which he replies to criticisms by the Hydrographer of the Nicaragua Canal Commission. As limitations of space prevent its insertion in the present issue of the SCIENTIFIC AMERICAN, it will be found in full in the current SUPPLEMENT. The subject of the Nicaragua Canal water supply is one of the most live questions in connection with that stupendous project, and Prof. Heilprin's article will be found to possess timely and very real interest.

A LARGE LATHE FOR TURNING GRANITE COLUMNS.

The new Cathedral of St. John the Divine, which is slowly rising on the site at the south of Morningside Park, bids fair to be many decades in building; and as it is one of the largest structures begun in the century just concluded, it naturally offers many engineering problems of great interest. The quarrying, turning, transportation and erection of the thirty-two granite columns of the choir presented many difficulties, as each weighs two-thirds as much as the obelisk in Central Park, usually known as "Cleopatra's Needle," and the successful solution of the questions involved may be regarded as a remarkable feat of engineering.

The choir, which is eastward of the great arch which is now such a prominent landmark in upper New York, has been built up from the footings to the height of the main floor. The eastern end of the choir is a semicircle, and on the massive foundations will rest great monolithic columns, 54 feet high and 6 feet in diameter, each weighing 160 tons. The blanks from which the columns are turned are quarried by the Bodwell Granite Company, Vinalhaven, Me. The blank shown in our engraving measured 64 feet in length and was 8 feet 6 inches in thickness one way by 7 feet the other, and weighed 310 tons. To turn an enormous mass like this required the construction of a lathe of vast proportions. It was designed and patented by E. R. Cheney and H. A. Spiller, of Boston, and was built by the Philadelphia Roll and Machine Company, of Philadelphia, Pa.

The lathe is 86 feet long, weighs 135 tons and swings 6 feet 6 inches by 60 feet long. Eight tools are used, each taking a 3-inch cut, so that the column is reduced 2 feet each time the cutters traverse the entire length of the bed. The head and tail stocks are carried on extensions of the bed, and the latter is made in six pieces, fastened together by stay-bolts. The entire length of the bed is 86 feet. The head and tail stocks weigh 15 and 14 tons respectively, and are securely bolted to the extensions of the bed. The hollow spindles each weigh 9 tons, and are made of cast open hearth steel. They run in Babbitt metal bearings. The main bearing is of ball design, 30 inches in diameter, and the bearing surface is 30 inches long. There is another bearing 20 inches long at the small end of the spindle; this construction is to obviate the tendency of any thrust on the head and tail stock. The latter is driven by back gears for cutting and is direct driven for the polishing speed. Pulleys 30 and 36 inches in diameter are used and are belted in the usual manner from a countershaft.

The platens which carry the cutting tools rest on friction rollers which raise them just off the bed. The two feed screws, one on each side, are 4 inches in diameter and are 66 feet 3½ inches long, 58 feet 6 inches being threaded. On the platen which carries the tool posts is secured a revolving table which is fitted on its upper side with slots which carry the lengthwise slide, this being operated by a feed screw and has a traverse of 18 inches. To each of the four slides are secured two tool-posts, each provided with feed screws operating at right angles to the feed screw of the lengthwise slide, so that each tool-post is independent and can be used or not as desired. The bearings of the tool-posts permit of a horizontal rotary movement, bolts controlling the angle of the tool. The latter, which is a circular disk of steel 10 inches in diameter and ⅞ of an inch thick, with a V-shaped edge for cutting, is wedged on a mandrel which is in turn held in a sleeve in the tool-post, bolts securing the rear end of the mandrel in position.

Head and tail chucks made of open hearth steel hold the blank in position until it becomes a finished column. They each weigh about 16 tons. Twenty-four set-screws serve to hold the blank, and the entire weight of the great mass of moving stone is entirely supported by these chucks; blocks of irregular shape can be readily adjusted to position.

The corners are roughly dressed off by hand, and the stone begins its six weeks of dressing and polishing. As the stone revolves, it imparts a rotary motion to the cutting disks or tools. The cut is really a splintering of the stone, and three inches of the granite are removed at each cut. After the column is shaped it is polished with hardened steel shot, held in position by a kind of cup carried in the tool-holder. The final polishing is done with the aid of emery and water. When cutting, one and three-quarter revolutions are made a minute, and when polishing, three revolutions. The lathe is driven by a 50 horse power engine, and, notwithstanding the great weight and friction of the moving parts, the lathe runs for about fifteen seconds after the belt is thrown off the pulley.

THE British Postal Department Commission, which has been inquiring into the subject of wireless telegraphy for several months, will shortly report in favor of the earliest possible adoption of the Marconi system. The Commission is also arranging for the purchase of Marconi patents, and is negotiating with France and Germany relative to their attitudes toward the Marconi inventions.

Automobile News.

Consul-General Wildman states that Hong Kong is no place for motor carriages. There are only three carriages of any kind in the entire city.

The motor car is evidently destined to attain popular favor as a public vehicle in England. Wagonettes have been plying for public hire for some time past at Bournemouth, a popular seaside resort on the South coast. One car has been in service for 304 days, during which time it has only been withdrawn for five days; has conveyed 53,806 passengers, and traveled 22,009 miles. It earned $3,225, and the cost of repairs during that period only amounted to $145. The car has never occasioned any trouble, and the petrol motor with which it is provided has been found to be absolutely reliable.

A simple method of recording the speed of motor cars and other vehicles has been devised by M. L. Gaumont, and accounts of the device appear in Cosmos, and La Nature of November 3. The instrument consists simply of a camera with a double shutter, by which two exposures are made of the same plate, separated by a known interval of time. On developing the photographs, two images are obtained of the moving object, and by measuring the distance between them, the dimensions of the car being supposed known, and also measured on the plate, it is easy to calculate the speed of the car at the instant when the photograph was taken. The object is to assist the authorities in regulating the speed of these vehicles and checking furious driving.

Prof. Hele Shaw recently delivered an interesting lecture before the London Society of Arts upon the subject of the Improvement of Road Locomotion. In England, he stated, there had been a remarkable revival of interest regarding the question of the roads of Great Britain, their improvement, and the improvement of means of communication over them. The chief point to be noted in this direction was that while a few experiments had been made upon separate wheels, drawn by mechanical means, the bulk of the observations made by Gen. Morin and by other investigators of the subject were effected by employing the tractive agency of the horse; and with the exception of a few of the experiments with traction engines, the muscular effort of animals had hitherto been the sole means of investigating road resistance. The increased speeds for light and heavy traffic rendered observations of resistance at lower speeds of little use, when they came to the subject of self-propelled vehicles. Motors for such vehicles had now been constructed with a power of as much as fifty horses, but there were strict limitations to the possible power of such motors, and it was important that knowledge should be available in what was comparatively a new subject, as to the conditions by which the greatest economy might be effected. M. Forestier had given instances of the running of heavy motor vehicles in connection with the "Poids Lourds" service in the Department de la Meuse, in which the wear of the roads had been largely increased—in one case, for instance, a wear of 163 cubic yards per year per mile, which involved an increased cost of $200 per mile, while in another it had been necessary to spend $400 per mile in widening and drainage, and to increase the annual expenses in repair by $140 per mile. At the last meeting of the British Association he had obtained the appointment of a committee to investigate the different causes of resistance for self-controlled vehicles on the common roads. Experiments had already been carried out at Liverpool with motor cars over macadam, stone sets, wood pavement, and asphalt. In the three matters of the regulation of speed, uniformity of tractive effort, and ability to maintain considerable speed, a few days' experiments sufficed to show that it was possible to secure accurate and scientific results. As to the effect of the vehicle upon the road surface, it was important to ascertain by experiment the best form of wheels, dimensions of the tire, the effect of the coning and canting of wheels, and of the results from loads of varying magnitude upon roads in all states and conditions. In the course of the discussion which followed, Col. R. E. Compton, who went through the South African campaign, stated that he was profoundly impressed by the alteration of the surface made by the wheels of the traction engines employed by the military in wet weather. The width and diameter of the wheel for conveyance of certain weights required careful consideration. To emphasize the fact that the design of the wheel was most important he observed that in South Africa they introduced a very broad wheel at the outset—absolutely contrary to the time-honored practice of the Boers, who used narrow wheels—and the result had been that the British had been enabled to transport enormous loads, day after day for months together, without hurting the surface; whereas two or three passages of the Boers' narrow wheels destroyed the surface to such an extent that the British could not afterward use the same route.