GREATEST RINGING BELLS.

By JOHN W. NYSTROM.

Russia is famous for having the greatest bells in the world, but if the great *Tzar Kolokol* of Moscow, which has never served the purpose of a bell, be excluded, then Burmah takes the honor of having the largest ringing bells.

BURMAH BELLS.

The *Burmah* bell founders appear to have attained great perfection in that art, and they take great pride in their productions. The quality of tone of the Burmah bells are said to be very fine. The Mengoon bell is the greatest ringing bell in the world, weighing 201,600 pounds, and its probable diameter is 203 inches.

The great bell in Rangoon, called "*Maha Ganda*," weighs 95,000 pounds, with probable diameter of 155 inches, is said to have a very fine tone.

RUSSIAN BELLS.

The first great bell in Moscow was presented to St. Ivan's Church by the Tzar Boris Godunof, in the sixteenth century. This bell was actually hung and rung, but its weight, 288,000 pounds, was too great for its support, it fell and broke and was recast in the year 1654. Diameter, 216 inches, and soundbow 18 inches. During the fire in 1706 the bell fell and broke again.

The greatest bell in the world is that at Moscow, called *Tzar Kolokol*, or monarch bell. Its dimensions are 19 feet 3 inches high, diameter 22 feet 8 inches, thickness of soundbow nearly 2 feet, and weighs 443,772 pounds. The weight has evidently been calculated, because the Russians had no scale upon which it could be weighed. From the dimensions of the bell, taken by the writer and the weight calculated, it should weigh nearly 500,000 pounds.

According to inscription on the bell, it was cast in the year 1733. In those days they had no means of transporting heavy weights and great bells were, therefore, cast in the churchyards close to where the bell was to be hung, as was the case with the great Moscow bell, which was cast in a pit close to St. Ivan's Church, in which tower it was intended to be hung.

The moulding of the bell was probably done in the ordinary way, namely, the core was built first, upon which the thickness of metal was laid with loam or clay, and the cope built over it. Judging from the unevenness of the inside surface of the bell, it is probable that the core was not swept but dubbed up, so that the bell is not of even thickness at equal distances from the lip. The outside surface is very even, and has evidently been swept by a steady sweep.

In preparing and melting the metal for casting the bell it appears that no exact composition was attempted, for the nobles and other capitalists of Moscow threw a great amount of silver and other metal into the furnace, which made it an uncertain alloy with much greater shrinkage than the minimum, which is, with 31 parts of tin to 100 of copper.

The moulding, casting and precautions for cooling and shrinkage of a bell of this size require more practical experience than probably these bellfounders were in possession of, for it is evident that the bell broke by shrinkage in the pit in which it was cast.

The cooling of a bell of this size requires a time of at least one month if not six weeks, from the day it was cast, but it appears that the bell founders attempted to dig up the bell a few days or a week after it was cast; and it is also said that water was poured on the mould or casting; at all events, the bell was cooled too quickly and cracked in several places around the lip, and in one place a piece weighing about 11 tons was broken off. The uneven thickness of metal also aided the breaking.

The great Moscow bell has, therefore, never been sounded, but laid in its casting-pit, partly uncovered, for a time of 103 years, in which time it was held in reverence by the natives who were extremely jealous of its being touched or measured by strangers. Thus it laid as an object of wonder to travelers, and the people of Moscow visited it with pride at their festivals.

In the year 1836 the Emperor Nicholas decided to have the bell exhumed and raised, which was accomplished with great difficulty and expense. The engineers who first undertook to raise the bell were not given a fair chance to accomplish the work, because on their first trial the tackle were too light and gave way, for which the engineers, it is said were sent to the mines of Siberia.

The board of admiralty then undertook to raise the bell, and succeeded in placing it in the position as shown in the accompanying illustration, which is reduced from a large photograph procured by the writer in

Moscow, in the year 1871. The bell is placed south of St. Ivan's Church, on an open piazza in the Kremlin, near to where it was cast.

It is said that the Empress Anne presented the bell to the church, but however that may be, it is known that the fragments of the bell which fell and broke in 1706 were used; and the citizens of Moscow contributed largely to the metal in the bell which contains much silver and some gold. It is said that the value of the metal in the bell is \$332,000, all uncirculating and dead money, for the bell has never struck a note.

· "Think of that, ye money-mongers on the Rialto," says Rev. Alfred Gatty.

In some records of the great Moscow bell it is stated that the bell was actually hung and rung in the tower of St. Ivan's Church, and that it had been broken by falling to the ground. It is also stated that the building over the casting pit took fire after the bell was cast, and the water used for putting out the fire fell on the bell in the pit and caused its breaking. But these records have been contradicted by competent judges.

TZAR KOLOKOL.—DESCRIPTION OF THE PLATE.

The accompanying plate, representing the "Bolshoy Tzar Kolokol," is produced by the phototype process invented by Mr. C. H. Jacobi, of Neuendorf-Coblentz, and now used exclusively by Mr. F. Gutekunst, 712 Arch street, Philadelphia. This process (with others allied to it) is one of the great achievements of recent times. With its aid a view can be taken from nature and as many copies as desired may be reproduced in the printing-press, preserving the softness of a photograph, the permanency of a steel-engraving and the absolutely correct representation of the original object. The illustration has never been touched by any handwork or artistic skill, but a negative taken from my photograph by which the printing-plate was prepared. This process is well known and widely used in Germany, and will, no doubt, be so also in America, for it has fortunately fallen into good hands.

The great Moscow bell, as represented on the plate, rests on a granite pedestal with its broken off piece on the ground. The enormous size of the bell can be perceived by the proportionate size of the men standing at the foot of it and by the size of the cathedral behind. The St. Ivan's

Phototype.

F. Gutekunst.

Philo.

GREAT BELL OF MOSCOW.

FOUNDED 1733.

Height 21 ft. 4½ in. Diameter 22 ft. 8 in. Weight 198 tons.

Church, in which tower the other large bells hang, is close by to the right of Tzar Kolokol, but not shown on the plate.

The scale of the bell represented on the plate is 8.095 feet to the inch, in the plan passing through the axis of the bell and parallel with the plate; but that scale will not be correct for measuring the height of the men in front of the bell, because they were 13 to 14 feet nearer to the camera obscura when the photograph was taken, and they therefore appear larger by that scale. The same is the case with the broken off piece on the ground, which by scale measurement is larger than the hole in the bell from which the piece was broken. The church on the other side of the bell is larger than the scale measurement. The axis of the photographic instrument was placed level with the lip of the bell.

The female figure in base relief on the left side of the *latus* represents the Virgin, and the inscription is on the right side towards St. Ivan's Church. The uneven thickness of metal, at equal distances from the lip, can be seen and measured at the top of the broken off piece on the ground. The form of the bell and its base relief ornaments are master pieces of fine arts. Omitting the accidental unevenness of thickness, the proportions of the bell indicate that its constructor understood the acoustic properties of the vibrating metal when a bell is tolled.

Our modern celebrated bell founders are far behind that constructor in proportioning bells for quality of sound. I should like very much to see the Tzar Kolokol recast the same size, and the form and ornaments exactly preserved. With our present knowledge and experience in founding the recast bell would be a success.

The other great bells in Moscow and other places are noted in the accompanying table, in their order of sizes.

The Russians have generally a great number of bells of different sizes in their churches, but they are not toned for musical harmony or melody, and their ringing is not agreeable to strangers, who often make severe remarks upon their noise. During my five years in Russia I could never get accustomed to or appreciate the bell-ringing, which is a disagreeable jangling.

The great bell in St. Ivan's Church is rung three times a year, and produces a tremulous effect throughout the city, like a distant thunder or the low notes on a powerful organ.

The old bells of Russia are much better in tone than modern bells cast in Moscow 25 years ago or thereabout, but I have information that they make better bells now.

The Russians never swing their bells, but hang them stationary, and even the smallest church bells are rung by ropes attached to the clappers.

CHINESE BELLS.

China is next in order of great bells, but their awkward form and projecting ornaments make them far inferior in tone to our bells.

The great bell in *Pekin* weighs 120,000 pounds, diameter 13 feet, and height 14 feet 6 inches. It is rung by one man striking its outside by a wooden mallet. An ordinary iron clapper would probably break the bell on account of its irregular distribution of metal.

The great bell of *Nankin* weighs 45,000 pounds. Large bells are very common in all cities of *China*, but all bad in tone, and chime ringing is unknown there. The construction of *China* bells shows absolute ignorance of the science of acoustics as applied to that art.

JAPANESE BELLS.

In *Japan*, ringing bells are very common, and are a little better than those in *China*. They make the bells cylindrical, with a spherical top, and ring them by a weight hung on a rope striking the bell outside.

The Chinese and Japanese bells require double the amount of metal for the same volume of sound produced by our bells.

The ancient literature, that is, from the year 1495 to the end of the last century, was rich on bells, and the subject was treated by able scientific men. A civil judge, *Maginus Tintunatius*, in the Venetian service at *Candia*, when besieged by the Turks in the year 1571, was taken prisoner, and in his captivity amused himself by writing a treatise on bells, which is said to be the best written on that subject; but, as the Turks considered the bell as a symbol of sinful infidelity, the author was beheaded by the order of a pasha. The manuscript was, however, preserved and published, by which his name is immortal.

When the Turks took *Constantinople*, in 1453, they forbade the ringing of bells, for the purpose of preventing signals being given for popular revolt.

The art of bell founding has not advanced in this century, but has gone backwards in many cases, which proves conclusively that a good bell cannot be produced by practical experience alone, but a scientific knowledge of acoustics is necessary with experience, not only for making a good bell, but also for producing the maximum volume of sound with the minimum quantity of metal.

The Largest Ringing Bells in the World.

NAMES AND LOCATION OF BELLS	Date Cast.	Actual Vibrat	Key-note.	Diam. Inches	Soundbow.		Weight Pounds
					Inches	Stroke.	
Moscow, Tzar Kolokol.....	1733	74	D	272	23	0·84	443,772
Burmah, Mengoon.....	.....	94	F#	203?	16?	0·80	201,600
Moscow, St. Ivans.....	1819	105	G#	185	14·75	0·80	127,350
Pekin, Great Bell.....	.....	.....	.....	156	.....	.....	120,000
Burmah, Maha Ganda.....	.....	125	B	155	12·5	0·80	95,000
Nishni, Novgorod.....	.....	125	B	151	12	0·80	69,664
Moscow, Church Redeemer	1879	141	C#	136·3?	10·6	0·80	60,736
Nankin, China.....	.....	.....	.....	112	.....	.....	45,000
London, St. Pauls.....	1881	157	E♭	114·25	8·75	0·76	42,000
Olmutz, Bohemia.....	.....	157	E♭	121	9·125	0·75	40,320
Vienna, Austria.....	1711	157	E♭	118	9·5	0·80	40,200
Westminster, London.....	1856	166	E	113·5	9·375	0·83	35,620
Erfurt, Saxony.....	1487	176	F	103·6	9·75	0·75	30,800
Notre Dame, Paris.....	1680	166	E	103	7·5	0·73	28,670
Montreal, Canada.....	1847	176	F	103	7·8	0·76	28,560
York, England.....	1845	187	F#	100	8	0·80	24,080
St. Peter, Rome.....	1786	187	F#	97·25	7·5	0·77	18,000
Great Tom, Oxford.....	1680	210	G#	84	6·125	0·73	17,024
Cologne, Germany.....	1477	198	G	95	7·2	0·76	16,016
Brussels, Belgium.....	.....	210	G#	95·81	7·75	0·71	15,848
State House, Philadelphia...	1875	198	G	88	6·375	0·73	13,000
Lincoln, England.....	1834	210	G#	82·85	6	0·73	12,096
St. Paul's, London.....	1716	222	A	81	6·08	0·75	11,500
Exeter, England.....	1675	210	G#	76	5	0·66	10,080
Old Lincoln, England.....	1610	249	B	75·5	5·94	0·78	9,856
Westminster, London.....	1857	249	B	72	5·75	0·79	8,960

LIBERTY BELL.

The Liberty Bell of Philadelphia was cast over four times before it became qualified to ring-in the Independence of the United States of America. It was cast the first time by Lester & Pack, 267 White-chapel, London, in the year 1752; brought to Philadelphia and hung in the State House the same year, but when struck for the first time it gave a droll sound, and upon examination it was found to be cracked in the rim. It was then decided to send the bell back to London and have it recast in the same foundry, but Messrs. Pass & Stow, brass founders, undertook to recast the bell in Philadelphia. The first recast bell, in 1753, did not satisfy the authorities, and a second bell was cast from the same original metal, but without the anticipated success, but it was broken up and recast a third time, when it proved successful, and twenty-three years after it rung-in this nation's independence of a foreign potentate. Its weight is 2080 pounds. In the morning of July 8, 1835, it was cracked while being tolled in memory of Chief Justice Marshall, but was still rung, with a doleful sound, until the 22d of February, 1843, when the crack increased so as to make the Liberty Bell thenceforth mute forever, though not dead. It was placed on the honorable retired list, and hung in a conspicuous place in the Hall of Independence, on duty to pay homage to visitors.

The accompanying illustration of the Liberty Bell is of a scale 0.55 of an inch to the foot.

Diameter at the lip,	48 inches.
Thickness of soundbow,	3 $\frac{1}{4}$ "
Keynote, American pitch	E.
Double vibrations per second,	392.
Weight,	2080 pounds.

The predestination of the Liberty Bell was inscribed with raised letters cast on it in London, 1752, as ordered by the Assembly of the Province of Pennsylvania. The same inscription was put on the recast bells by Pass & Stow, Philadelphia, 1753, namely, as follows:

"PROCLAIM LIBERTY THROUGHOUT THE LAND TO ALL THE INHABITANTS THEREOF."—Levit. xxv, 10.

The predestination was realized twenty-three years after the bell was cast, when the sovereign people assembled, with the benediction, *All men are born free and independent.*

The 10th verse, chapter xxv of Leviticus reads thus: "And ye shall hallow the fiftieth year, and proclaim liberty throughout *all* the land, unto all the inhabitants thereof; it shall be a jubilee unto you." Like a flash of lightning the quotation became intelligible to every ear, and was promulgated in rhyme and prose.

SECOND STATE HOUSE BELL.

The second State House bell was cast by John Wiltbank, of Philadelphia, in the year 1828, and weighed 4600 pounds. This bell was cast over three times before proving successful, but the last one turned out to be a very good bell, and was used for fire alarm and time striking. In the year 1875 it was taken down and removed to Germantown Town Hall, where it is now doing good service by sounding time with the same old clock as used in the State House.

THIRD STATE HOUSE BELL.

The third State House bell was presented to the City of Philadelphia by Henry Seybert, Esq., on July 4, 1876. Its weight is 13,000 pounds, and was cast twice by Messrs. Menealey & Kimberly, of Troy, N. Y. The first bell, after having been hung in the State House

tower and sounded, was found to be unsatisfactory in quality of tone, whereupon it was taken down and returned to Troy for recasting. The second bell proved to be a little better, but competent judges say that it is not a good bell. Its dimensions and key-note will be found in the foregoing table. Mr. Seybert also presented to the city the clock which strikes the bell.

WESTMINSTER BELL OF 1856.

The London Westminster bell of 1856 proved to be a failure, and was therefore taken down and recast the next year. The first bell weighed 35,625 pounds, and the second weighs only 8960 pounds.

There are many bells rung in different parts of the world which are much worse than some of those that have been condemned for producing bad sound.

REPORT ON EUROPEAN SEWERAGE SYSTEMS, WITH SPECIAL REFERENCE TO THE NEEDS OF THE CITY OF PHILADELPHIA.*

By **RUDOLPH HERING, C.E.**

Philadelphia, Autumn of 1881.

SAMUEL L. SMEBLEY, Esq.,

Chief Engineer and Surveyor of City of Philadelphia.

DEAR SIR:—In order to finally present the conclusions gained during my visit to Europe, and their application to Philadelphia, I shall group the material according to subjects, instead of to the places visited, which latter method, however, was the more expedient one to pursue for the six preliminary reports I sent you from Europe. And I shall confine myself now to the consideration of only those points which have a bearing on the existing works and future needs of our city.

The best way of treating the matter will be: To briefly state the conditions presented by our city, and allude to its present sewerage system, the details and management, in order to clearly understand in

* The author of the following report was selected by the National Board of Health to examine and report upon the sewerage works in Europe. The report we publish was prepared from facts noted and observations made while performing this duty.