HOW CHURCH BELLS ARE CAST.

BY F. P. LOTZ.

Christ Church, Boston, claims to have a fine old set of bells rung in the old way as in England. I am told that they possess a very sweet tone and are among the oldest in the country. South Congregational Church, New Britain, Conn., has a magnificent set of fourteen bells, which are rung both by hand and by a combination apparatus, using electricity and compressed air in a set of pneumatics. A similar set, exclusive of pneumatics, is in the tower of St. Simeon's Church, Philadelphia, and another in Christ Church, New Haven, Conn. As fine a set of eleven bells as have ever been made are in St. John's Roman Catholic Church, Clinton, Mass. There are numerous other very fine chimes of bells in this country, among which may be mentioned those in St. Michael's Church, St. Thomas's, and St. Andrew's in New York city, and an excellent set in St. Patrick's Church, Cleveland, Ohio.

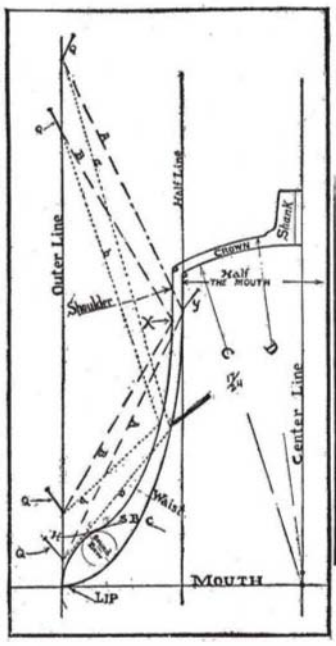

Fig. 1.—The Lay-out of the Bell on the Drafting Board.

Bells have been the subject of some of the best poems, Longfellow having written no less than nine on this subject. Among these are "The Belfry of Bruges," "The Song of the Bell," "The Bells of St. Blas," "The Bell of Atri," and "The Bells of Lynn"; and who has not heard of Poe's "The Bells," which, with his weird monody "The Raven" made his name famous? Then there are also Tennyson's poems on bells and Schiller's "Lay of the Bell."

The mechanical process of bell founding is extremely interesting to those not familiar with it. The following description of it is illustrated with photographs taken while the work was in progress in the usual every-day routine. With some modifications all founders proceed very much in the same manner, but some of the modifications mean much in the result. However, by explaining one method the whole proceeding is made very clear, and with the illustrations will, no doubt, be readily comprehended.

Having mathematically worked out the proportionate requirements and having procured a suitable pattern board, the drafting is proceeded with as shown in Fig. 1. First the center line and the mouth line are laid off, exactly at right angles. Then the half line and outer line are laid off parallel to the center line. The required measurements are then laid off and pins set in place, as shown by *Q* and *X* and *Y*; a string which cannot stretch is then adjusted along the line *A A*, the pin at *X* is removed and a pencil substituted, with which, keeping the string quite taut and carrying it downward, is thus drawn the inside or large elliptical curve down to the point of the lip, as indicated by the dotted line *a a*. In a similar way exactly the outer or small elliptical curve is drawn, shown by *B B* and carried down by the dotted line *b b*, ending at *H* and representing the string. The sound-bow is then drawn over the circle so marked, with a compass, making the line marked *S B C*. This done, there remains only a very small gap to fill up by hand or any other convenient way where the line *B B* ends at *H*. Then from the points *X* and *Y* a straight line is drawn up to the little circles at the shoulder, and from there on the crown is drawn with a trammel *C* and *D* up to the shank. It will be seen that the *inside* diameter of the bell at the shoulder is just *half* the mouth diameter. The thickness of the bell through the sound-bow is one-fourteenth of the mouth diameter; the waist thickness is half the sound-bow, and the shoulder thickness is a third of the sound-bow. The height of the bell is about eighteen times the thickness of the sound-bow.

According to this layout, two sweepboards are now fashioned, one called the "core" sweep and the other the "case" or "outer" sweep, as shown in Fig. 2; the sweepboard having the long stem is called the core sweep, the other being the case sweep. Two iron flasks are next provided, called respectively the "case" and the "core." The former is larger by an inch or two than the required finished mold, and in this the outer shape is molded. The core is an inch or two smaller than the required finished mold, and on this the inner shape is molded. A general view of the foundry (Fig. 3) shows these molds set up, the case with its wide part up and the core with its wide part down. Fig. 4 shows a molder at work near the end of the sweeping up of a core mold with the rough loam coating. Then comes the last work on the outer mold, that of slicking over just after impressing the inscription, which will appear on the bell in raised letters.

The molds are next closed and set around in order under a large crane ready for casting, and here there is a marked difference between the American and the European method. It will be noticed that these iron flasks have numerous holes which are provided for a twofold purpose—to make the loam coating adhere more thoroughly and to allow the gas which is generated during the few seconds required for the pouring to escape through these "vent" holes and burn itself out. The European method is to sweep up the molds over brick cores in a pit, and then over this to sweep a bell of clay, and over this, beginning with the smooth coat, they lay on the outer loam form. When the molds are done, they lift off the outer mold, break up the clay bell, replace the outer mold, and then pack the whole in the pit by pressing down the dirt previously excavated and then weighting it down. Nothing shows above the foundry floor level but the "heads" or "gates" for the entrance of the molten metal. There is always danger of gas explosion by the European method. By our method this danger is reduced to practically nothing, because all our casting is done practically above ground and in a way that allows the gas to burn out. The next step is that of tapping the generally well known hot-air furnace of the melted bell metal, which in a few minutes is poured into the molds in the manner shown by Fig. 5, and this view also shows how the molds are set under the big crane ready for casting, to which reference has already been made. This casting is generally done as early during the day as possible, so as to give plenty of time to allow the metal to cool slowly down by the next day, when the bells are removed from the molds and allowed to finish cooling.

If some of these bells are intended for a peal or chime, they are then lifted up and tested somewhat in the manner shown in Fig. 6, to ascertain how near to accuracy the pitch is. Generally they come pretty close to what is desired, and a little skillful mechanical tuning brings it to standard accuracy. A finished peal of four bells is shown in Fig. 7. A chime of bells appears complete and set up in Fig. 8. These are played in the tower with the lever keyboard as shown in Fig. 9. If the bell be for a tower clock or for fire alarm use, for school or church tower, used singly—i. e., not a part of a musical set—then no tuning is done to it after being cast, and this because without the tuning it has a certain individuality all its own which is very desirable, and for school or church use it is mounted in the usual way. In this position it does duty during its life, away up in the steeple, patiently though sometimes noisily, striking the hours and reminding us that Time is fleeting and soon Eternity dawns.

In the school tower the bell summons the children with heavy feet to school to garner the seeds of instruction that fit them to fill worthily our places when we are gone. In the fire alarm tower it rings its call for heroes to duty in quenching fires or in the saving of human life. And last but not least, the church bell gives softly and sweetly the call to worship.

Fig. 2.—Bell Sweeps for Forming the Molds.

A Novel Storehouse.

BY W. K. FISHER.

Many mammals, chiefly rodents, store quantities of food against a season of scarcity, but it is worthy of note that very few birds have acquired the habit. In California, however, where there are long dry summers in the valleys, a shining example of thrift has been developed among the woodpeckers. This bird is the handsome California woodpecker, *Melanerpes formicivorus bairdi*, closely related to the red-headed woodpecker of the Eastern and Middle States. It is one of the most industrious creatures in California, and to the casual observer its principal occupation might seem to be the hoarding of acorns. Our woodpecker does not go about its work in the offhand, slipshod manner of the California jay, which pounds its acorns into the ground, with a guilty air, and then apparently forgets all about them. Instead, Melanerpes drills a neat round hole in the bark of a tree, and into this wedges the acorn, which fits so tightly that one has to use a pen-knife to extract it. The birds are most active during the autumn and winter, when they store many acorns for food, showing a decided preference for the slender nut of the California live oak. Whether the birds particularly desire a grub which lives in the acorn is not known, but we do know that they eat the nuts. The habit of fitting them so tightly into holes in bark may have been acquired for pro-

Fig. 3.—The Foundry, Showing Flasks and Cores.

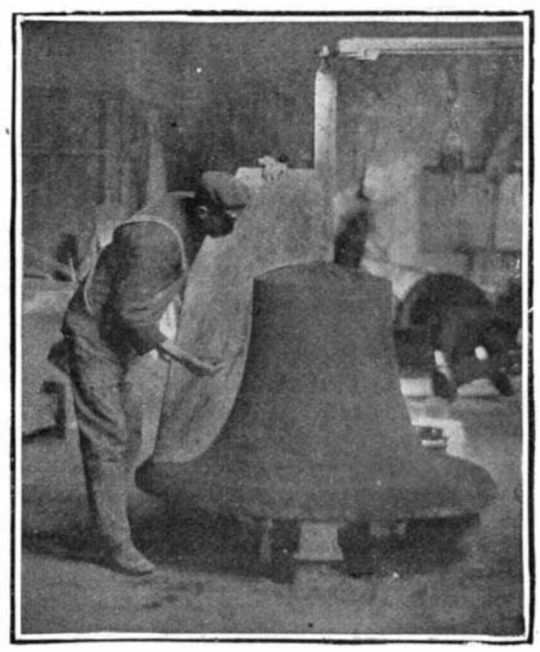

Fig. 4.—Sweeping the Core.

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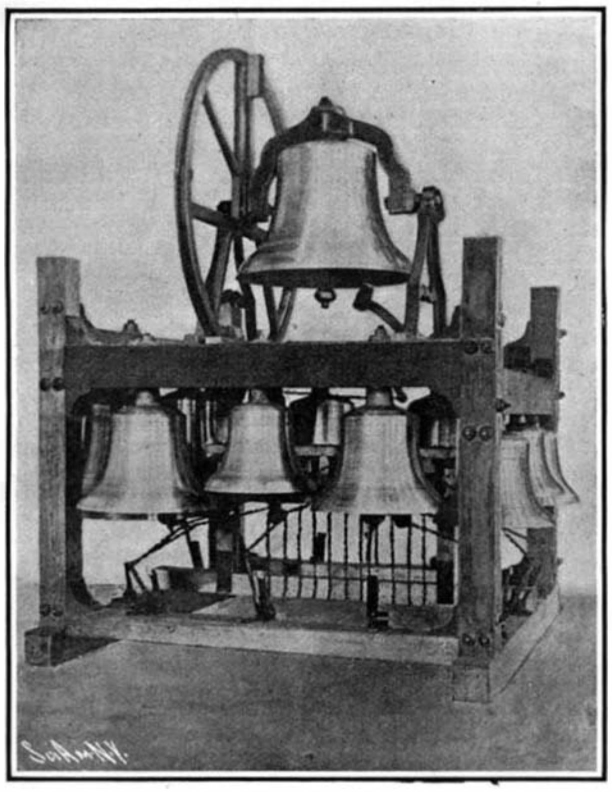

Fig. 8.—A Chime of Bells.

Fig. 9.—A Lever Keyboard.

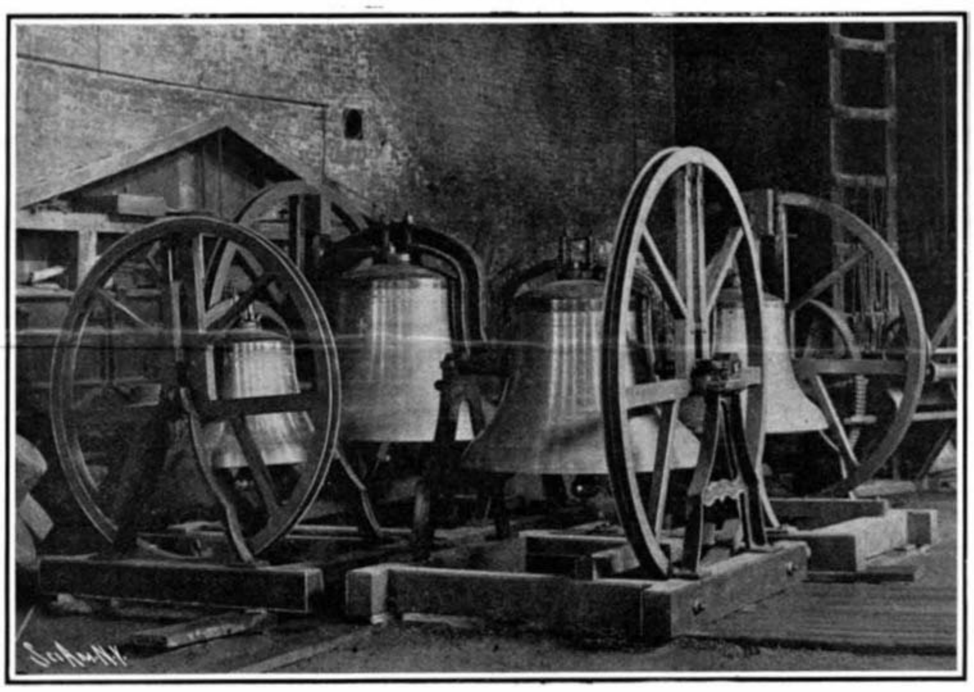

Fig. 7.—A Finished Peal of Four Bells.

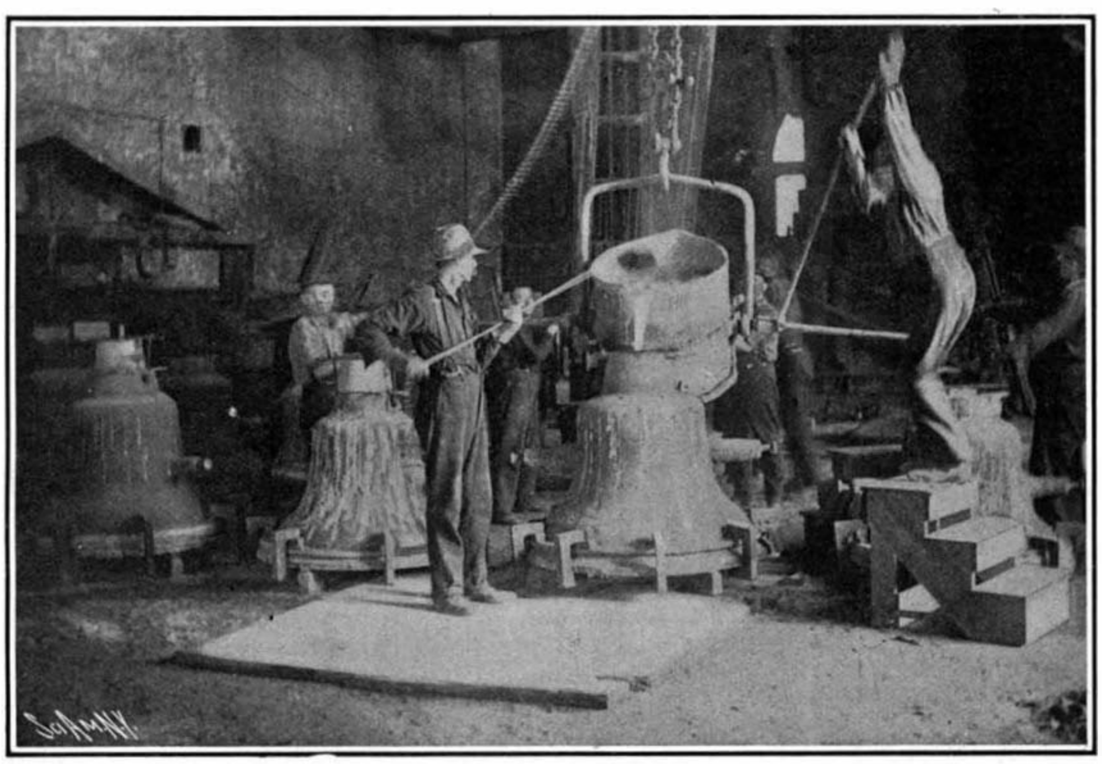

Fig. 5.—Casting the Bell.

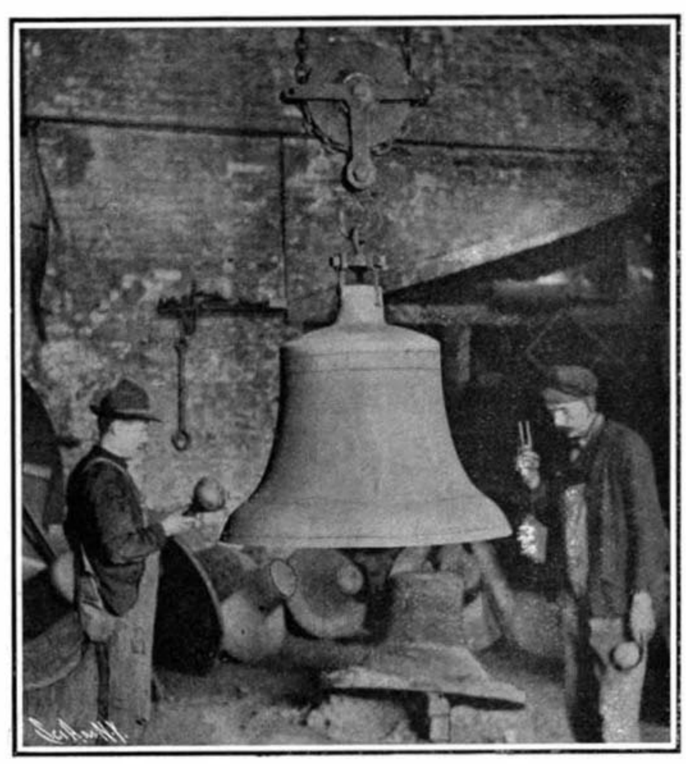

Fig. 6.—Testing the Tone of the Bell.

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tection against the depredation of ground squirrels.

Although scattered acorns are found in telegraph poles, in fence posts, in the sides of houses, or wedged under shingles, the woodpeckers seem to prefer live oaks, in the valleys. In the mountains conifers are used also. Leaky roofs often result from the wedging of acorns under shingles, or from holes drilled into them; and many a rancher has been provoked to profanity by having his house perforated.

A characteristic of the woodpeckers is their fondness for certain individual trees. They store their acorns in the same tree and use the same holes year after year, adding new holes as time goes by, and the old ones wear out. A few of these trees must have a reputation among woodpeckers for miles around, judging by the way they are visited and the number of acorns deposited in their bark. Such a tree—a large live oak, now somewhat famous, at least locally—stands in front of President David Starr Jordan's residence at Stanford University, California. Its bark is closely studded with acorns, even out onto the smaller limbs. Some of them have been driven into the ends of old, partially decayed nuts, which they have telescoped, the old shell inclosing the fresh acorn. Only a portion of each acorn is eaten by the woodpeckers, many remaining till they decay, or are "driven to the wall" by the insertion of fresh nuts. After a time the bark partially decays about the old holes so that the acorns will not fit tightly. Such holes are often abandoned.

A Singular Effect of Friction.

In a communication presented to the French Academy, E. Guyou comments upon some curious experiments made by De Saintignon, of which Guyou gives a brief account only. A spherical vessel is rotated about its vertical axis some eight hundred times per minute; dimensions are not given. Powdered substances are distributed in the water contained in the vessel. When the vessel is rotated, the powdered particles will arrange themselves along the axis of rotation, if they are less dense than water. But if they are heavier than water they will collect, not on the equator of the vessel, as one might expect, but on two rings corresponding to equal parallels of latitude on both sides of the equator. In explaining this apparent paradox, Guyou points out that, after a certain time, the particles will revolve with the velocity of the globe, and the effects of gravity and of centrifugal acceleration may be neglected. The resultant of the remaining forces will urge any particle in the direction of the radius of the parallel in which it finds itself. If the particle is less dense than the liquid, the resultant will be centripetal, and the particle will move toward the axis of rotation; if the particle is denser than the liquid, the particle will travel toward the wall of the vessel. Having reached the wall, the particle will be pressed against it by this radial force which is at right angles to the axis of rotation, and therefore oblique to the wall. The angle which the normal to the respective point of the wall forms with the force will be equal to what we call latitude in determining positions on our globe; we may thus speak of the latitude of the particle. If now the latitude of the particle is greater than the angle of friction between the particle and the wall corresponding to the conditions of the experiment, the particle will glide toward the equator. If, however, the latitude of the particle is smaller than the angle of friction, or equal to it, the particle will remain at the point where it met the wall. The globe may thus be imagined to be divided into three zones. The central zone will lie between the two parallels, north and south of the equator, whose latitude is equal to the angle of friction; the two other zones or segments will lie outside this equatorial belt. For the particles within the belt the latitude will be smaller than the angle of friction, and they will therefore remain in their belt; the particles outside the belt will have a greater latitude, and they will glide down to the parallel where the latitude and the angle of friction are equal to one another. Thus, with powdered charcoal, we observe two black circles of latitudes about 30 deg., limiting an equatorial belt which is turbid with black spots of charcoal, while the two polar segments will be clear. The case of coal is unfortunately the only one concerning which the brief details quoted are given. It would be interesting to have further data, and to ascertain whether friction is really the only or the chief determining factor in the phenomenon. Experiments might be made with heavy precipitates. Guyou suggests that the observed latitude should be measured for the direct determination of the angle of friction.

The X-ray is being used by pearl fishers of Ceylon to determine the presence of pearls in oysters.