and T=*flt*. But by the triangle of forces (fig. 43) P = Tδ*θ*. Hence *f=p*R*∣t.*

The ends of the cylinder may or may not be held together by longitudinal stress in the cylinder sides ; if they are, then, whatever be the form of the ends, a transverse section, the area of which is 2πR*t*, has to bear a total force *p*πR2. Hence, if *f'* be the intensity of longitudinal stress, *f' =p*R*∣*2*t =* 1/2*f.*

74. A thin hollow sphere under internal pressure has equal circumferential pull in all directions. To find its value consider the plate of fig. 42. There are now four equal forces T, on each of the four sides, to equilibrate the radial force P. Hence P = 2Tδ*θ* and *f=p*R/2*t*

75. When the thickness is not small compared with the radius, the radial pressure is transmitted from layer to layer with reduced intensity, and the circumferential pull diminishes towards the out­side. In the case of a thick cylinder with free ends@@1 we have to deal at any point with two principal stresses, radial and circum­ferential, which may be denoted by *p* and *p,* respectively. Sup­posing (as we may properly do in dealing with a cylinder which is not very short) that a transverse section originally plane remains plane, the longitudinal strain is uniform. Since there is no longi­tudinal stress this strain is due entirely to the lateral action of the stresses *p* and p', and its amount is (*p* *+p')∕σE*. Hence at all points *p + p'≈* constant.@@2 Further, by considering the equilibrium of any

thin layer, as we have already considered that of a thin cylinder, we have *d*/*dx*(*pr*)=*p'.*

These two equations give by integration, p = C + C'∕*r*2, and *p*' = C - C'∕*r*2.

If *r*1 be the external and *r*2 the internal radius, and *p*0 the pressure on the inner surface, the conditions that *p=p*0 when *r* = *r*2 and *p* = 0 when *r=r*1 give C = - *p*0*r*22∕(*r*12 - *r*22) and C' = -C*r*12. Hence the circumferential stress at any radius *r* is *p'*= *p*0*r*22(l+*r*12/*r*2 )∕(*r*12 - r22). At the inside, where this is greatest, its value is -*p*0(*r*12 + *r*22)∕(*r*12 - *r*22),—a quantity always

greater than *p*0, however thick the cylinder is.

In the construction of guns various devices have been used to equalize the circumferential tension. With cast guns a chilled core has been employed to make the inner layers solidify and cool first, so that they are afterwards compressed by the later contrac­tion of the outer layers. In guns built up of wrought-iron or steel hoops the hoops are bored small by a regulated amount and are shrunk on over the barrel or over the inner hoops. In Mr Long­ridge’s system, now under trial, the gun is made by winding steel wire or ribbon, with suitable initial tension, on a central barrel.

76. The circumferential stress at any point of a thick hollow sphere exposed to internal fluid pressure is found, by a process like that of the last paragraph, to be -*p*0*r*23(1 + *r*13∕2*r*3)∕(*r*13 - *r*23), which gives, for the greatest tension, the value

-*p*0(*r*13 + 2*r*23)∕2(*r*13 - r23). (J. A. E. )

STRICKLAND, Agnes (1806-1874), a popular his­torical writer, was born in 1806, the third daughter of Thomas Strickland, of Roydon Hall, Suffolk. Her first literary efforts were historical romances in verse in the style of Walter Scott,—*Worcester Field* (published without date), *Demetrius and other Poems* (1833). From this she passed to prose histories, written in a simple style for the young. A picturesque sketch of the *Pilgrims of Walsingham* appeared in 1835, two volumes of *Tales and Stories from History* in the following year. Then with the assistance of her sister she projected a more ambitious work, *The Lives of the Queens of England,* from Mathilda of Flanders to Queen Anne. The first volume appeared in 1840, the twelfth and last in 1849. Miss Strickland was a warm partisan on the side of royalty and the church, but she made industrious study of “official records and other public documents,” gave copious extracts from them, and drew interesting pictures of manners and customs. While engaged on this work she found time to edit (in 1843) the *Letters of Mary, Queen of Scots,* whose innocence she championed with enthusiasm. In 1850 she followed up her *Queens of England* with the *Lives of the Queens of Scotland,* completing the series in eight volumes in 1859. Unresting in her industry, she turned next to the *Batchelor Kings of England,* about whom she published a volume in 1861. The *Lives of the Seven Bishops* followed in 1866— after a longer interval, part of which was employed in producing an abridged version of her *Queens of England.* Her last work was the *Lives of the Last Four Stuart Princesses,* published in 1872. In 1871 she obtained a civil list pension of £100 in recognition of her merits. She died at Roydon Hall on the 8th of July 1874.

A *Life* by her sister, Jane Margaret Strickland, appeared in 1887.

STRIEGAU, an industrial town of Prussia, in the pro­vince of Silesia, is situated on a small, tributary of the Weistritz, 30 miles to the south-west of Breslau. In 1880 it contained 11,470 inhabitants, 6928 of whom were Protestants and 4379 Roman Catholics. Their chief occupations are tanning and the manufacture of albums, portfolios, and other articles in leather. Granite is

quarried in the neighbourhood, and a trade is carried on in grain. It was near Striegau that Frederick the Great gained the important victory usually named after the village of Hohenfriedberg (June 4, 1745).

STROMBOLI. See Lipari Islands.

STRONTIUM, a metallic chemical element intermedi­ate in its character between barium and calcium, with which it forms a natural “ triad.” Though widely diffused as a frequent companion of calcium (including oceanic), it occurs nowhere in abundance. Its most important mineral forms are the sulphate, SrSO4, known as *Cœlestine* (from the sky-blue colour of certain varieties), and the carbonate, SrCO3, called *Strontianite* because it was discovered first at Strontian, in Argyllshire, Scotland. Crawford and (independently of him) Cruickshanks in 1790 were the first to recognize the latter mineral as a thing of its own kind and different from witherite (BaCO3). Hope, in 1793, proved it to be the carbonate of a new earth, which discovery was confirmed by Klaproth.

Regarding metallic strontium, see Chemistry, vol. v. pp. 525-6. For the making of strontium preparations strontianite, of course, is the handier raw material, being readily convertible into (for instance) nitrate by treatment with dilute nitric acid. From the nitrate the oxide, SrO, is obtained by prolonged calcination at ultimately a bright red heat, as a greyish-whifce absolutely infus­ible and non-volatile mass, which acts violently on water with formation of the hydrate, Sr(OH)2, which latter readily takes up 8H2O of water to form crystals soluble in fifty parts of cold and far less of boiling water. An impure oxide is obtainable directly from strontianite by strong ignition with charcoal ; and from such crude oxide pure crystals of the hydrate are easily produced by obvious operations.

In the working up of cœlestine the first step is to reduce it to sulphide, SrS, by means of charcoal at a red heat. The sulphide when boiled with water is decomposed thus :—

2SrS + 2H2O = SrOH2O + SrSH2S.

Hydrate. Sulph-hydrate.

Both products dissolve in the hot water ; from the solution the S of the SrH2S2 is easily eliminated, by treatment with oxide of copper or oxide of zinc, as insoluble metallic sulphide; the filtrate on cooling gives crystals of pure hydrate. From it any strontia salt of course is easily made by means of the respective acid ; in many cases the salt wished for can be obtained similarly from the sulphide.

Nitrate of strontia from hot solutions crystallizes in anhydrous octahedra, SrN2O6, soluble in about ⅜ part of boiling and in 5 parts of cold water. From colder solutions hydrated crystals, SrN2O6 + 4H2O, separate out. The anhydrous salt is used largely by pyrotechnists for the making of “red fire.”

The hydroxide some years ago promised to play an important part in the sugar industry as a precipitant for the cane-sugar known to be present largely in uncrystallizable molasses (see Sugar), but the process so far has failed to take root in industry.

@@@1 This condition is realized in practice when the fluid causing internal pressure is held in by a piston, and the stress between this piston and the other end of the cylinder is taken by some other part of the structure than the cylinder sides.

@@@2 The solution which follows in the text is applicable even when there is longitudinal stress, provided that the longitudinal stress is uniformly distributed over each transverse section. If we call this stress *p*", the longitudinal strain is *p*"∕E+(*p*+*p*')∕σE. Since the whole strain is uniform, and *p"* is uniform, the sum of *p* and *p'* is constant at all points, as in the case where the ends are free.