This form of arch has several demerits. It is not structurally sound, as defects such as shearing at the haunch joints may occur, especially if the rise is relatively small. Labour costs are high, as special care must be taken in its setting-out and erection if abnormally shaped curves at the intrados and extrados are to be avoided. It is sometimes preferred to the segmental arch where a comparatively large span is required and the height is restricted. The rise of the arch should be at least one-third the span.

As the student will be aware, an ellipse is produced when a cone is cut by a plane which does not intersect the base and is not parallel to it. A true elliptical curve cannot be constructed with compasses, as no part of it is circular. However, for reasons of economy and the need to reduce the number of voussoir templets to a minimum, it is usual to adopt a geometrical method for setting-out the intrados and extrados of a semi-elliptical arch. There are several methods, that set out from five centres shown at J being one of the best, as by it compound curves can be produced which closely conform to that of the true ellipse.

Setting-out.—Draw the major and minor axes; make *cd* = half span *ab*; construct circle with *d* as centre and *db* as radius, and mark off *be* and *bf* = radius *db*; draw lines *dem, dfr, ken* and *kfo*; *g, e, k, f* and *h* are the five required centres for both the intrados and extrados, and *dm, kn, ko* and *dr* are common normals. Construct tangential curves *as, st, tu, uv* and *vw* with *g, e, k, f* and *h* as centres respectively; construct the extrados in a similar manner; mark off the thickness of the voussoirs on the extrados (if the bricks are axed, purpose-made or rubbed) and draw the bed joints of the voussoirs. It is important to note that these joints are radial, as shown by the broken constructional lines; thus the voussoirs within the portion of the arch *mnts* radiate from centre *e*, and those within portion *nout* radiate from centre *k*. It will be seen that the bricklayer will only require three differently shaped templets to which axed or rubber voussoirs are shaped, *i.e.*, one for the central voussoirs, one for those within the intermediate portions *mnts* and *orvu*, and one templet for the voussoirs within the two end portions. Also for purpose-mades, three similarly shaped but larger (to allow for shrinkage) moulds will serve the moulder to shape the bricks.

ELLIPTICAL ARCH (see K, Fig. 19).—This may be adopted as an alternative to the circular arch H. The method of setting out briefly indicated in the figure has been selected as an alternative to that described for the semi-elliptical arch J. It will be seen that only four centres *e, m, n* and *f* are required.

Setting-out.—After the major and minor axes have been drawn and their lengths decided upon, with centre *a* and radius *ab* describe arc *bc*; join *bh*, with centre *h* and radius *hc* describe arc *cd*; bisect *bd*, and the two centres *e* and *f* are at the intersection between this bisector and the two axes; the two remaining centres *m* and *n* are easily obtained by making *am* = *af* and *an* = *ae*. The voussoir joints of each of the four sections of the arch radiate towards its centre. Only two templets are required for the whole of the voussoirs.

POINTED ARCHES.—These are also known as Gothic arches, as the pointed arch is characteristic of this style of architecture. The intrados and extrados of each of the several forms of this type of arch are segmental curves which intersect at the pointed apex at which each half abuts to form a vertical joint on the centre line. It is therefore not usual to have a key.

There are five forms of pointed arch, *i.e.*, equilateral, drop, lancet, Tudor and Venetian.

The first three are illustrated at T, Fig. 19. The *equilateral arch* is shown at R, bonded on face; the radius of each curve of the intrados equals the span, the centres are at the *ends* of the springing line and the extrados is parallel to the intrados. A *drop arch*, as at Q, has its centres on the springing line and *within* it; in the example the span is 4-ft. 6-in. and the radius is 3-ft. 9-in. A *lancet arch* has its centres on the springing line and *outside* the span; that shown by broken lines at S has a span of 2-ft. 3-in. and the radius is 2-ft. 7½-in. In each form the bed joints of the voussoirs radiate to their respective centres. The equilateral and drop arches are shown in section at O.

TUDOR ARCH (see N, Fig. 19).—This arch, commonly employed during the Tudor period, has four centres, all within the span; two of them are on the springing line and the other two are below it. The Tudor arch, like the semi-elliptical, is a weak form.

Setting-out.—There are several methods. In that shown, *ac* is set up and made equal to ⅜ (or ⅝) rise *em*; join *mc* and draw *mn* at right angles to it of indefinite length; mark off *mn* and *ar* = *ac*; join *nr*, bisect it and continue the bisector until it intersects *mn* continued at *s*; *s* and *r* are the required centres for the right half of the arch, and *sr* produced to *u* is a common normal. The remaining two centres *v* and *w* may be found by measuring from the centre line. The voussoir bed joints radiate from the respective centres. Two templets are required for the voussoirs.

VENETIAN ARCH (see L, Fig. 19).—This pointed arch is deeper at the crown than at the springing line. The centres are on the latter. The voussoirs are radial from the centres of the *intrados* curves.

FLORENTINE ARCH (see M, Fig. 19).—This, like the Venetian arch, is deeper at the crown than at the springing. The intrados curve is semicircular, and the extrados has a pointed apex as it consists of two segmental curves, as shown. Here also the voussoirs are normal to the *intrados* curve. Sometimes the extrados is semi-elliptical.

A *semi-hexagonal arch* and a *tiled segmental arch* are illustrated in Fig. 24 (see p. 64). Note also the flat arch at H, Fig. 24, Vol. III.

The centering for the above arches is described on pp. 60 and 62, Vol. III.

DAMP PROOFING OF BASEMENTS

The materials used for horizontal damp proof courses and their application are described on pp. 17 and 18, Vol. I. Vertical damp proof courses will now be considered.

The materials chiefly used for vertical damp proof courses are (1) bituminous substances and (2) waterproofed cement and concrete.

1. BITUMEN is a name applied to natural pitchy (see p. 54) substances consisting principally of hydrocarbons which vary in colour and hardness. It includes (*a*) natural asphalt, (*b*) artificial asphalt and (*c*) fibrous asphalt felt.