

W. FENNELL.  
TUBE MILL.  
APPLICATION FILED JUNE 12, 1913.

1,154,982.

Patented Sept. 28, 1915.

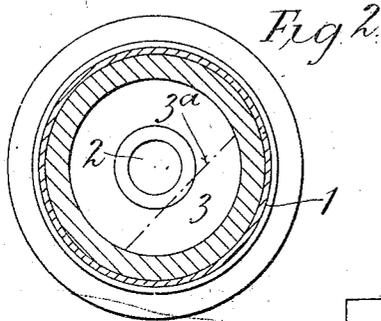
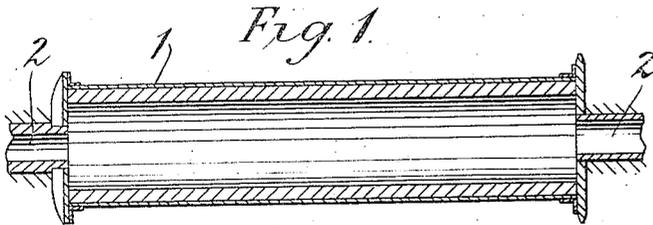


Fig. 3.

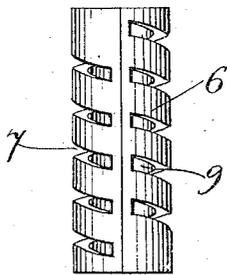


Fig. 4.

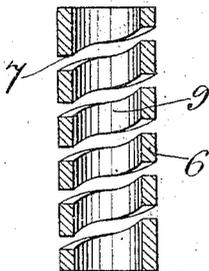
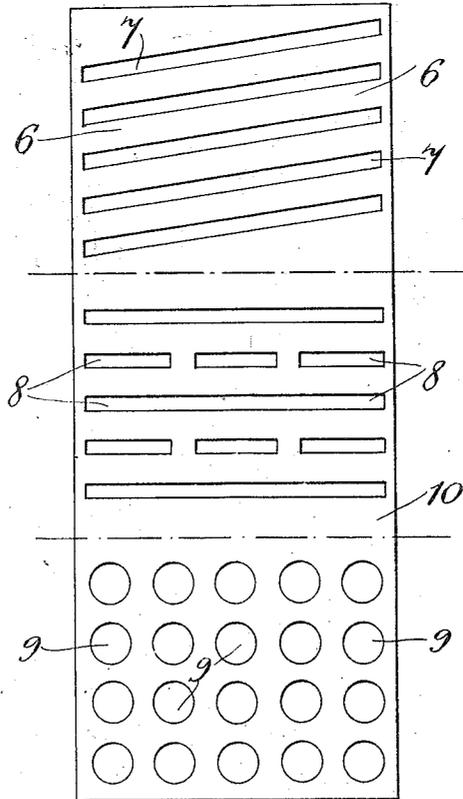


Fig. 5.



Witnesses:  
*[Signature]*  
*[Signature]*

William Fennell  
By Davis & Davis  
Attorneys

# UNITED STATES PATENT OFFICE.

WILLIAM FENNELL, OF SOUTHAM, NEAR RUGBY, ENGLAND.

## TUBE-MILL.

1,154,982.

Specification of Letters Patent. Patented Sept. 28, 1915.

Application filed June 12, 1913. Serial No. 773,189.

To all whom it may concern:

Be it known that I, WILLIAM FENNELL, a subject of the King of Great Britain and Ireland, residing at Southam, near Rugby, in the county of Warwick, England, have invented Improvements in or Relating to Tube-Mills, of which the following is a specification.

In the specification of another application for Letters Patent filed by me November 16th 1912, Serial No. 731861, I have described the use in tube mills for grinding and pulverizing cement, slag, limestone, ore, coal and other materials, of a large number of loose freely movable grinding bodies each made hollow or partly hollow for the reception and movement of material to be ground and made of comparatively small length in relation to the diameter of the mill but of greater length than diameter or width, the relative dimensions and shape being such that the several grinding bodies when in use will not roll upon each other but will move in planes at right angles, or approximately so, to the axis of the rotating mill and will raise material to be ground from the lower part of the mill and distribute it among the grinding bodies, all as and for the purposes set forth in the said specification.

In the said former specification, the grinding bodies described by way of example, comprised short bodies of circular, oval or elliptical shape in cross section and having a hole extending centrally and lengthwise therethrough, their length being equal to only a small fraction of the radius of the mill. Now according to the present invention, the comparatively small elongated hollow grinding bodies are each formed with one or more grooves, recesses, holes or passages (hereinafter referred to generically as holes) extending from its exterior surface inward to any desired extent but preferably so as to pass completely through the wall of the hollow body and communicate with the hole or passage extending lengthwise therethrough. In either case the weight of the grinding body relatively to its overall dimension will, with advantage, be decreased as compared with the grinding bodies described in the said former specification. The holes may be of any de-

sired shape, as for example circular or slot-like, and in the latter case may be curved or straight and be variously arranged, as for example at right angles or inclined to the axis of the grinding body. The unrecressed or unperforated portion or portions of the outer surface of the grinding bodies must of course be wider or larger than the recessed or perforated portion or portions thereof so as to avoid any possibility of adjacent grinding bodies becoming interlocked or entangled with each other instead of sliding endwise one against the other.

Grinding bodies such as described may be of hardened and tempered steel or of other metal or material according to the nature of the material to be ground.

In the accompanying illustrative drawings, Figure 1 shows in central longitudinal section, and Fig. 2 in cross section, to a larger scale, a tube mill, Figs. 3 and 4 show respectively in side elevation and vertical section, one of the improved grinding bodies. Fig. 5 shows a perforated metal strip from which grinding bodies such as shown in Figs. 3 and 4 can conveniently be made. Fig. 6 shows in end view a modified form of the grinding body.

1 is a tube mill of any ordinary construction having hollow trunnions 2 and in which a large number of loose freely movable grinding bodies constructed according to the present invention, with intermixed cement or other material to be ground, are placed for the purpose of grinding such cement or other material when the mill is rotated, the mass of grinding bodies with intermixed material being indicated at 3 and bounded at the top by the dotted line 3<sup>a</sup>.

Figs. 3 and 4 show a hollow grinding body made in the form of a short cylindrical tube 6 having a number of holes extending through its wall. Such holes may be elongated and inclined to the axis of the hollow body, as shown at 7 in Figs. 3, 4 and 5, or be arranged at right angles to the axis of the body as shown at 8 in Fig. 5, or be made of curved form, for example of circular form, as shown at 9 in Fig. 5. Such hollow perforated grinding bodies may conveniently be made from strip metal 10, for example steel (see Fig. 5), in which the holes of the de-

sired shape are punched and which is then cut into short lengths or blanks that are bent into tubular shape in any convenient manner to form the required hollow perforated grinding bodies. The grinding bodies instead of being of circular cross section, as shown in Fig. 4, may each be of other shape in end view or cross section, for example of hollow oval shape as shown in Fig. 6. The new grinding bodies may advantageously be made about 2 inches in length, about  $\frac{1}{4}$  of an inch in external diameter and about  $\frac{1}{8}$  of an inch in internal diameter.

Grinding bodies according to the present invention are used in the manner described in the specification of my said former application Serial No. 231861, such bodies moving endwise in planes at right angles approximately to the axis of the mill, rising where they are in contact or near to the inner surface of the mill and then turning over at the top of the load and descending and also turning over end for end when they abut endwise against each other until they reach the bottom of the mill when they again ascend. In this way the bodies slide endwise against each other and grinding material between them. The holes or passages 7, 8, 9 (Figs. 3, 4 and 5) extending through the walls of each body serve in addition to the hole 11 extending through the center of the body, to further lighten the body as compared with its overall bulk, and also to raise material to be ground and distribute it among the mass of grinding bodies in such manner that a greater output of ground material is obtained from a mill of given size in a given time charged with such grinding bodies than with the same weight of grinding bodies previously used. Furthermore, by making the hollow grinding bodies of helical or perforated shape as described, they have a greater overall bulk for a given weight than hollow grinding bodies such as described in the specification of my said former application Serial No. 731861, and a far greater overall bulk for a given weight, as compared with solid metal cylinders, each having the same area of grinding surface, so that the volume or bulk of the load, composed of cement or other material to be ground and grinding bodies, in the mill will be increased as compared with a load comprising the same weight of cement or other material and grinding bodies of either of the other forms referred to, with the result that not only will the output of the mill be considerably increased but the power required to drive the mill and its load will be decreased.

What I claim is:—

1. The combination with a tube mill of a number of loose freely movable hollow grinding bodies each made of a length that is equal to a fraction only of the radius of

the mill but is of greater length than diameter and has in its peripheral surface a plurality of holes the width or diameter of each of which is less than the width of adjacent portions of the said peripheral surface.

2. The combination with a tube mill of a number of loose freely movable hollow grinding bodies each made of a length that is equal to a fraction only of the radius of the mill but is of greater length than diameter and has a plurality of holes extending completely through its wall, the width or diameter of each hole being less than the width of adjacent portions of the peripheral surface of said wall.

3. The combination with a tube mill of a number of loose freely movable hollow grinding bodies each made of a length that is equal to a fraction only of the radius of the mill but is of greater length than diameter and has a plurality of elongated holes extending partly around and completely through its peripheral wall.

4. The combination with a tube mill of a number of loose freely movable hollow grinding bodies of uniform external cross sectional dimensions throughout their length, each of said bodies being made of a length that is equal to a fraction only of the radius of the mill but is of greater length than diameter and having a plurality of holes extending through its peripheral wall at an angle to the open ended hole extending centrally and longitudinally through the longest dimension of the body.

5. The combination with a tube mill of a number of loose freely movable hollow grinding bodies of uniform cross section throughout their length, each of said bodies being made of a length that is equal to a fraction only of the radius of the mill but is of greater length than diameter and consists of a tube of sheet material divided longitudinally and having holes extending through its wall.

6. The combination with a tube mill of a number of loose freely movable hollow cylindrical grinding bodies each made of a length that is equal to a fraction only of the radius of the mill but is of greater length than diameter and consists of a longitudinally slitted metal tube having a plurality of slot shaped holes through its walls and its edges adjacent to the slit arranged near together.

7. The combination with a tube mill of a number of loose freely movable grinding bodies each made of a length that is equal to a fraction only of the radius of the mill but of greater length than diameter and of uniform cross sectional dimensions externally from end to end and having a hole extending freely therethrough and a plurality of holes extending through its peripheral wall.

8. The combination with a tube mill of  
a number of loose freely movable hollow  
grinding bodies each made of a length that  
is equal to a fraction only of the radius of  
5 the mill but of greater length than diameter  
and of cylindrical shape both externally and  
internally and having a plurality of holes  
extending through its peripheral wall at an  
angle to the open ended hole extending cen-

trally and longitudinally through the long- 10  
est dimension of the body.

Signed at London, England, this 4 day  
of June 1913.

WILLIAM FENNELL.

Witnesses:

CYRIL UNDERLAW,  
O. J. WORTH.