



**EUROPEAN PATENT APPLICATION**

Application number : **92300953.4**

Int. Cl.<sup>5</sup> : **E21D 9/06**

Date of filing : **04.02.92**

Priority : **04.02.91 GB 9102357**

Inventor : **Washbourne, Jim**  
**8 Isis Close**  
**Long Hanborough, Oxon OX7 2JN (GB)**

Date of publication of application :  
**12.08.92 Bulletin 92/33**

Representative : **Arthur, Bryan Edward**  
**Withers & Rogers 4 Dyer's Buildings Holborn**  
**London EC1N 2JT (GB)**

Designated Contracting States :  
**BE DE DK ES FR GB IT NL**

Applicant : **OXFORD POLYTECHNIC**  
**External Relations Centre**  
**Headington, Oxford OX3 0BP (GB)**

**Seal between linearly and angularly moveable parts, in particular for tails of shield tunneling machines.**

This invention relates to seals and more particularly to seals for sealing between two relatively movable parts which may be linearly and angularly moveable.

The seal is characterized by at least two confronting rows of sealing elements with adjacent element at each row positioned to overlap each other and with the element of any two confronting rows located to overlap in opposite directions.

This invention relates to seals and more particularly to seals for sealing between two relatively moveable parts which may be linearly and angularly moveable.

Many sealing systems have been proposed for sealing between relatively moveable parts including ring seals, plate seals, and labyrinth seals and such seal may be made from relatively rigid material such as metals, loaded and unloaded plastics materials, synthetic and natural rubbers. One form of seal a packing for use when tunnelling underground is a so called brush seal such as that described and claimed in UK Patent No. 1,545,930. Specifically, the brush type packing according to UK Patent No. 1,545,930 is used for sealing an annular gap between two surfaces, either the surfaces of two parts of the apparatus or of the apparatus and the wall of the tunnel and comprises a ring-shaped brush of resilient wear-resistant fibres, and means securing said brush to one surface at the position where the gap is to be closed, the fibres projecting away from said one surface at an angle to engage said other surface, the interstices between the brush fibres being sealed with a material which can be applied in a condition of sufficient fluidity to permeate said interstices and when applied renders said brush substantially impermeable to water without substantially reducing the resiliency of the brush.

A seal in accordance with the present invention is particularly but not exclusively useful when tunnelling underground and when sinking a shaft especially when such tunnelling and shaft work is carried out below the water table. Considerable advances have been made in the development of slurry and mechanical earth pressure balance tunnelling machinery and the seal according to the present invention is eminently suitable to constitute an accessory or an integral part of such machines. When tunnelling using such machines, seals are required to allow only unidirectional movement. Such seals are frequently referred to as tail seals and must withstand pressures imposed by a bentonite lubricating slurry or grout.

According to the present invention a seal for sealing between two relatively moveable parts is characterized in that the seal comprises at least two confronting rows of sealing elements, in that adjacent elements of each row overlap each other and in that the elements of any two confronting rows overlap in opposite directions.

The invention also includes a seal for sealing between two relatively moveable parts characterized in that the seal comprises at least two confronting rows of sealing elements, in that adjacent elements of each row successively overlap each other to form a series of steps and in that the overlap of adjacent elements in any one row is a mirror image of the overlap of adjacent elements in a confronting row. It will, therefore, be appreciated that the overlapping configuration of the elements in any one row forms a series of sealing

lines between adjacent elements and that these sealing lines are directed in the opposite sense to the sealing lines between adjacent elements in the next confronting row.

The invention further includes a seal for sealing between two relatively moveable parts characterized in that the seal comprises at least two confronting rows of sealing elements, in that the adjacent elements of each row successively overlap each other to form a series of steps and in that the steps of the one row of sealing elements extend towards a sealing element in a confronting row of sealing elements. Preferably the steps in one row are staggered with respect to the steps of a confronting row.

A seal in accordance with the present invention may, if desired be used in conjunction with a brush-type seal such as that disclosed in UK Patent No. 1,545,930.

One form of seal in accordance with the present invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is part longitudinal section taken along a line AA of Figure 2 through two confronting rows of overlapping sealing elements;

Figure 2 is a transverse section taken along a line BB of Figure 1 and

Figures 3 and 4 show, in plan two forms of sealing elements, whereas

Figure 5 is a section taken on line M-M- of Figure 3.

Referring to Figure 1, two confronting rows 1 and 2 of steel plate sealing elements A are shown with adjacent sealing elements in overlapping and contiguous relationship to form a succession of overlapping elements. Considered slightly differently, the overlapping elements form a series of steps.

The degree of overlap is indicated at O in Figure 1 and this may vary between 10% and 75% and is preferably between 40% and 60%. The two rows 1 and 2 are separated or divided by an imaginary line joining double headed arrows N in Figure 1. From figure 1 it will be seen that the overlapping configuration of row 1 is a displaced mirror image of the overlapping configuration of the confronting row, row 2.

Referring to Figure 3, each sealing element includes a first portion 3 having 2 fixing holes 5 and a sealing portion 4. As indicated in Figure 5, the sealing element is bent along a line 6 out of the plane of the portion 3 by an amount of 50 degrees to form a sealing portion 4.

Figure 2 shows an assembly of sealing elements as indicated in Figure 1 bolted at 7 to a support plate 8 with a silicone rubber sealing fillet 9 disposed between the assembled rows of sealing elements and the support plate 8.

Where a seal consists of a single row of overlapping sealing elements such as row 1 (see Figure 1),

it will be appreciated that application of a force in the direction of arrow X to any individual element A will create a leakage path between that element A which the force is applied and an adjacent overlapping element at position L in Figure 1. On the other hand where at least two rows of confronting elements are used and where the overlapping configuration in one row is opposite from the overlapping configuration of the next confronting row, application of a force in the direction X although producing a leakage path L will, nevertheless, serve to increase the contact pressure between overlapping sealing elements in the second row and thereby effect a satisfactory seal. This same sealing effect would obtain in reverse if a force is applied to any sealing element in row 2 of Figure 1 in a direction Z. In this situation however leakage paths would be produced between adjacent and overlapping element in row 2 whereas a mechanical face to face seal would be produced between adjacent overlapping sealing elements in row 1.

The sealing elements A may be made from steel, spring steel, alloys capable of withstanding corrosive environments and frictional wear, loaded and unloaded plastic materials and natural and synthetic rubbers.

If desired, the sealing elements may be coated with a natural or synthetic material such as silicone composition. Further, greases containing flake and/or fibre additive may be forced in the interstices between confronting rows as an additional sealing medium. Coating of the sealing elements using a silicone composition possesses an added advantage in that front which is usually present during tunnelling or boring will not stick to the elements. Teflon (Registered Trade Mark) may also be used as a coating material.

Figure 2A shows a modification of the opposing overlapping arrangement of Figure 1.

### Claims

1. A seal for sealing between two relatively moveable parts characterised in that the seal comprises at least two confronting rows of sealing elements, in that adjacent elements of each row overlap each other and that the elements of any two confronting rows overlap in opposite directions.
2. A seal for sealing between two relatively moveable parts characterised in that the seal comprises at least two confronting rows of sealing elements, in that adjacent elements of each row successively overlap each other to form a series of steps and in that the overlap of adjacent elements in any one row is a mirror image of the overlap of adjacent elements in a confronting row.
3. A seal according to claim 2 characterised in that the overlap of adjacent elements in anyone row is a displaced mirror image of the overlap of adjacent elements in a confronting row.
4. A seal for sealing between two relatively moveable parts characterised in that the seal comprises at least two confronting rows of sealing elements, in that each element in a row overlaps an adjacent element of the same row to form a succession of overlapping elements, and in that the overlapping configuration of the elements in any one row is a mirror image of the overlapping configuration of the elements in a confronting row.
5. A seal for sealing between two relatively movable parts characterised in that the seal comprises at least two confronting rows of sealing elements, in that the adjacent elements of each row successively overlap each other to form a series of steps and in that the steps of the one row of sealing elements extend towards a sealing element in a confronting row of sealing elements.
6. A seal according to claim 5 characterised in that the steps of one row are staggered with respect to the steps of a confronting row.
7. A seal according to any preceding claim characterised in that each sealing element comprises a first portion and an elongate sealing portion inclined at an angle to the first portion.
8. A seal according to claim 4 characterised in that the sealing portion has a width, measured in a direction transverse to the elongation thereof, which is greater than a corresponding transverse dimension of the first portion.
9. A seal according to claim 7 or claim 8 characterised in that the first portion of each sealing element is mounted in a support.
10. A seal according to claim 9 characterised in that the support is arcuate, annular or linear.

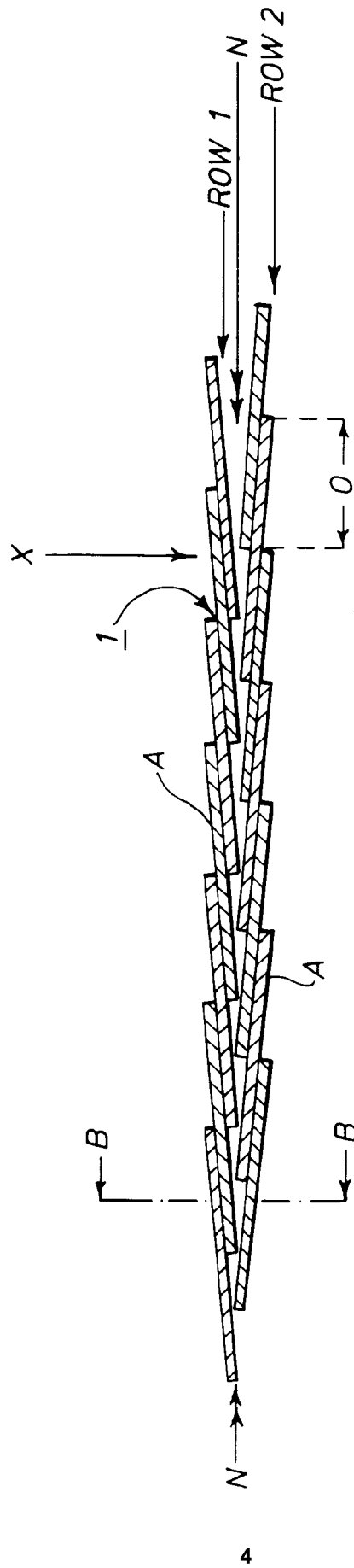


Fig.1.

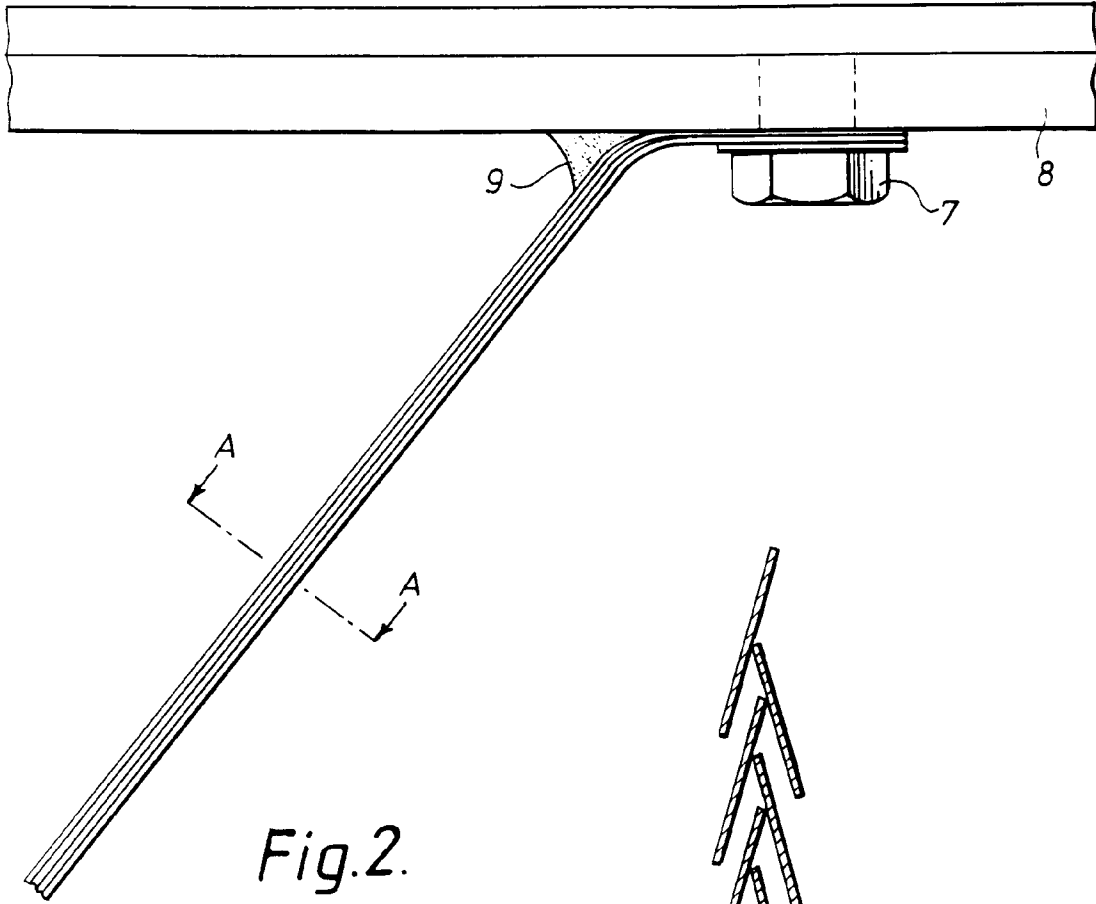


Fig. 2A.

