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1,686,938

H. R. STRATFORD

SURFACING APPARATUS

Filed April 10, 1926

2 Sheets-Sheet 1

Fig. 1.

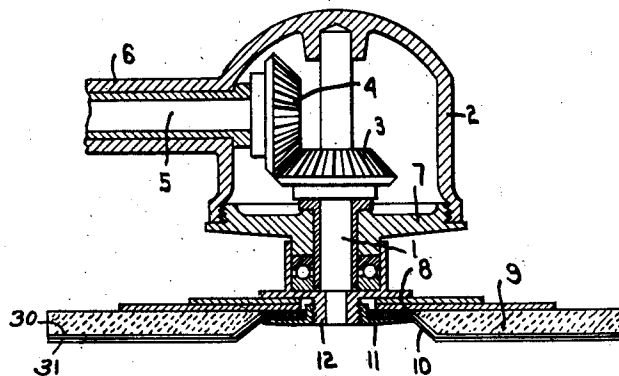


Fig. 5.

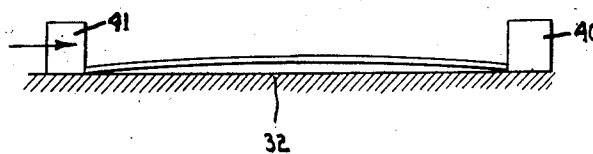
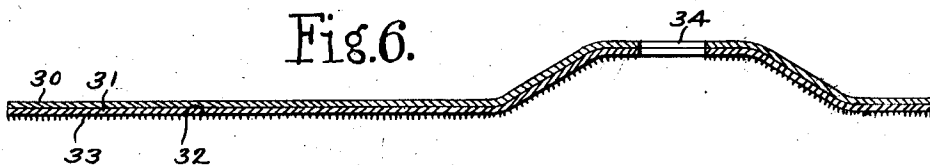


Fig. 6.



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2 Sheets-Sheet 2

Fig. 2.

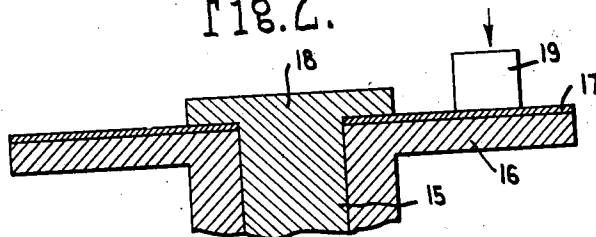


Fig. 3.

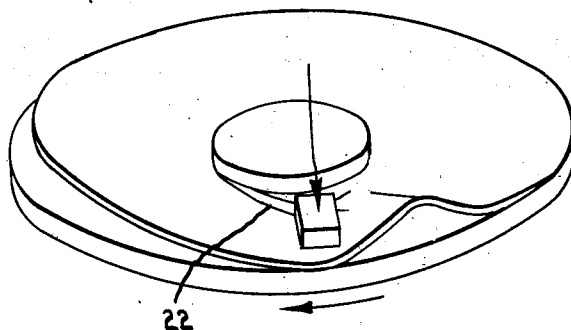
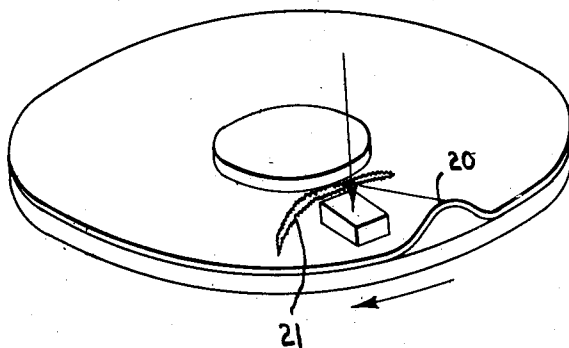


Fig. 4.



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SURFACING APPARATUS.

Application filed April 10, 1926. Serial No. 101,087.

The present invention, relating, as indicated, to surfacing apparatus is particularly directed to an improved surfacing disk for use with apparatus of the general character in which a sheet or disk of coated material is secured to a moving shaft, such as a rotating or oscillating shaft, for operation against a surface of wood, metal or other character, and is further directed to the provision of a disk for the purpose stated having the properties enabling it to withstand the extremely severe conditions to which such a disk is subjected in service. To the accomplishment of the foregoing and related ends, said invention, then, consists of the means hereinafter fully described and particularly pointed out in the claims.

The annexed drawings and the following description set forth in detail certain mechanism embodying the invention, such disclosed means constituting, however, but one of various mechanical forms in which the principle of the invention may be used.

In said annexed drawings:—

Fig. 1 is a transverse central section through one form of surfacing apparatus illustrating the use of a surfacing disk in conjunction therewith; Fig. 2 is a transverse central section illustrating the conditions to which such a disk is subjected in service; Fig. 3 is a view in perspective illustrating one type of strain to which said disk is subjected; Fig. 4 is a similar view illustrating another type of strain; Fig. 5 is a diagrammatical view of a strip of my improved material; and Fig. 6 is a transverse central section through my improved disk.

The surfacing of metal sheets or plates and panels of metal, wood and other materials, either coated or uncoated, can most expeditiously be carried out by apparatus employing moving sheets of surfacing material, such for example as with a machine in which a sheet or disk of abrasive paper, cloth or other material is rapidly moved over such a surface while properly supported by a compressible or yieldable support. The sheets of abrasive paper may be either secured all over their reverse surface to a suitable support by means of an adhesive of certain characteristics, or they may be secured

at a central point or over a central area to the support or operating member. Up to the present time apparatus of this general character has been used in which disks have been secured to the operating member or shaft throughout a small central area only, and great difficulty has been experienced in the manufacture of any sheets of abrasive material which would withstand the very severe conditions of use and would operate satisfactorily for a reasonable length of time without rupture. The present invention is directed to the provision of such a sheet of surfacing material, and specifically an abrasive disk for use on a rotatable or oscillatory shaft.

Referring now to Fig. 1, there is shown a machine of a type now in general use in which an operating shaft 1 is suitably supported within a framework or housing 2 and is driven through gears 3 and 4, the gear 4 being carried on the shaft 5, which extends through, and is journaled in, an extension of the casing 6, and may be secured and operated by any suitable mechanism, such, for example, as a flexible shaft (not shown). The shaft 1 extends through one side 7 of such casing and carries at its extending end a suitable supporting member or plate 8 formed of metal, and a second supporting pad 9, which may be formed of any suitable compressible material, such as felt, rubber or the like. If desired, the pad 9 may be formed with a centrally disposed recessed portion 10, into which a correspondingly formed portion of the disk now to be described will be received and there held by means of a clamping disk 11 adapted to be engaged by means of threading 12, or other suitable mechanism, with the projecting end of the shaft 1.

My improved disk is illustrated in Fig. 6 and consists, as elsewhere stated, of a sheet 30 of a suitable stiff and relatively inflexible cellulose product to which is adhesively secured all over one surface a second sheet of cloth or fabric 31, while to the free surface 32 of the fabric is adhesively secured a layer of grains 33, this composite disk being provided with a central opening 34 for convenient attachment to the shaft of the machine

described by means of the attaching nut 11.

The action to which a disk employed in the machine illustrated in Fig. 1 is subjected is illustrated in Fig. 2, in which the operating shaft is represented at 15, the supporting members for the disks being represented as a single element 16, while a disk 17 is shown supported against the member 16, and there held by means of a clamping and driving element 18. If such a device is engaged with a surface to be operated upon by pressing one side or segment of the surfacing disk against such work, the work may be represented by a block 19, shown in Fig. 2 and represented as a resistance pressing against the outer or free side of the surfacing disk and tending to retard the movement of this disk as it is driven around by the operating shaft 15.

The various forces acting against the disk tend to produce a wave behind the portion of the disk applied to the work, namely, behind the block 19 of Figs. 2, 3 and 4. This action is illustrated in Fig. 4, in which the disk is shown as bent up with a waved portion 20 behind the engaged portion of the disk. The result of these forces acting against the disk is to produce a rupture of the character represented at the point 21 in Fig. 4, in which the outer portion of the disk has been torn loose from the central portion, the break occurring along a line approximately as indicated in that figure.

A second result of the force to which the disk is subjected is illustrated in Fig. 3, and is seen to consist of a waving up of the flexible disk ahead of the friction body to such an extent that the disk may be actually lifted away from the surface of the supporting element. The result of this force, if continued to a point exceeding the resisting strength of the disk, is a rupture, indicated along the line 22 in Fig. 3, which follows upon the producing of a number of tangentially disposed wrinkles in the disk extending from the centrally held portion toward the outer edge.

A third possibility when a disk is subjected to the action described is that the disk may break loose from the clamp without being otherwise damaged, but obviously this action can only occur if the force necessary to overcome the stationary friction of the clamping member 18 is smaller than the force which will tear off or wave the disk, as illustrated in Figs. 3 and 4, respectively.

Simply stated, the forces acting on the disk tend to produce either tension in the disk which causes a direct rupture, or buckling of the disk, that is, in the case of disks which are held at their center or over a relatively small central area, as in the case of the disk illustrated in the drawings described. In such a disk the total tensile strength T of the disk is equal to the width times the thickness times the tensile strength of the disk itself in

pounds per square inch. In relatively thin disks, such as will most ordinarily be employed in the type of apparatus referred to, in order to have a suitable flexibility in the disk, it is difficult to measure the thickness accurately, and it is hence advisable in the consideration of the materials from which such disks may be constructed to consider as the tensile strength the number of pounds required to break one inch strips of the coated material. This property of the disks is entirely definite and is easily determined.

I have found that the only suitable material for the manufacture of abrasive coated disks which can be satisfactorily used in apparatus of the type described is a built-up or composite disk composed of united layers of a suitable paper or fiber stock, and cloth of suitable character, on which composite sheet the abrasive is then coated with a material which also adds somewhat to the total strength of the sheet. Such a reinforced or composite material is not only considerably stronger in tension than the backing materials which have heretofore been used in the manufacture of abrasive paper strips, belts and the like, but has a far more uniform strength when stressed in various dimensions. In addition to these properties such a reinforced material has an appreciable strength before rupture, and it therefore follows that the failure of such a disk will first occur by buckling rather than by direct rupture produced by an excess of oppositely applied pressures over the tensile strength of the material.

The force necessary to cause buckling in such a disk can be determined by Eulers' formula for long columns, which is expressed—

$$P = \frac{4\pi^2 E I}{L^2}$$

In this equation P is the load in pounds, $4\pi^2$ is the constant for fixed ends, E is the modulus of elasticity in pounds per square inch, I is $1/12 B \cdot D^3$ (axial moment of inertia), and L is the length in inches.

Substituting in this equation, we have—

$$P = \frac{\pi^2 b \cdot d^3 E}{3 L^2}$$

The modulus of elasticity for composite materials is of course unknown and is very difficult to determine. In the case of composite materials in which the adhesive is used to unite them and therefore the modulus of elasticity in the above equation has been determined directly by deflection with the use of the formula—

$$E = \frac{4 W \cdot g \cdot L^3 \lambda}{16 b \cdot d^3}$$

In this equation W is the weight in pounds, g equals 32.2 ft. per second, L equals the

length expressed in inches and λ equals the deflection also in inches. In such an equation the thickness of the material enters as the third power, and hence even minor errors in its measurement would introduce a large area in the modulus of elasticity obtained by this formula.

Either of the above mathematical equations is therefore extremely difficult to apply to determine the strength which is required for any surfacing disk under the conditions noted, and I have therefore determined the load required to cause failure by buckling by direct measurement. By using an apparatus having fixed and movable members between which were put the strips of material to be investigated, and in which a uniformly increased load could be applied against the opposite ends of the strip I have found that it is possible to determine the resistance to buckling of various types of material, including those which have heretofore been used for abrasive sheets and in the composite or reinforcing sheet, which is the only type which I have found suitable for the present use. By these determinations I have discovered that a composite sheet made up of cloth, a suitable paper stock and coated with an adhesive and then with abrasive grains, is approximately four times as strong as the strongest backing material ever used heretofore for abrasive sheets, whether used in disks in sheet form, in belts, or in strips. These determinations included the testing of a large number of samples of various types of material, in which the average strength of the composite abrasive sheets averaged more than four times the strength of the next best material heretofore used, which was cloth unreinforced by any type of paper stock.

Specifically, I have found that disks which consist of a strong cloth to which grains are glued upon one surface and which is then glued by a suitable adhesive to a sheet of cellulose stock has a resistance to buckling, which is a quality absolutely essential in a disk under the conditions noted, of more than 26 pounds per cross-sectional inch.

In Fig. 5 I have shown a method of determining the buckling strength or resistance of one inch strips of my composite material. This was determined by taking a strip an inch wide and two inches long and placing them between a fixed pier 40 and movable pier 41 and supporting the strip upon a flat surface 32. The strip was given a very slight curvature away from the support 32. By applying gradual increasing pressures to the movable member 31 the buckling resistance of various types of materials was readily determined, and no materials were found except my improved composite sheet which showed anything like a sufficient buckling resistance to withstand the forces acting against the sheets when in use as disks in the manner previously

described and illustrated in Figs. 1 and 2. All other materials, both by tests of the nature just described and also in actual use, were entirely insufficient to withstand the strains and buckled and wrinkled, finally producing ruptures, as well as marring the surface of the work prior to the actual breaking of the material.

It is essential in the product which I have described to have a uniformity of resistance to buckling over the entire disk which can only be secured by a composite material due to the irregularities in the strength of any single sheet of material, such, for example, as cardboard, fiber or paper. Furthermore, as it is necessary for the entire sheet to have a slight flexibility to accommodate itself to the surface which it is operating upon it is necessary that the abrasive be adhesively secured, not to a smooth, hard surface, such as a disk of fiber, cardboard stock or the like, but to a cloth which the adhesive will penetrate to some extent, and into the surface of which the abrasive may be slightly impressed when applied. All of these desirable and necessary factors are secured in the composite disk which I have described, and are absent in any other type of disk of the various types which have heretofore been used.

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the mechanism herein disclosed, provided the means stated by any of the following claims or the equivalent of such stated means be employed.

I therefore particularly point out and distinctly claim as my invention:—

1. A surfacing device consisting of a supporting pad and a surfacing disk, said disk consisting of a stiff and strong sheet of a cellulose product, a sheet of cloth adhesively secured over substantially its entire area thereto, and a coating of grains adhesively secured over the free surface of said cloth, said composite disk being relatively stiff and rigid and having the capacity of resisting the torsional and buckling strains imposed upon it under rotation at high speed from a central point and when supported over its rear surface by said pad free therefrom except adjacent such central point, and having also the capacity of flexing when under lateral pressure.

2. In a surfacing apparatus, the combination of a shaft, disk supporting means secured to the end of said shaft, and including a compressible pad, and a composite disk secured to said shaft at its center in position to be supported by said pad, said disk being free from said pad except at the center and consisting of adhesively joined sheets of a cellulose product and cloth having grains adhesively secured over one surface of said cloth and the cloth being interposed between said grains and said

sheet of cellulose product, said disk being relatively stiff and inflexible in its own plane, but having the capacity of flexing when under lateral pressure.

- 5 3. A composite surfacing element comprising a sheet of a cellulose product, a sheet of cloth adhesively secured over its entire area thereto, and a coating of grains adhesively

secured over the free surface of said cloth, said composite element being relatively stiff 10 and rigid in its own plane and having the capacity of resisting torsional and buckling strains and of flexing under lateral pressure.

Signed by me, this 8th day of April, 1926.

HERBERT R. STRATFORD.