Jan. 5, 1954 H. F. FISCHER 2,665,054

REPLACEABLE BLADE FAN

Filed Jan. 7, 1948 3 Sheets-Sheet 1

Fig. 1.

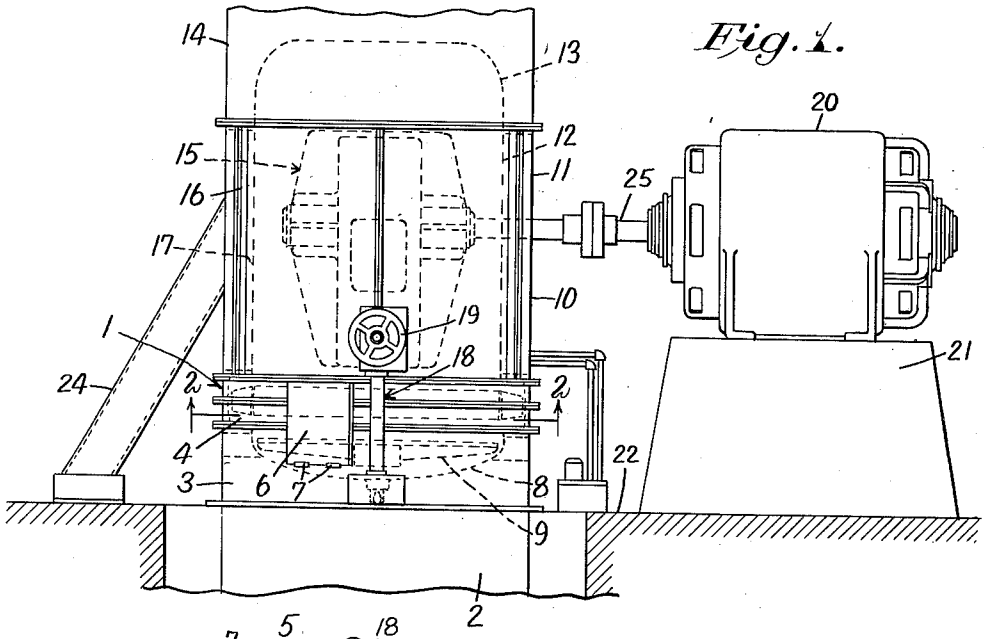
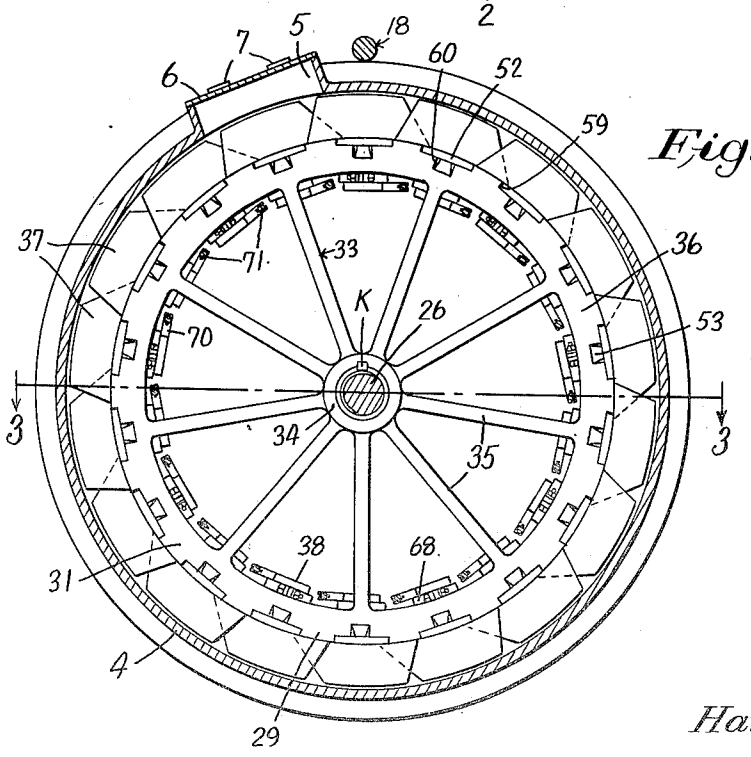


Fig. 2.



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REPLACEABLE BLADE FAN

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Fig. 3.

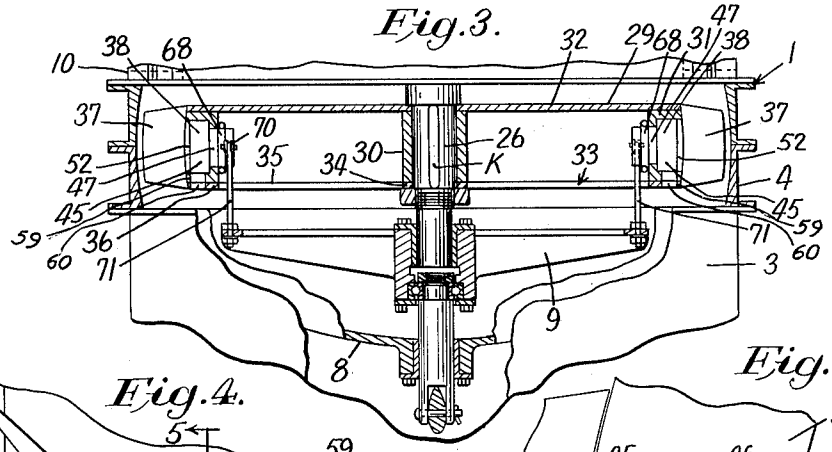


Fig. 4.

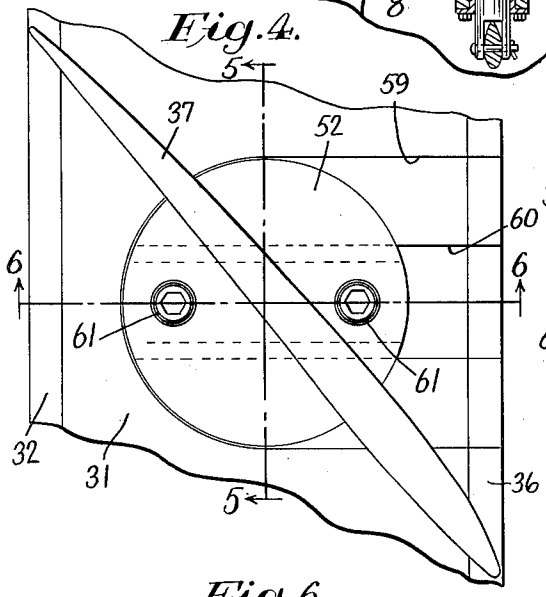


Fig. 5.

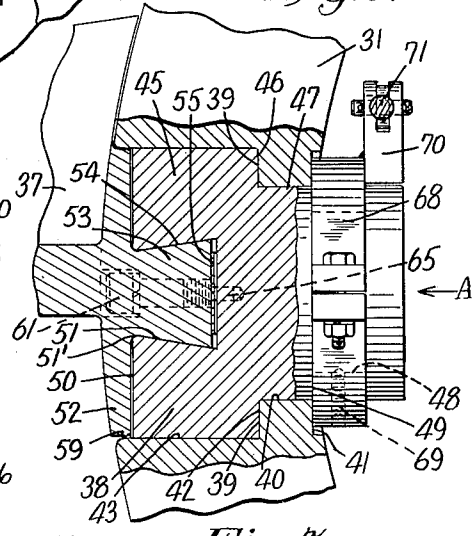


Fig. 6.

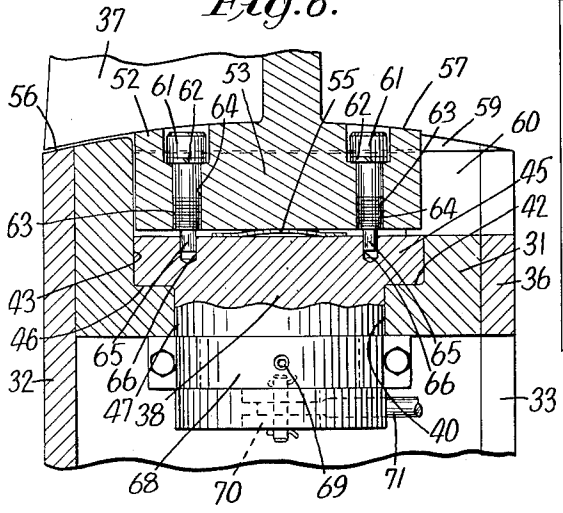
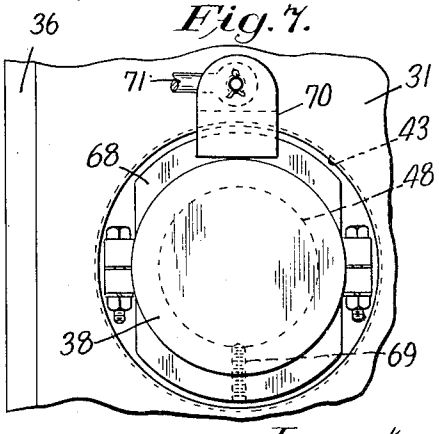


Fig. 7.



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REPLACEABLE BLADE FAN

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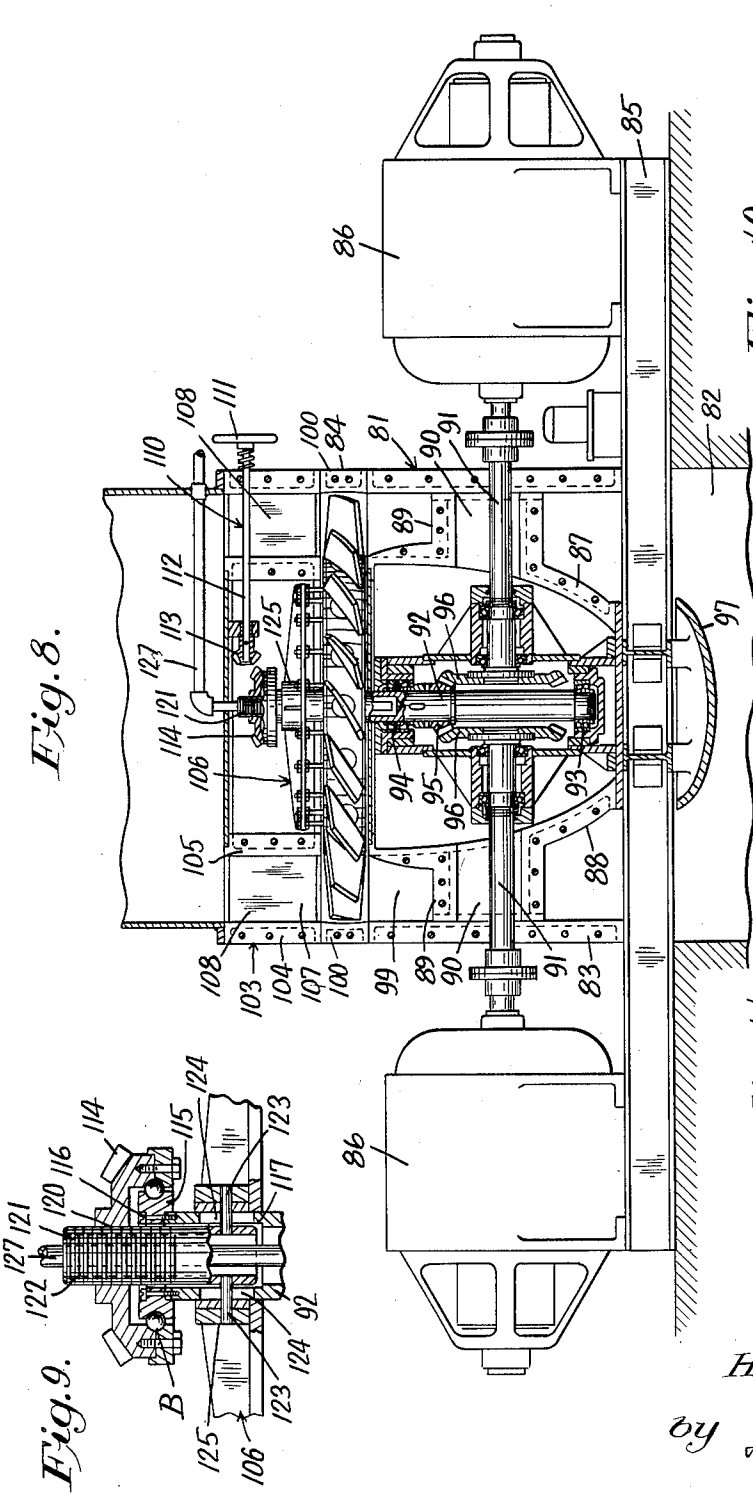


Fig. 8.

Fig. 9.

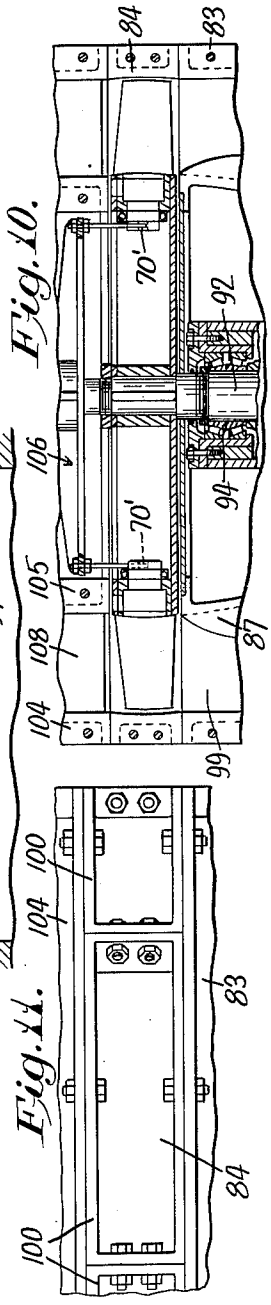


Fig. 10.

Fig. 11.

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Patented Jan. 5, 1954

2,665,054

UNITED STATES PATENT OFFICE

2,665,054

REPLACEABLE BLADE FAN

Hans F. Fischer, New Philadelphia, Ohio, assignor to Joy Manufacturing Company, a corporation of Pennsylvania

Application January 7, 1948, Serial No. 866

14 Claims. (Cl. 230—114)

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My invention relates generally to fans for moving air or other gaseous fluids under pressure through ducts, and more particularly to fans for uses in which the blades are subjected to very severe conditions resulting in their erosion, or progressive destruction in other manners, with the result that frequent changes of the fan blades are necessary.

Fans of the character herein involved find a very important field of use in connection with blast furnace operation. A great deal of loose ore dust collects in the filters on the tops of blast furnaces, and in order that it may be used and have the iron recovered from it, it is subjected to a sintering process in a sintering plant. In these plants the ore dust is put on top of hot coke on a conveyor belt constructed of suitable metal. A burner is associated with the conveyor belt, and this burner ignites the coke, and in order to keep the coke burning as the belt moves along, wind boxes are arranged beneath the conveyor belt and air is drawn through the ore dust and coke on the belt, and thereby not only is combustion maintained, but loss of the ore dust is reduced, and its holding in close contact with the coke is effected. The wind boxes are connected to a common duct, which in turn is connected to a fan supplying the necessary suction for the system. Commonly, before the air reaches the fan, it is put through an air cleaner in order to filter out as much of the dust as possible. However, a large amount of dust goes through the filter, and accordingly the air which reaches the fan blades contains a large amount of abrasive and erosive material, which acts on at least the blades of the fan rotor, which may be so arranged as to protect practically all of it except its blades, but these naturally must act on the stream of air and gas. After the air passes through the fan, it is led to a stack and discharged. The temperature that fans have to handle in systems of this kind is in the neighborhood of 400° F., which is a further factor in making replacement of the fan blades a not infrequent occurrence. These sintering plants cannot advantageously be shut down for substantial periods, and it is therefore necessary to have means which will enable blades which are no longer capable of efficient operation to be removed very quickly and replaced by new blades.

It is one of the particular objects of my invention to provide an improved fan structure, meeting the problems described. It is another object of my invention, more broadly, to provide an improved fan. It is a further object of the invention to provide an improved and simple mechanism permitting the expeditious exchange of fan blades. It is still another object of my invention to provide an improved mechanism for enabling the substitution of new blades for old in adjustable pitch fans. It is still another object of my invention to provide an improved arrangement for supporting fan blades in a fan rotor which will permit relatively easy replacement of the blades while at the same time avoiding looseness which would permit objectionable pounding of the parts. It is yet a further object of my invention to provide an improved blade supporting mechanism for a fan. Another object is the provision of an improved quick change blade supporting mechanism for a fan. Still another object of the invention is to provide an improved dovetail type mounting for fan blades having sufficient clearance to prevent binding of the parts even when abrasive material has infiltered between them, and having resilient means for preventing looseness in operation. A still further object of the invention is the provision of an improved replaceable blade fan structure having improved means permitting ease of access to and ease of change of fan blades. Still another object of the invention is to provide an improved fan having improved adjusting means. Yet a further object of the invention is to provide an improved blade angle adjusting means for a fan operating under adverse temperature conditions. Other objects and advantages of the invention will hereinafter more fully appear.

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While the invention may be incorporated in other types of fans, I have shown the same embodied in a sintering fan of the type hereinabove referred to; and, in the accompanying drawings, where two illustrative embodiments are shown,

Fig. 1 is a side elevational view with parts dotted in showing a portion of a sintering system and particularly showing an improved sintering fan and the drive therefor.

Fig. 2 is a section, on a larger scale, taken on a horizontal plane through the fan rotor and fan housing section, being taken on the plane of the line 2—2 of Fig. 1.

Fig. 3 is a vertical section, on a like scale, through the fan rotor and fan housing taken on the plane of the line 3—3 of Fig. 2.

Fig. 4 is a much further enlarged, end-on view of a fan blade and of a portion of the rim of

the rotor of the fan, showing the structure of the blade supporting means.

Fig. 5 is a section, on the plane of the line 5—5 of Fig. 4, through the blade mounting, the plane of the section including the axis of adjustment of the fan blade and being at right angles to the axis of rotation of the fan rotor.

Fig. 6 is a section on the plane of the line 6—6 of Fig. 4, this section also being taken on a plane including the axis of adjustment of the fan blade and, in this case, also the axis of rotation of the fan rotor.

Fig. 7 is an end view of a single fan blade support and of a part of its blade angle control, the view being taken in the direction of the arrow A in Fig. 5.

Fig. 8 is a view, mainly in vertical axial section, showing a portion of a sintering system, and particularly another improved sintering fan, including the driving and adjusting mechanisms therefor, some parts being shown in elevation.

Fig. 9 is an enlarged axial section showing a detail of the blade-adjusting mechanism of Fig. 8.

Fig. 10 is a vertical, axial section on an enlarged scale through the propeller ring, fan proper, and fan blade angle adjusting means.

Fig. 11 is an enlarged fragmentary view showing details of construction of the sectional propeller ring of the fan illustrated in Figs. 8 to 10.

Referring now to the drawings, and at this time to Figs. 1 to 7 thereof, and first to Fig. 1, it will be observed that there is shown in this figure a sintering fan generally designated 1. This sintering fan includes an intake connection 2 with an air cleaner or filter (not shown) through which ore dust and gases are passed from a sintering plant on their way to the fan 1, which provides the suction for the moving column of dust laden gases. The fan includes an intake section 3 mounted over and connected to the intake connection 2 and supporting a propeller ring structure 4. The intake section 3 and propeller ring structure 4 have an opening 5 in them over which a hinged door 6 is arranged, the hinges 7 connecting this door 6 to the intake section 3 permitting downward swinging of the door and ready access through the opening 5 to the fan blades individually as they are brought opposite the opening. A stationary nose 8 is mounted within the intake section 3, and within it there is arranged an adjusting mechanism spider 9 (see also Fig. 3) the adjustment of which spider may be accomplished as hereinafter described. Above the propeller ring there is arranged a vane ring assembly 10 including an outer fairing 11 and an inner fairing 12, the latter housing a gear unit and terminating in a stub tail 13 in a conduit 14 leading to an exhaust stack or the like. A suitable gear unit generally designated 15 is arranged within the inner fairing 12. Replaceable stationary vanes 16 extend between the inner and outer fairings 12 and 11, between which there is a generally annular duct 17, divided of course by the stationary vanes 16. Adjusting mechanism generally designated 18 for the adjusting mechanism spider 9 is controllable by a hand wheel 19 outside the outer fairing 11. A motor 20 is mounted upon a suitable pedestal 21 supported on a floor 22 adjacent the mechanism 1, which will be observed to be supported by supporting braces 24 upon the floor 22, and this motor supplies power through a driving shaft connection 25 and through the gear unit 15 to rotate the shaft 26 of the fan, it being noted that the gear unit effects a right angle turn in direction between the axis of motor rotation and the axis of fan rotation. It may be observed that this gear unit is adapted for dual motor drive if necessary, and may be similar to the drive shown in Fig. 8, from which it would of course differ in that the fan is in this present arrangement located forwardly of the gear unit.

A fan rotor 29 is mounted on the shaft 26 and held against rotation with respect to the shaft in any suitable manner, as by the key K. The rotor 29 may be of built up construction, or otherwise constructed, and is herein shown as consisting of a hub element 30, an annular rim portion 31, a solid web or plate portion 32, and an opposite web portion 33, which includes an annular hub portion 34, "spokes" 35, and a rim portion 36. The rim portion 36, the rim part of the plate 32, and the rim proper 31 of the fan rotor, may be suitably held together as by welding or in any other desired manner. The hub portion 34, the inner part of the web portion 32 and the hub element 30 are also suitably secured together, as by welding.

The rim 31 of the rotor is provided with a plurality of mountings for adjustably supporting the blades 37 of the fan. For the rotatable support of the fan blades, hub portions 38, which may be conveniently referred to as cartridges, are received in shouldered bearing seats 39. These bearing seats include an inner cylindrical bore or portion 40 surrounded by a flat annular surface 41 at its inner end, the surface 41 being turned or otherwise suitably machined on the rim portion 31 at the inside end of the cylindrical bore 40. At the outer end of the bore 40 there is provided another annular flat surface, numbered 42 in the drawings, and outwardly of the surface 42 there extends again a cylindrical internal surface 43 coaxial with the bore 40 and opening through the outer peripheral surface of the rim 31. It will accordingly be noted that each cartridge 38 has provided for it a stepped bore, the smaller, inner portion of which has plane surfaces at each end thereof.

The cartridges 38 each include a larger cylindrical portion 45 rotatably received and journaled in the internal cylindrical surface 43, and a reduced cylindrical portion 47 received and journaled in the cylindrical bore 40, and each has an annular surface 46 adapted to engage the annular surface 42 and formed at the inner end of the portion 45. The reduced cylindrical portion 47 extends, when the surfaces 46 and 42 are in mutual contact, well in beyond the surface 41 and has a peripheral groove 48, whose radially outer wall 49 is in the same plane with the surface 41, for a purpose later described. The dimension of the cylindrical portion 45 radially of the rotor is a little less than the depth of the bore bounded by the surface 43, and this cylindrical portion has a plane outer surface 50, traversed by a diametrically extending undercut or dovetail groove 51, the corners at the mouth of the groove 51 being rounded as at 51'.

Each fan blade 37 has a radially shallow, circular hub portion 52 from the inner side of which a dovetail projection 53, adapted to be received in groove 51, projects. This projection is of slightly smaller radial extent than the groove 51, and has a very small clearance between its lateral, relatively inclined surfaces 54 and the walls of the groove 51 when the hub portion 52 engages the surface 50. A suitable bowed spring 55, shown as having flattened ends, is arranged between the inner end of each dovetail projection 53 and the inner wall of the associated dove-

tail groove 51 and normally maintains the fan blade 37 thrust outwardly as far as possible and thus prevents clatter of the parts when the fan is rotating at but a slow speed.

It will be observed that the outer surface of the fan rotor rim as a whole is curved to conform to a zone of a sphere (see at 56), and the hub portions 52 of the fan blades 37 are formed as at 57 so as to conform to the same shape, as are also the inner end surfaces of the blades proper.

Means is provided so that when the cartridge 38 has its dovetail groove 51 extending parallel to the rotor shaft, with the arrangement shown, the blades 37 with their hub portions 52 and dovetail projections 53 can be slid out of the cartridges which respectively support them. To this end the rotor rim 31 and the rim portion of the plate 33 are cut away to provide a slideway which is generally T-shaped in section on planes transverse to the direction in which the slideway extends, this slideway including an outer, relatively shallow portion 59 through which the hub portion 52 of the fan blade may move, and a portion 60 which, in effect, constitutes a continuation of the dovetail groove 51 and opens through the rim portion 36. Obviously, the portion 60 could be made of the same cross section as the dovetail groove 51, but for ease in machining and the later handling of the parts, it may be made rectangular in cross section, and this arrangement is shown in the drawings.

It will be evident that the structure so far described permits the fan blades to be slid individually through the cutaway portions 59 and 60 in a direction longitudinally of the shaft 26, and there is provided to hold the fan blade elements to the cartridge elements 38 pairs of screws 61 having associated lock washers 62 and threadedly engaging at 63 within threaded bores 64 formed in the dovetail projections 53, these screws carrying pins 65 adapted to be received in bores 66 in the hub or cartridge elements 38. When these pins are in the bores 66, the fan blades are held against lateral movement, but when the screws 61 are backed out, the pins 65 are withdrawn from the bores 66, and then the blades may have their hub portions 52 and dovetail projections 53 slid outward through the grooves provided for this purpose in the rotor structure.

Split rings 68 are clamped to the inner portion 47 of each hub or cartridge element 38 and are received in the grooves 48 and engage the flat surfaces 41. They are held against turning relative to the cartridge elements by the clamping and also as by locking screws 69. This arrangement prevents outward movement of the hub or cartridge elements 38 and also permits, by rotation of the rings 68, rotation of the hubs or cartridges 38, with resultant adjustment of the blade angles. To effect this adjustment, one element of each of the rings 68 is provided with an arm portion 70 with which there is pivotally connected an adjusting rod 71, which adjusting rods are also suitably connected to the adjusting mechanism spider 9 and extend through the spaces between the spokes 35; and accordingly longitudinal movement of this spider along the shaft 26 will change the angle of all of the blades of the fan so that the quantity of air displaced may be varied. Any suitable connections between the hand wheel 19 and the spider 9 may be provided for moving the spider 9 in a direction to change the blade angle as desired, and movement in the other direction may be effected either by

opposite adjustment of the hand wheel or may be caused, by movement of the hand wheel, to provide clearance for the movements of the fan blades under the reaction of the air and of the centrifugal forces, or either of them. As such adjusting mechanisms are broadly old, they need not be described in detail. They generally comprise a primary adjusting means (such as a telescopic screw having means for controlling the length thereof), represented herein by 18, 19 and connections, including a lever pivoted at one end and moved by its other end by the primary adjusting means and connected through antifriction means with the adjusting spider or the like. Such a mechanism is diagrammatically shown in Figs. 1 and 3.

It will be noted that the size of the access door 6 is sufficient to enable a fan blade to be removed and replaced by another one, this process simply involving opening the access door, bringing the fan blade which is to be replaced opposite the opening, if necessary adjusting the blade angle so as to aline the groove 51 with the slots 60, backing off the screws 61, slipping the fan blade 37, its hub 52, its dovetail portion 53, and its associated screws 61 out of the rotor, slipping in a new blade, putting the spring 55 in position, screwing in the pair of screws 61, which are to be used to hold it in place, until the pins 65 enter the bores 66, reclosing of the access door, and readjusting the blade angle control if it had to be disturbed to make the change.

It will be evident that the changing of blades is a simple and very quick operation, that a new blade will automatically be in the proper angular relation to the other blades of the rotor, that any excessively eroded blade can be changed without having to change any other blade, that the structure is strong and durable, that having the hub portions 52 integral with the fan blades prevents erosion of the cartridge member 38, and that it is unnecessary to exert forces having any tendency to damage the hub or cartridge portion 38 through the screws 61, and that since the pins 65 are not tight fits for the bores 66 the spring 55 can perform its function of preventing chatter effectively.

Reference may now be had to sheet 3 of the drawings and to Figs. 8 to 11 thereon. Here it will be noted, as the description proceeds, that an arrangement is illustrated in which the fan has a dual motor drive, in which the fan is arranged rearwardly of the gear unit, and in which there is provided improved means for cooling working parts. Parenthetically, it may be remarked at this point that suitable arrangements may be made for localized cooling with respect to the structure of Figs. 1 and 3 if desired.

In Fig. 8 it will be observed that a sintering fan (fan mechanism) generally designated 81 includes an intake connection 82 with an air cleaner or filter (not shown) through which ore dust and gases are passed from a sintering plant on their way to the fan 81, which provides the suction for the moving column of dust laden gases. The fan includes an intake section 83 mounted over and connected to the intake connection 82 and supporting a propeller ring structure 84. More specifically, it may be noted that suitable supporting beams 85 extend across the intake connection 82 and at either end, as shown, have mounted upon them driving motors 86. The intake section 83 is of built up construction, so as to enable its piecemeal reconstruction as its destruction in use takes place. It houses a gear

casing 87, in the form of stationary nose 88, and fairings 89 provide spaces 90 through which drive shafts 91 actuated by the driving motors 86 extend into the gear casing 87. The latter supports and houses a fan-driving and supporting shaft 92 supported in lower and upper bearings 93 and 94 and driven by a bevel gear or pinion 95 secured to it and meshing with bevel pinions or gears 96 mounted on and driven by the shafts 91. A deflector or flow guiding plate 97 is arranged below the beams 85 in coaxial relation with the hollow nose 88. An annular passage 99 for gas flow—annular except as modified by the presence of the fairings 89—delivers the gases to the propeller ring 84. This propeller ring is made up of a plurality of sections 100, and any of these can be removed, providing thereby ready access to the fan blades individually as they are brought opposite the opening. Above the propeller ring 84, there is arranged a vane ring assembly 103 including an outer fairing 104 and an inner fairing 105, the latter housing an adjusting mechanism spider 106 (see also Figs. 9 and 10), and the annular passage 107 between the fairings 104 and 105 leads to an exhaust stack or the like. Replaceable stationary vanes 108 extend between the inner and outer fairings 105 and 104, and divide up the annular passage 107. Adjusting mechanism generally designated 110 is provided for the spider 106. This includes a hand wheel 111 outside of the fairing 104 supported by a longitudinally slidable shaft 112 and carrying a bevel pinion 113 adapted to be moved into mesh with and rotate a bevel gear 114 which is connected through a suitable ball bearing B, taking both radial and axial thrust, with an annulus 115 secured by holding means 116 to a hollow portion 117 of the fan supporting shaft 92. Thus the bevel gear 114 may rotate relative to the shaft 92 but is fixed against movement axially of the latter. This bevel gear is formed centrally as a nut 120 and coacts with a tube 121 projecting into the bore of shaft portion 117 and externally threaded as at 122 and having pins 123 extending radially therefrom and passing through longitudinal slots 124 in the shaft portion 117 and extending into the hub portion 125 of the spider 106 which, by these pins and slots, is held against rotation relative to the shaft 92, but is movable longitudinally of the latter when rotation of the gear 114 causes the threaded tube 121 to move in one direction or the other axially of the shaft 92. The spider 106 may be connected essentially in the same manner as the spider 9, with the fan blade angle control arms 70', but because the spider is to the rear of the fan rotor, instead of in advance of it, the arms 70' extend oppositely—as compared with the arms 70—from their associated "cartridges." As the fan rotor, blades, cartridges, etc. are essentially the same in this embodiment as in the one first described, no more need be said about the present arrangement except to say that the openings or passages 90 provide for cooling air to flow for preventing excessive heating of the gearing, and to point out that a conduit 127 for cooling air extends through the tube 121 and down within the hollow portion 117 of shaft 92 so as to aid in cooling the spider adjusting mechanism and the bearing 94, the air admitted to the bottom of the bore in the shaft portion 117 flowing back up inside and out at the top of the latter and escaping to the stack connection.

A new summary of the advantages of the invention seems unnecessary, in view of the similarities of the two embodiments, and the individual advantages of the specific differences of the second embodiment appear to have been adequately explained above. It may, however, be renoted that by removing a section of the propeller ring and turning the fan rotor to bring any blade needing replacement under or opposite the opening, removal and replacement in the manner before described as to Figs. 1 to 7 is readily possible. Any or all sections of any of the casing parts may be made readily removable and replaceable.

While there are in this application specifically described two forms which the invention may assume in practice, it will be understood that these forms of the same are shown for purposes of illustration, and that the invention may be modified and embodied in various other forms without departing from its spirit or the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent is:

1. In a fan, a rotor having radially extending bearings in its periphery for the reception of fan blade pivots, fan blade pivots received in said bearings, means for precluding axial outward movement of said pivots in said bearings but freely permitting rotation thereof, fan blades, and means for detachably connecting one of said fan blades to each of said pivots, the detachable connecting means between said fan blades and said pivots including interlocking portions carried by said blades and by said pivots and extending transversely with respect to their axes and preventing, while in interengagement with each other, radial separation of the fan blades from said pivots but being relatively slidable transversely with respect to the axes of said pivots to effect detachment of said blades from said pivots, and means for holding said interlocking portions against relative sliding.

2. In a fan, a rotor having radially extending bearings in its periphery for the reception of fan blade pivots, fan blade pivots received in said bearings, means for precluding axial outward movement of said pivots in said bearings but freely permitting rotation thereof, fan blades, and means for detachably connecting one of said fan blades to each of said pivots, the detachable connecting means between said fan blades and said pivots including relatively slidably separable interlocking portions extending transversely with respect to the axes of said pivots and carried by said blades and by said pivots and coacting, while in interengagement with each other, to prevent radial separation of the fan blades from said pivots, and means for holding said interlocking portions against relative sliding including pin and pin receiving recess holding means carried in part by said blades and in part by said pivots.

3. In a fan, a rotor having radially extending bearings in its periphery for the reception of fan blade pivots, fan blade pivots received in said bearings, means for precluding axial outward movement of said pivots in said bearings but freely permitting rotation thereof, and fan blades detachably connected to said pivots, the detachable connection between each fan blade and the pivot to which it is connecting including a dovetail groove formed in and extending diametrically of said pivot and a correspondingly shaped projection carried by said fan blade, and means supported by each pivot for holding the dovetail projection which is supported there-

on against sliding in said groove in a direction radial of said pivot.

4. In a fan, a rotor having radially extending bearings in its periphery for the reception of fan blade pivots, fan blade pivots received in said bearings, means for precluding the axial outward movement of said pivots in said bearings but freely permitting rotation thereof, and fan blades detachably connected to said pivots, the detachable connection between each fan blade and the pivot to which it is connected including a dovetail groove formed in and extending diametrically of said pivot and a correspondingly shaped projection carried by said fan blade, and means for holding said dovetail projection against sliding in said groove in a direction radial of said pivot, said last mentioned means including at least one pin element extending through said dovetail projection and a socket for said pin element formed in the pivot at the bottom of said groove.

5. In a fan, a rotor having radially extending bearings in its periphery for the reception of fan blade pivots, fan blade pivots received in said bearings, means for precluding the axial outward movement of said pivots in said bearings but freely permitting rotation thereof, and fan blades detachably connected to said pivots, the detachable connection between each of said fan blades and the pivot to which it is connected including a dovetail groove extending diametrically of said pivot and a correspondingly shaped projection carried by said fan blade, and means for holding said dovetail projection against sliding in said groove in a direction radial of said pivot, said dovetail projection being shallower than the radial depth of said dovetail groove, and resilient means being provided between the bottom of said groove and the innermost end of said dovetail projection for taking up slack.

6. In a fan, a rotor having radially extending bearings in its periphery for the reception of fan blade pivots, fan blade pivots received in said bearings, means for precluding the axial outward movement of said pivots in said bearings but freely permitting rotation thereof, and fan blades detachably connected to said pivots, the detachable connection between each of said fan blades and the pivot to which it is connected including a dovetail groove extending diametrically of said pivot and a correspondingly shaped projection carried by said fan blade, and means for holding said dovetail projection against sliding in said groove in a direction radial of said pivot, said last mentioned means including at least one pin element extending through said dovetail projection and a socket for said pin element at the bottom of said groove, and said dovetail projection being shallower than the radial depth of said dovetail groove, and resilient means being provided between the bottom of said groove and the innermost end of said dovetail projection for taking up slack, and said pin element being disposed relative to said resilient means to prevent escape of the latter.

7. In a fan, a rotor having radially extending bearings in its periphery for the reception of fan blade pivots, fan blade pivots received in said bearings and held against displacement in either direction radially of the fan rotor, means coacting with said fan blade pivots for turning the same concurrently on their several axes, and fan blades releasably supported one by each of said fan blade pivots and each having a portion received within the periphery of said rotor and separable from the rotor and its fan blade pivot by movement transversely of the axis of said pivot.

8. In a fan, a rotor having radially extending bearings in its periphery for the reception of fan blade pivots, fan blade pivots received in said bearings and held against displacement in either direction radially of the fan rotor, means coacting with said fan blade pivots for turning the same concurrently on their several axes, and fan blades releasably supported one by each of said fan blade pivots each having a portion received within the periphery of the rotor and removable by movement transverse to the axis of the pivot which supports it only when said pivot is in a predetermined angular relation to the rotor.

9. In a fan, a rotor having radially extending bearings in its periphery for the reception of fan blade pivots, fan blade pivots received in said bearings and held against displacement in either direction radially of the fan rotor, means coacting with said fan blade pivots for turning the same concurrently on their several axes, and fan blades releasably supported one by each of said fan blide pivots, each said blade being removable from its pivot by movement transversely of said pivot, but only in a predetermined angular relation of its respective pivot to the rotor, said rotor and said pivots having openings alined in predetermined angular relation of said pivots to said rotor for the sliding of said fan blades out of and into mounted relation on said fan blade pivots.

10. In a fan, a rotor having radially extending bearings in its periphery for the reception of fan blade pivots, fan blade pivots received in said bearings, means for rotatably holding said pivots in said bearings, fan blades one connected with each of said pivots, and means including undercut connections between said blades and pivots, and lateral openings through the periphery of said rotor, for replaceably mounting said blades on said pivots.

11. In a fan, a rotor having radially extending bearings in its periphery for the reception of fan blade pivots, fan blade pivots received in said bearings, means for rotatably holding said pivots in said bearings, fan blades one connected with each of said pivots, and dovetail connections for each blade with its associated pivot lying radially inside the periphery of said rotor and including portions carried by said blade and pivot respectively, said rotor having lateral openings through the rim thereof and said dovetail connections alineable with said openings for the withdrawal of the portions of said dovetail connections carried by said blades.

12. In a fan, a rotor having radially extending bearings in its periphery and a hub portion, a shaft on which said hub portion is mounted, fan blades rotatably supported by said bearings, devices fixed relative to said blades acting when actuated to change the angles of the latter, and actuating means for said devices including a spider slidable axially of but fixed against rotation relative to said shaft, a nut rotatably but non-slidably fixed to said shaft, a threaded element engaged by said nut and fixed against relative rotation with respect to said shaft and said spider, and slidable axially relative to the former but having a connection with the latter confining them to movement together axially of said shaft, and means for rotating said nut.

13. In a fan, a rotor having radially extending bearings in its periphery and a hub portion, a

shaft on which said hub portion is mounted, fan blades rotatably supported by said bearings, devices fixed relative to said blades acting when actuated to change the angles of the latter, actuating means for said devices including a spider slidable axially of but fixed against rotation relative to said shaft, a nut rotatably but non-slidably fixed to said shaft, a threaded element engaged by said nut and fixed against relative rotation with respect to said shaft and said spider, and slidable axially relative to the former but fixed against sliding relative to the latter, and means for rotating said nut, and means for preventing extremes of temperature of said actuating means including means for effecting a circulation of a fluid thereover.

14. In a fan, a rotor having radially extending bearings in its periphery and a hub portion, a shaft on which said hub portion is mounted, bearing means for said shaft, fan blades rotatably supported by said radially extending bearings, devices fixed relative to said blades acting when actuated to change the angles of the latter, actuating means for said devices including a spider slidable axially of but fixed against rotation relative to said shaft, a nut rotatably but non-slidably fixed to said shaft, a threaded element engaged by said nut and fixed against relative rotation with respect to said shaft and said

spider, and slidable axially relative to the former but fixed against axial movement relative to the latter, and means for rotating said nut, and means for preventing extremes of temperature of said actuating means and of at least a part of said bearing means including means for delivering fluid to said shaft adjacent said part of said bearing means and through the latter to said actuating means.

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