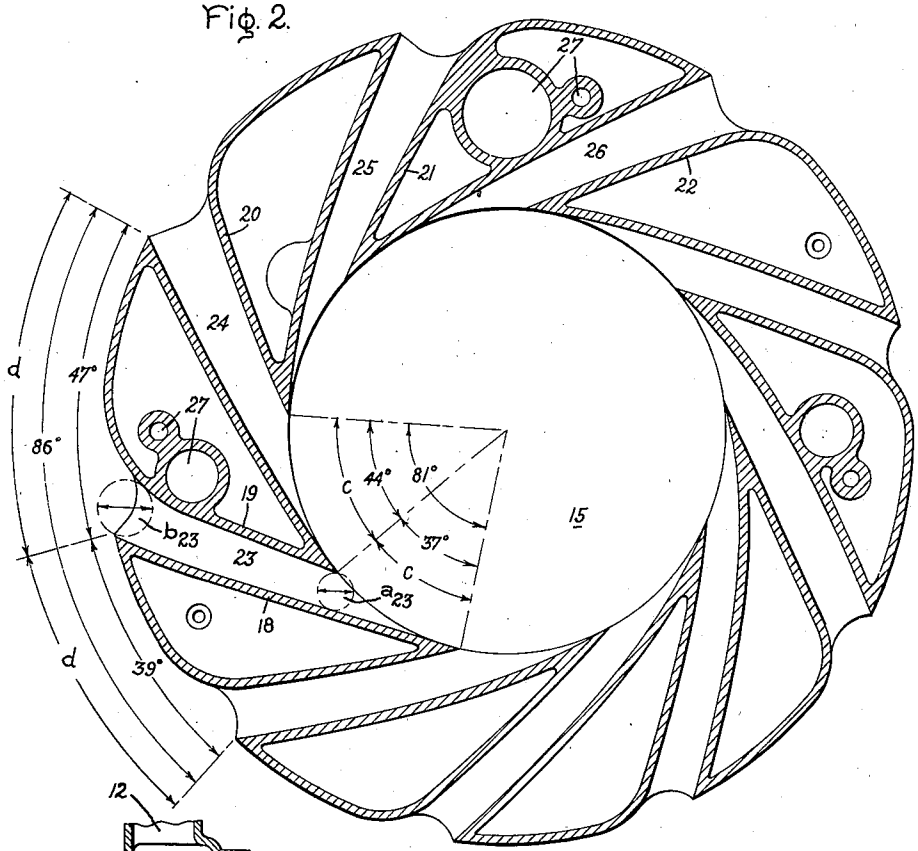
May 2, 1939. S. A. MOSS 2,157,002

DIFFUSER FOR CENTRIFUGAL COMPRESSORS

Filed May 7, 1938

Fig. 2.



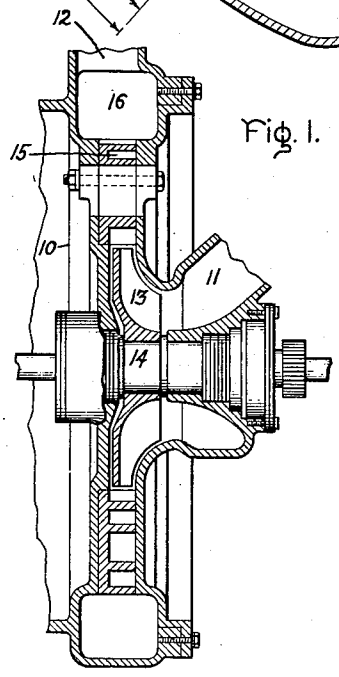


Fig. 1.

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DIFFUSER FOR CENTRIFUGAL COMPRESSORS

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5 Claims. (Cl. 230—132)

The present invention relates to diffusers for centrifugal compressors or pumps, more particularly to diffusers for compressors which have a plurality of circumferentially spaced discharge openings through which air or other compressed medium is discharged to several consumers such as the several cylinders of a combustion engine. In such arrangements it is important that the diffuser vanes forming passages for converting velocity energy of a medium into pressure energy are uniformly spaced. In case uniform spacing is not possible, as is the case where the diffuser vanes have to be built around obstacles in the form of shafts, bolts or other elements projecting through the diffuser chamber, satisfactory operation and good efficiency may be attained by a diffuser arrangement in which the ratios of inlet height to inlet arc, outlet height to outlet arc, inlet height to outlet height and inlet arc to outlet arc respectively of each passage are equal to certain constants. An arrangement of this kind is fully described in and covered by the Patent No. 1,879,561 to C. W. Smith, issued September 27, 1932, and assigned to the same assignee as the present application. In certain cases predetermined conditions, that is, the obstacles or fixed elements around which the diffuser vanes have to be built are of such nature as to render it impossible to meet the aforementioned conditions, that is, to make for instance the ratio of inlet height of a passage to inlet arc of a passage equal a certain constant for all passages.

The object of my invention is to provide a diffuser arrangement with which best efficiency and operation may be obtained though the vanes are non-uniformly spaced and the above mentioned conditions cannot be made with regard to the individual diffuser passages formed between the vanes. This is accomplished in accordance with my invention by an arrangement in which the ratios of the sums of the inlet heights to the sums of the inlet arcs of different groups of passages are equal to a constant, the ratios of the sums of the outlet heights to the sums of the outlet arcs of different groups of diffuser passages are equal to a constant which constant may differ from the first mentioned constant. Likewise the ratios of the sums of the inlet heights to the sums of the outlet heights as well as the ratios of the sums of the inlet arcs to the sums of the outlet arcs of the passages of different groups of passages are equal to certain constants.

For a better understanding of what I believe to be novel and my invention, attention is directed to the following description and the claims appended thereto in connection with the accompanying drawing.

In the drawing Fig. 1 represents a sectional view of a compressor, and Fig. 2 is a detail view of the diffuser of such compressor embodying my invention.

The compressor comprises a casing 10 which has an inlet 11 and a plurality of circumferentially spaced outlets 12 for connection to different cylinders of a combustion engine, not shown, in case the compressor is used to supercharge such engine. An impeller 13 is disposed in an impeller chamber formed by the casing and secured to a drive shaft 14. The medium impelled and discharged from the impeller is conducted through a diffuser 15 for converting velocity energy of such medium into pressure energy but such medium is conducted through a scroll or outlet chamber 16 and the openings 12 formed by the casing. The diffuser has a plurality of vanes 18, 19, 20, 21, 22, etc., forming diffuser passages 23, 24, 25, 26, etc. The vanes are built around certain fixed obstacles 27 of different dimensions and irregularly spaced, making it necessary to use different vanes forming openings or bearings for such obstacles and rendering it impossible to make the ratios of certain dimensions of the individual passages equal to a certain constant. Thus in the present instance the vane 19 is arranged to form two openings for two obstacles to pass therethrough so that essentially different diffuser passages 23 and 24 are defined between the vane 19 and the adjacent vanes 18 and 20 respectively. If we designate the inlet and outlet heights of a passage, that is, the shortest distances between the passage walls at the inlet and outlet, with a and b respectively and the inlet arcs and outlet arcs of the same passage with c and d respectively and use the reference characters of the diffuser passages as suffixes for the corresponding dimensions, then the arrangement in accordance with my invention meets the following conditions:

$$\frac{a_{23}+a_{24}}{c_{23}+c_{24}}=k_1$$

$$\frac{b_{23}+b_{24}}{d_{23}+d_{24}}=k_2$$

$$\frac{a_{23}+a_{24}}{b_{23}+b_{24}}=k_3$$

$$\frac{c_{23}+c_{24}}{d_{23}+d_{24}}=k_4$$

In other words, the passages **23** and **24** form a group in which the ratios of the sums of certain dimensions are equal to certain constants, which constants are always the same for the rest of the passages taken collectively and may be the same for the rest of the individual passages if it is possible to provide the rest of the passages with equal dimensions. Thus, generally expressed, whenever it is not possible to make the ratios of the individual passage heights and arcs alike, I provide in accordance with my invention an arrangement in which the ratios of total inlet or outlet passage heights and total inlet or outlet passage arcs of different groups are alike. Algebraically expressed, the Greek letter Σ standing for the term "sum" or "total", thus Σa representing the algebraic sum of the inlet heights of a group of passages,

$$\frac{\Sigma a}{\Sigma c}=k_1$$

$$\frac{\Sigma b}{\Sigma d}=k_2$$

$$\frac{\Sigma a}{\Sigma b}=k_3$$

$$\frac{\Sigma c}{\Sigma d}=k_4$$

In the present instance

$$a_{23}=.466 \text{ inch},$$
$$a_{24}=.800 \text{ inch},$$

thus the sum of both inlet heights being equal to 1.266 inches. The outlet passage heights b_{23} and b_{24} are .745 inch and 1.280 inches respectively. The sum of these outlet heights is 2.025 inches. The ratio of the sums then is equal to

$$\frac{1.266}{2.025}=.63=k_3$$

This ratio or constant of .63, as stated above, always applies to the rest of the diffuser passages collectively and if the other passages are alike the ratio applies to each individual passage. The inlet arcs of passages **23** and **24** are 37° and 44° respectively, the sum of these inlet arcs being 81° and the outlet arcs of the passages **23** and **24** are 39° and 47° respectively, the sum being 86°. The ratio of the sums of the inlet arcs and the sums of the outlet arcs of the groups of passages **23**, **24** is the same for the rest of the passages taken collectively, irrespective of the shape of the other passages and it is the same for each individual passage if the rest of the passages are alike.

In general it is of course desirable to satisfy all of the above named conditions exactly. In actual practice, however, it may happen that one or the other of the ratios cannot be maintained exactly constant. Thus, for instance, the ratios k_1 and k_2 may be exactly alike for different groups of nozzles while the ratios k_3 and k_4 may only be approximately alike. In any case an attempt should be made to satisfy the above conditions as far as is practicably possible to obtain best performance of the compressor.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. A diffuser for use in a centrifugal compressor to convert velocity energy of an impelled medium into pressure energy, such diffuser comprising a plurality of vanes non-uniformly spaced circumferentially and forming groups of different passages, the ratio of the sum of the passage inlet heights and the sum of the passage inlet arcs being substantially a constant for each group.

2. A diffuser for use in a centrifugal compressor to convert velocity energy of an impelled medium into pressure energy, such diffuser comprising a plurality of vanes non-uniformly spaced circumferentially and forming groups of different passages, the ratio of the sum of the passage outlet heights and the sum of the passage outlet arcs being substantially a constant for each group.

3. A diffuser for use in a centrifugal compressor to convert velocity energy of an impelled medium into pressure energy, such diffuser comprising a plurality of vanes non-uniformly spaced circumferentially and forming groups of different passages, the ratio of the sum of the passage inlet heights and the sum of the passage outlet heights being substantially a constant for each group.

4. A diffuser for use in a centrifugal compressor to convert velocity energy of an impelled medium into pressure energy, such diffuser comprising a plurality of vanes non-uniformly spaced circumferentially and forming groups of different passages, the ratio of the sum of the passage inlet arcs and the sum of the passage outlet arcs being substantially a constant for each group.

5. A diffuser for use in a centrifugal compressor to convert velocity energy of an impelled medium into pressure energy, such diffuser comprising a plurality of vanes non-uniformly spaced circumferentially and forming groups of different passages with inlet and outlet the dimensions of the passages of each group satisfying substantially the following conditions:

$$\frac{\Sigma a}{\Sigma c}=k_1$$

$$\frac{\Sigma b}{\Sigma d}=k_2$$

$$\frac{\Sigma a}{\Sigma c}=k_3$$

$$\frac{\Sigma c}{\Sigma d}=k_4$$

in which Σa designates the sum of the inlet heights of a group of passages, Σb designates the sum of the outlet heights of a group of passages, Σc designates the sum of the inlet arcs of a group of passages and Σd designates the sum of the outlet arcs of a group of passages.

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