United States Patent [19]

Callahan

[11] **3,873,231**

[45] **Mar. 25, 1975**

[54] **CENTRIFUGAL PUMP DIFFUSER**

[75] Inventor: **Thomas R. Callahan,** Milford, Ohio

[73] Assignee: **Allis-Chalmers Corporation,** Milwaukee, Wis.

[22] Filed: **Sept. 13, 1973**

[21] Appl. No.: **397,080**

Related U.S. Application Data

[62] Division of Ser. No. 279,978, Aug. 11, 1972, Pat. No. 3,823,063.

[52] **U.S. Cl.** **415/195,** 415/186, 415/211, 415/119

[51] **Int. Cl.** **F04d 29/44,** F01d 5/16

[58] **Field of Search** 415/211, 195, 186, 207, 415/119

[56] **References Cited**

UNITED STATES PATENTS

2,157,002	5/1939	Moss	415/211
2,373,713	4/1945	Shoults	415/211
3,006,603	10/1961	Caruso et al.	415/211
3,184,152	5/1965	Bourgward	415/211
3,335,943	8/1967	Sorrenti	415/211
3,706,510	12/1972	O'Connor	415/211

FOREIGN PATENTS OR APPLICATIONS

899,637	10/1944	France	415/211
581,164	7/1933	Germany	415/211
914,099	6/1954	Germany	415/211
33,130	5/1908	Austria	415/211
419,544	11/1934	United Kingdom	415/211

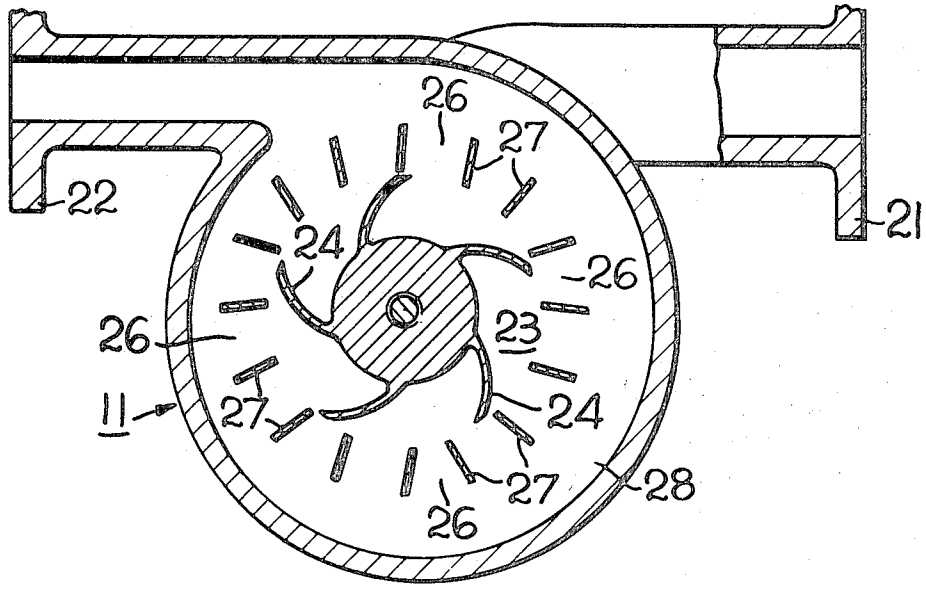
Primary Examiner—Henry F. Raduazo

Attorney, Agent, or Firm—John P. Hines

[57] **ABSTRACT**

A rotary pump having a plurality of impeller blades and a plurality of circumferentially spaced vanes located about the periphery of said blades. The blades and vanes cause the fluid being acted upon by the pump to be delivered in pressure pulses of relatively high frequency and low magnitude. The spacing between adjacent vanes is nonuniform to prohibit uniform pressure patterns in the process fluid.

3 Claims, 5 Drawing Figures



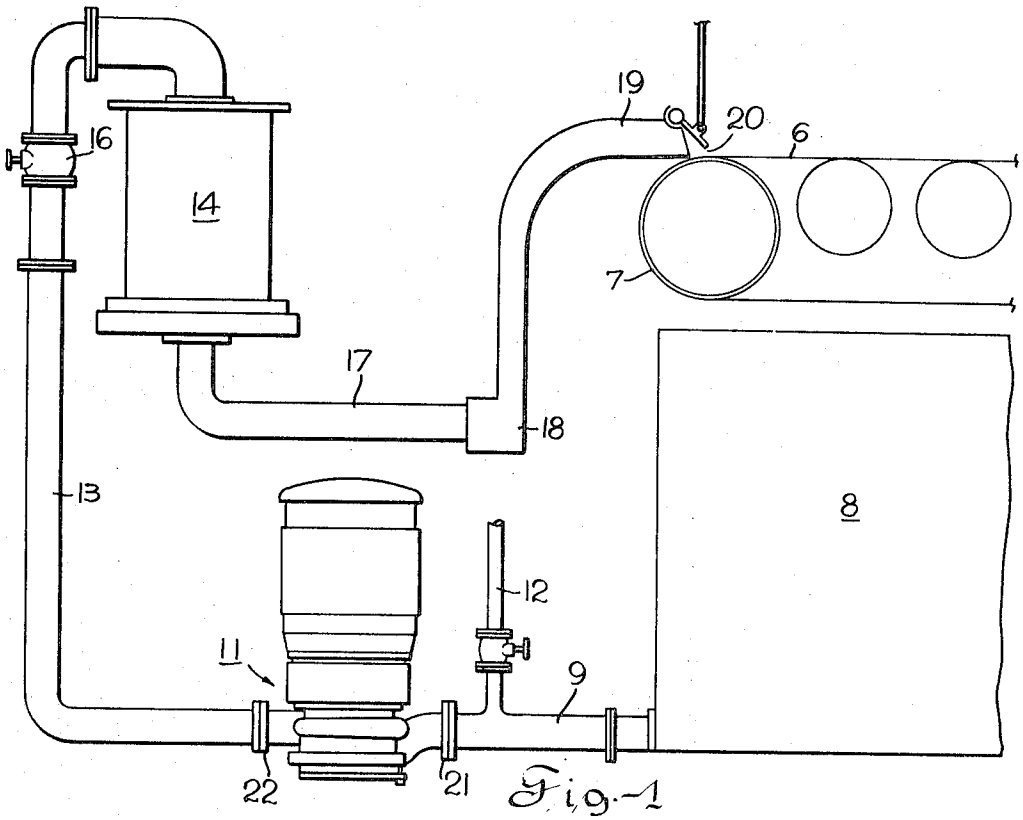

19
20
6
16
14
7
17
18
8
13
12
11
9
22
21

Fig. 1

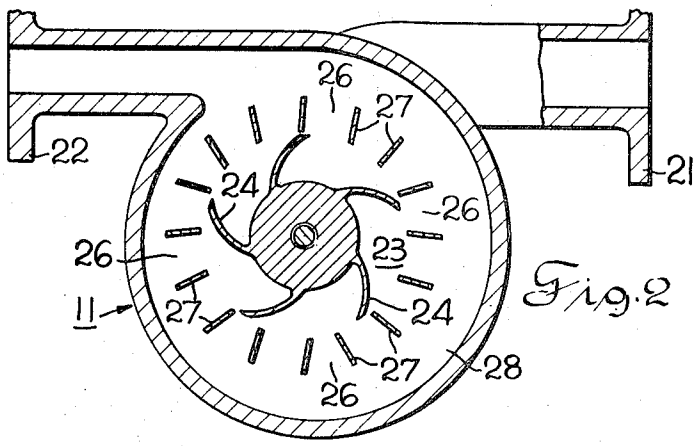

26
27
22
21
24
26
26
23
11
27
24
27
28
26

Fig. 2

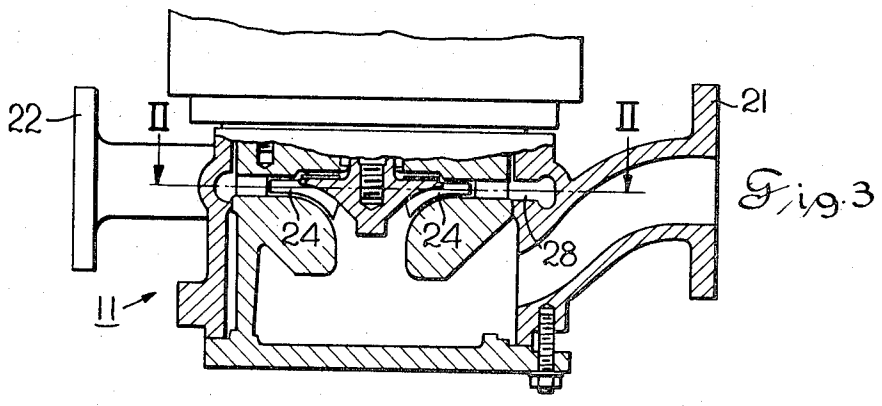


Fig. 3

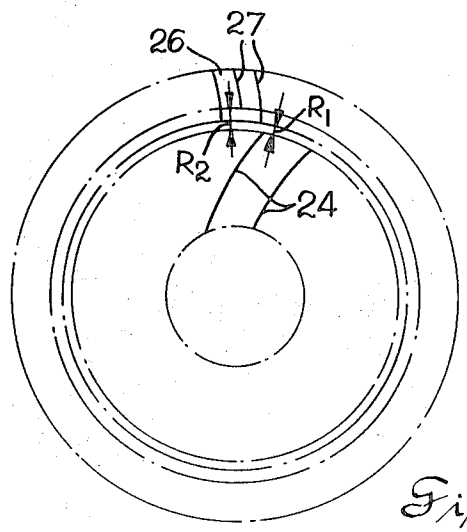


Fig. 4

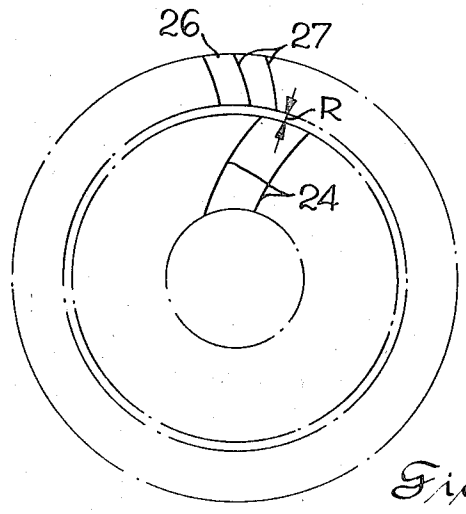


Fig. 5

CENTRIFUGAL PUMP DIFFUSER

This is a division of application Ser. No. **279,978** filed Aug. **11, 1972,** now U.S. Pat. No. **3,823,063.**

This invention relates in general to pumps and more particularly to a pump for supplying pulp stock to a sheet forming device.

In the operation of paper or sheet making machines of various types, it is necessary to deliver the fiber-containing liquid stock or slurry from which the sheet is manufactured to the web forming region of the machine in the form of a wide and relatively shallow flowing stream of rectangular cross section which may or may not be under considerable pressure. Also in such machines it is desirable for economic reasons, to collect and reuse the white water (that is, the liquid that passes through the sheet forming wire). The white water is mixed with additional pulp or stock before being returned to the paper or web forming region. A practical method of accomplishing this operation is by use of a suitable pump or pumps located in the conduit system. It thus becomes necessary in the stock conduit system to transform the confined stream of liquid discharged by the pump into the shallow, relatively wide stream which is required at the web forming region.

In order to produce a sheet having uniform physical properties, the stock (which includes water, pulp, fiber, filler, dye, glue, etc.) delivered to the web forming region of the machine should be evenly distributed across the machine width. Expressed mathematically, this means that the kinetic energy and fluid pressure in unit areas of the stream delivered to the web forming region should be as uniform as possible throughout the stream cross section and, in addition, the entire stream should be maintained in a condition which is as near to steady-state flow as is possible to obtain. In other words, the stock should be delivered to the web forming region at a uniform pressure and velocity across the width of the machine and constant pressure and velocity relationship should be maintained at all times. The desirability of obtaining the uniform pressure steady-state flow conditions described above during the operation of sheet making machines is well recognized in the paper making art and various control arrangements have been suggested and used in an effort to attain these conditions.

One particular undesirable phenomena encountered in the manufacture of paper which occurs if this steady-state condition is not maintained is a condition known as "barring." Barring is the change in sheet thickness or caliper in parallel lines. These lines or barrs occur at regular intervals running across the sheet perpendicular to the direction of flow of the sheet machine. Barring is detrimental primarily because it reduces the uniformity and quality of a sheet for such subsequent operations as printing and coating.

There are a number of possible causes of barring. Since the pump is the energy source in the stock supply system, it is considered by many to be the cause of barring. Each time a pump impeller blade passes the discharge lip of the pump, a pressure impulse is transmitted to the stock slurry. These pressure pulses flow through the system in the form of a sine wave and result in high pressure pulses at the web forming device in a uniform pattern which can result in the undesirable barring effect above referred to.

To overcome this, double suction pumps with staggered impeller blades have been utilized, thereby in effect doubling the number of blade tips passing the discharge lip of the pump per revolution. This has the effect of doubling the frequency of the pressure pulsation generated each time an impeller blade tip passes the discharge lip. Also, the pump speed has increased over the years which also increases the pulsation frequency. If the volume of slurry moved is maintained constant and the pulsation frequency is increased, the magnitude of each pulse will be reduced decreasing the tendency to barr.

The manufacturers of sheet forming devices have developed machines operating at higher speeds with both horizontal or nonhorizontal wire arrangements or web forming devices. These conditions have placed greater demands on the system for uniform flow of stock while at the same time the pump manufacturer is reaching a physical limit to the number of impeller blades which may be used and speeds at which the pump may be operated. Thus a new approach is necessary in order to increase the pulsation frequency and decrease the magnitude of individual pulses.

It is, therefore, the intention and general object of this invention to provide a stock supply pump wherein the magnitude of the pressure pulses caused by the system pump are reduced and their frequency is increased.

A more specific object of the subject invention is to provide a pump of the hereinbefore described type wherein the outer ends of the adjacent vanes are equally spaced circumferentially whereas the inner ends of adjacent vanes are unequally spaced circumferentially.

An additional specific object of the subject invention is to provide a pump of the hereinbefore described type wherein the radial distances between the radially outer ends of adjacent impeller blades and the radially inner ends of adjacent vanes are unequal.

These and other objects of the subject invention will become more fully apparent as the following description is read in light of the attached drawing wherein:

FIG. **1** is a schematic view of a stock supply system utilizing a Fourdrinier type machine in which the pump of this invention is particularly useful

FIG. **2** is a cross sectional view of a pump constructed in accordance with this invention taken along the lines II—II of FIG. **3**;

FIG. **3** is a partial vertical cross sectional view of a novel pump of this invention;

FIG. **4** is a schematic view of a modified form of novel pump and prior art

FIG. **5** is a schematic view of a typical prior art vaned diffuser pump.

Referring to the drawing and particularly FIG. **1**, a stock supply system is shown for purposes of illustration applied to a Fourdrinier type machine. The paper or web forming device includes a forming wire **6** traveling over breast roll **7**. Excess white water or stock draining from the forming wire is collected in a collecting trough or wire pit **8** and flows through a pipe **9** to a circulating pump generally designated **11**. A new stock supply conduit **12** is normally provided upstream from the pump **11** to make up any additional stock for the system. The resulting stock mixture is supplied through a pipe **13** to a suitable screening and/or cleaning device **14**. The flow through the pipe **13** may be controlled by a number of methods such as valve **16** shown. From the screening machine the stock flows

through the conduit 17 into a spreader 18 of any conventional type which spreads the stock out to equal the width of the sheet desired. From the spreader the stock is delivered through the header 19 to the discharge or slice 20 and to the web forming device.

The pump 11 shown herein for purposes of illustration is an in-line pump which can be connected directly to the system conduit. The pump inlet flange 21 may be bolted directly to one end of the conduit 9 and the pump discharge flange 22 is bolted to one end of conduit 13. Stock enters the pump pumping chamber 23 wherein it is acted upon by the impeller blades 24. The impeller blades 24 mix and pressurize the paper stock and propel it between the spaces 26 defined by adjacent vanes 27. These vanes are located about the outer peripheral edge of the impeller blades and define a plurality of passageways for the stock. The stock is caused to split into a large number of separate streams as it passes through the spaces defined by adjacent vanes. This then results in the system witnessing a large number of low magnitude pressure pulses. After the stock passes through the spaces defined by adjacent vanes, it is collected in the volute or annular chamber 18 defined by the outer peripheral ends of the vanes 27 and the pump casing. The separate streams are combined into a single stream in the volute 28 which then passes through the pump discharge into the conduit 13.

It should be noted that the spaces between the inner ends of adjacent vanes of the pump shown in FIG. 2 are unequal to one another, whereas the spaces between adjacent outer ends of the diffuser vanes are equal. The unequal spacing of vanes 27 at the flow inlet area results in an uneven distribution of low magnitude pressure pulses, whereas the even spacing of vanes at the flow outlet area results in a smooth transition to singular flow in the volute or annular chamber 28.

FIG. 4 shows a modified form of pump. This pump is distinguished from a typical vaned difusser pump as shown in FIG. 5 by the spacing R_1 and R_2 of alternate vanes 27. In the typical vaned diffuser pump shown in FIG. 5, the spacing R is constant. It is desirable to keep the spacing R at a minimum to maximize efficiency of the pump. However, it has been determined that with a minimum R distance a line of turbulence is developed in the space R. This turbulence has the tendency to produce undesirable noise.

If the spacing R is increased, the noise level is reduced, however, the efficiency of the pump is also reduced. It has been determined that by staggering the spaces R_1 and R_2 as shown in FIG. 4 the noise level is reduced and the higher efficiency is maintained.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A rotary fluid pump comprising;
walls defining a pumping chamber;
an impeller rotatably contained within said pumping chamber and having a plurality of substantially radially disposed circularly spaced blades; and
a plurality of substantially radially disposed circularly spaced vanes located about the periphery of said blades and fixed to said walls the circular distances between points on adjacent vanes defined by the intersection thereof by a pair gradually spaced circles having as their centers the axis of the pump impeller being equal at the outer ends of said vanes and being unequal at the inner ends of said adjacent vanes.

2. The rotary pump set forth in claim 1 wherein the radial distance between the outer ends of said blades and the inner ends of said vanes are equal.

3. The rotary fluid pump set forth in claim 1 wherein the inner ends of alternate vanes are spaced a greater distance from the outer ends of said blades than the inner ends of adjacent vanes.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,873,231 Dated March 25, 1975

Inventor(s) Thomas R. Callahan

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 24, a comma (,) should be inserted after "walls"; line 26, "pair gradually" should read --- pair of radially ---.

Signed and sealed this 15th day of July 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks