May 15, 1956 A. J. SYROVY 2,745,353

ROTOR WHEEL

Filed May 3, 1949 2 Sheets-Sheet 1

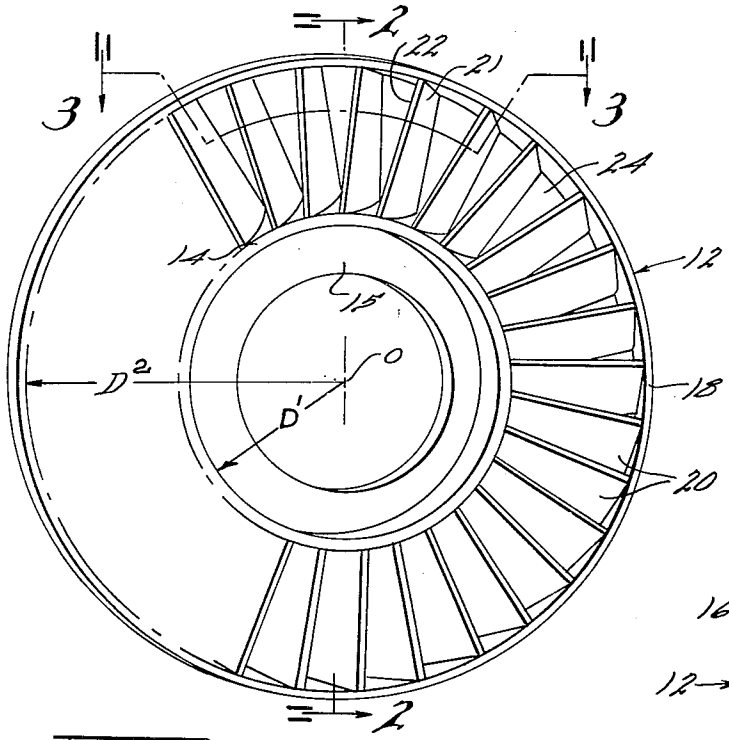



Fig. 1.

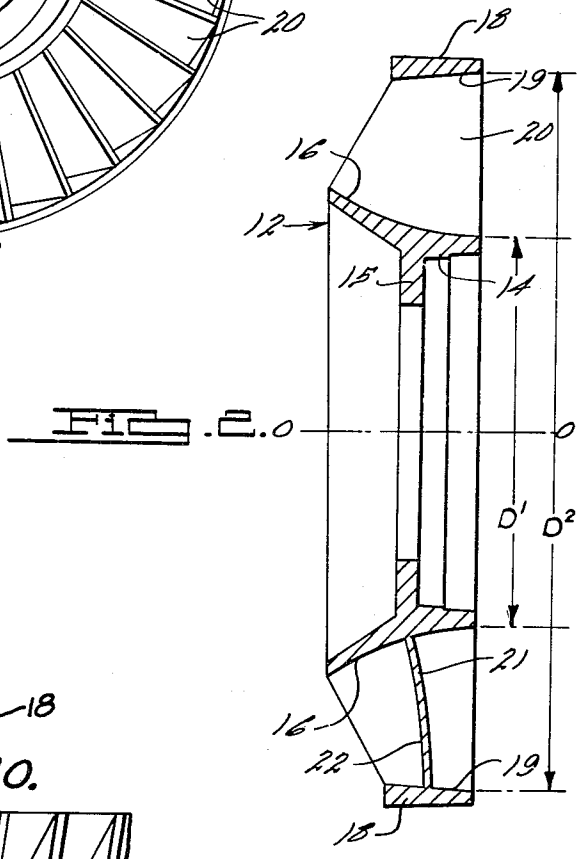



Fig. 2.

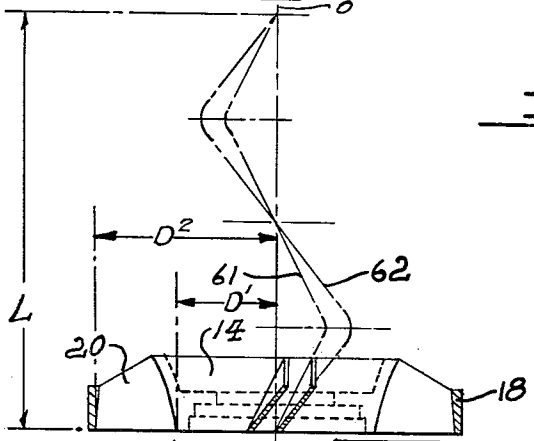



Fig. 10.

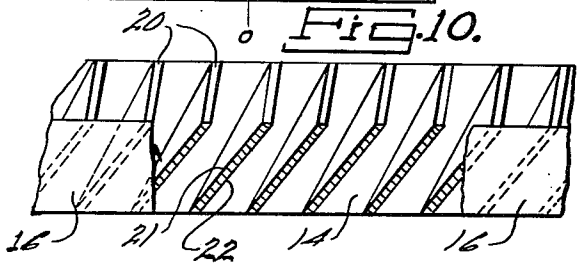



Fig. 3.

INVENTOR.
Augustin J. Syrovy.
BY
Harness and Harris
ATTORNEYS.

May 15, 1956 A. J. SYROVY 2,745,353

ROTOR WHEEL

Filed May 3, 1949 2 Sheets-Sheet 2

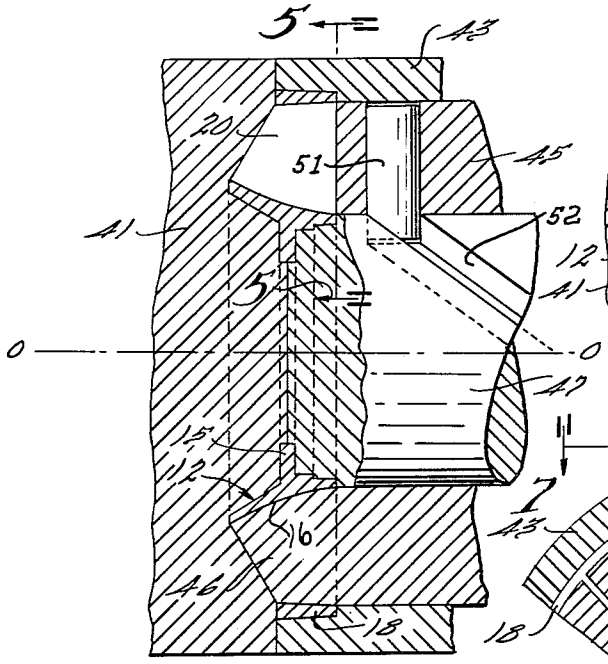



Fig. 4.

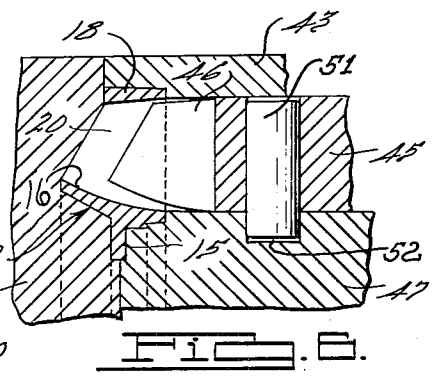



Fig. 6.

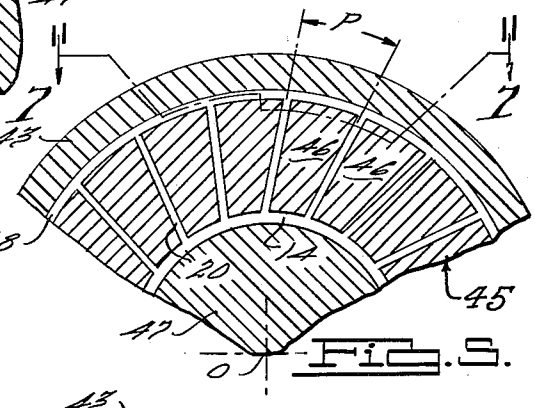



Fig. 5.

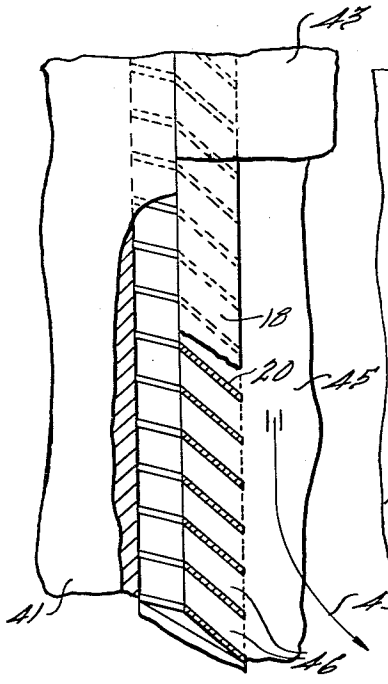



Fig. 7.

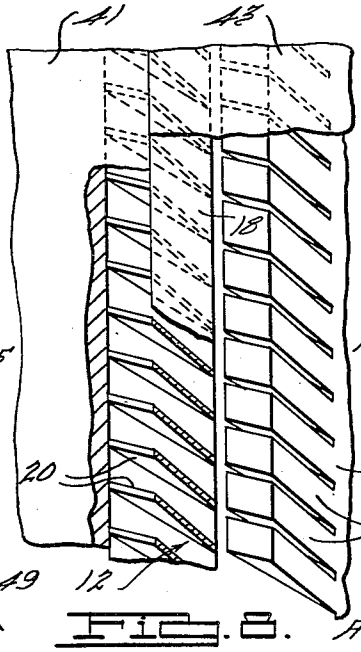



Fig. 8.

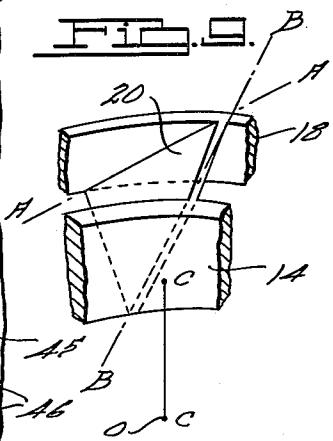



Fig. 9.

INVENTOR.
Augustin J. Syrovy.
BY
Harness and Harris
ATTORNEYS.

United States Patent Office 2,745,353 Patented May 15, 1956



2,745,353

# ROTOR WHEEL

Augustin J. Syrovy, Detroit, Mich., assignor to Chrysler Corporation, Highland Park, Mich., a corporation of Delaware

Application May 3, 1949, Serial No. 91,057
2 Claims. (Cl. 103—115)

This invention relates to bladed rotor wheels and particularly to rotor wheels formed with helically curved blades which will permit the wheel to be manufactured as an integral unit by a die casting process or the like.

In the past it has been common practice to form bladed rotor wheels for hydraulic torque converters or the like by building up the wheels from a plurality of stampings or by casting the wheels by conventional destructible core casting processes. Stamped wheels have been somewhat costly to manufacture due to the labor required in assembling the various wheel components and wheel balancing has presented additional problems. Wheels cast by destructible core methods have been relatively costly to manufacture due to the time consuming and relatively expensive steps associated with this type of casting process. Due to the conventional curved shape of the blades of a hydraulic torque converter rotor wheel, it has been practically impossible to cast this type of wheel by a die casting process and consequently the more expensive and time consuming method of casting the wheels with destructible cores has been the general practice. The curvature of hydrodynamic torque converter wheel blade elements heretofore used has usually been such as to prevent removal of the blade forming die from the wheel mold without destroying either the blades or the movable die so consequently cast rotor wheels have usually been formed by molding processes using plaster of paris or sand core elements that are destroyed in order to remove the cores from the integrally cast wheels. It is obvious that a destructible core process would be considerably more expensive than a die casting process where a permanent type of die core could be used continuously to quickly, easily and economically fabricate bladed wheels, all of which would have the same smooth, accurately formed, blade element faces.

The rotor wheel comprising this invention is conventional in that it includes an outer peripheral rim portion, an inner coaxially arranged hub portion and a plurality of radially extending, curved, blade elements connected between the rim and hub portions. In order to permit formation of this rotor wheel as an integral unit by a die casting process, the curved blade elements are shaped such that they have helically curved faces formed with a constant lead or helix angle wherein the angularity of the blade element faces progressively increase with increase in diameter of the wheel. Forming the blade elements with a curvature that is generated by a line having a constant lead so as to produce a variable blade angle with increase in diameter of the wheel permits the blade forming die core element to be screwed out of the wheel casting and thus a permanent type of core element may be used to fabricate the rotor wheels by conventional die casting processes or the like.

In addition to providing a rotor wheel that is easy and economical to manufacture, it has been found that the helically shaped blades of a rotor wheel formed in accordance with this invention are efficient and particularly adapted for use as the guide vanes in a reaction wheel of a hydrodynamic torque converter or the like.

Thus not only is it possible to increase the production rate and reduce the wheel cost due to the use of permanent type die molds and core elements, but in addition the die casting methods give very smooth surfaced rotor wheels with accurately controlled dimensions that tend to prevent turbulence in the fluid passed through the wheel



and this tends to increase the efficiency of the torque converter unit utilizing such a wheel.

While this invention is primarily concerned with an improved type of reaction wheel for a fluid torque converter, still, the scope of this invention is not restricted thereto and is limited only by the wording of the appended claims.

It is an object of this invention to provide a helically bladed rotor wheel wherein the curved blade elements are shaped such that a permanent type of die core may be used to form the blade elements, said core being easily retracted from the cast wheel without damage to either the wheel or the core element.

It is a further object of this invention to provide a bladed rotor wheel with helically curved blade elements wherein the curvature of the blade elements has a constant lead, and the blade angle, and the distance between the blade elements progressively increases with increase in diameter of the wheel from the hub to the peripheral rim.

It is another object of this invention to provide an improved method of manufacture of rotor wheels having curved blade elements which will permit fabrication of the rotor wheels by die casting or the like.

Fig. 1 is a plan view of a rotor wheel formed in accordance with this invention, certain of the blade elements being omitted for the sake of clarity;

Fig. 2 is a sectional elevation of the rotor wheel shown in Fig. 1, the view being taken along the line 2—2 of Fig. 1;

Fig. 3 is a fragmentary sectional elevation of the blade elements of the wheel of Fig. 1, the section being taken along the line 3—3 of Fig. 1;

Fig. 4 is a sectional elevation through a wheel casting die assembly in which a wheel is being formed in accordance with this invention;

Fig. 5 is a framentary sectional elevation of the die and contained wheel shown in Fig. 4, the view being taken along the line 5—5 of Fig. 4;

Fig. 6 is another fragmentary sectional elevation of the die and contained wheel, the view being similar to Fig. 4 but showing the movable die core element retractably screwed part way out of the wheel unit;

Fig. 7 is a fragmentary side elevation of a portion of the die assembly and contained wheel, the view being taken along the line 7—7 of Fig. 5 with portions of the die components being broken away and shown in section to more clearly disclose the arrangement of the wheel within the die assembly;

Fig. 8 is a fragmentary side elevation similar to Fig. 7 but showing the core ring of the die assembly screwed completely out of the wheel unit, certain parts of the die assembly being broken away and shown in section for the sake of clarity;

Fig. 9 is a fragmentary perspective view of portions of the wheel hub, a blade element and the wheel rim with reference lines indicating the variation in blade angularity between the hub and rim; and

Fig. 10 is a sectional view through the wheel in the plane of the wheel axis and showing the development of a helical blade element having a constant lead.

The rotor wheel 12 is an integrally formed unit comprising an annular hub portion 14, a concentrically arranged peripheral rim portion 18 and a plurality of axially directed, helically curved, radially extending, blade elements 20 connected between the hub and rim portions 14, 18. Hub portion 14 has a radially extending flange portion 15 to facilitate mounting of the rotor wheel 12 on a suitable supporting member. Flange 15 may be bolted, riveted or welded to a supporting member (not shown) in any well known manner. The hub portion 14 (see Figs. 2, 4 and 6) has an outer, axially extending, surface 16 that is curved radially inwardly from the

left side of the wheel towards the right side of the wheel so that the subsequently described movable die core element **45**, used to form the wheel, may be readily withdrawn from the right side of the wheel casting. The inner axially extending side **19** of the rim portion **18** is likewise sloped radially outwardly from the left side of the wheel towards the right side of the wheel to facilitate removal of the core element **45** from the wheel. The divergence of the surfaces **16** and **19** facilitates removal of the blade element die core from the wheel casting and also improves the flow of the working fluid through the wheel passageways **24**.

The blade elements **20** are formed with helically curved faces **21** and **22** each of which has a constant lead L (see Fig. 10), and a blade angularity AA—BB (see Fig. 9) progressively increases with increase in the diameter $D^1$ to $D^2$ (see Fig. 1) of the wheel **12**. Furthermore, the blades **20** radiate from the hub **14** such that the spaces P (see Fig. 5) between adjacent blades **20** progressively increase in width with increase in diameter of the wheel. The helically curved blade elements **20** are generated about the axis of rotation **0—0** (see Fig. 10) of the wheel **12** and the blade element lead L remains constant even though the angle of the blade element varies from the hub to the peripheral rim (see Fig. 9). To maintain the blade elements of uniform thickness, it is necessary for the distances between blades P to progressively increase as the diameter of the wheel increases from the hub **14** to the rim **18** (see Fig. 5). It is possible to vary the thickness of the blade elements by varying the rate of change of the distances P with change in diameter of the wheel and still withdraw the die from the wheel mold for the movement of the die is in an axial direction.

Fig. 10 is thought to clearly show the method of development of the wheel blades such that the blades **20** have a constant lead L. The lines **61** and **62** denote respectively the inner and outer edges of a blade element **20** during its process of generation about a cylinder having an inner hub radius $D^1$ and an outer rim radius $D^2$. The constant lead of the blade elements with the progressive variation in blade angularity permits withdrawal of the blade forming core element **45** without destruction of the blade or core upon unscrewing of the core element about an axis that coincides with the axis of the rotor wheel.

Figs. 4–8 show a portion of the die casting apparatus used to fabricate a rotor wheel in accordance with this invention. Numeral **41** represents a portion of the die that would ordinarily be mounted on the fixed platen of a die casting machine (not shown). Also mounted on the fixed platen of the die casting machine is another die part **43**. The fixed portion of the die is made up of the two parts **41** and **43** to provide a means for locking the cast wheel **12** to the fixed platen of the die casting machine during the withdrawal operation of the movable die core elements **45** and **47**. Core elements **45** and **47** are carried by the movable platen of the casting machine (not shown) and are adapted to be moved relative to each other during removal of the wheel from the die.

Manufacture of the wheel disclosed may be accomplished by assembling the die parts **41**, **43**, **45** and **47** in assembled relationship as shown in Fig. 4. Thereafter sufficient molten metal under pressure is introduced to the die through a gate (not shown), this metal completely filling the die cavity. After the molten metal has hardened in the die then the core element **45** is retracted out of the cast wheel **12** by a left handed or counterclockwise unscrewing movement. Fig. 7 shows the die parts **41**, **43** and **45** in assembled relationship about the cast wheel **12**, the wheel blade elements **20** being shown spaced by the fingers **46** of the core element **45**. The direction of rotation of the die core element **45** to remove the core **45** from the wheel is indicated by the arrow **49**. Fig. 8 shows the core element **45** completely removed from the wheel **12** by the axial unthreading movement of the core **45** relative to the wheel **12**. As a result of the helical formation of the wheel blades **20**, it is possible to unscrew the core **45** from the wheel **12** without damage to either the wheel or core element and consequently a permanent type of core may be used to form the rotor wheels. Furthermore, the particular helical blade formations herein disclosed provide a very efficient bladed wheel for use as a reaction wheel or the like in a hydrokinetic torque converter. To facilitate the axial withdrawal of the movable die core **45** from the cast wheel **12**, the core element **45** is provided with a guide pin **51** that extends into a guide channel **52** formed in the peripheral surface of the cylindrical core element **47**. The guide channel **52** is a helically formed groove having a constant lead so that the fingers **46** of core element **45** may be readily withdrawn from between the wheel blade elements **20** when core element **45** is rotated in a counterclockwise direction when looking at Fig. 4 in the direction of the arrows **5—5**.



It is to be understood that the term die casting as used herein includes pressure and gravity die casting as well as permanent mold casting and related processes that depend upon the use of a permanent type of core element.

I claim:

1. An integrally cast rotor wheel comprising concentrically arranged annular hub and rim portions with radially extending, axially directed blade elements connected between the hub and rim portions, said blade elements being of substantially uniform thickness and each having helically curved, opposed, faces generated about the axis of rotation of the wheel, said blade elements having a twist wherein the angularity of twist varies uniformly with increase in the diameter of the wheel whereby said helically curved blade element faces have constant lead throughout their extent, and a circumferential spacing between adjacent blades that progressively increases with increase in the diameter of the wheel.

2. An integrally cast rotor wheel comprising concentrically arranged annular hub and rim portions with radially extending, axially directed blade elements connected between the hub and rim portions, said blade elements each having helically curved opposite faces generated about the axis of rotation of the wheel, said blade elements having a twist wherein the angularity of twist varies uniformly with increase in the diameter of the wheel whereby said helically curved blade element faces have constant lead throughout their extent, and a circumferential spacing between adjacent blades that progressively increases with increase in the diameter of the wheel, said hub and rim portions of the wheel having axially extending, opposed surfaces extending between the adjacent blade elements that diverge from one side of the wheel towards the opposite side thereof.


**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 383,217 | Fox | May 22, 1888 |
| 500,080 | Rateau | June 20, 1893 |
| 506,572 | Wagener | Oct. 10, 1893 |
| 1,518,502 | Gill | Dec. 9, 1924 |
| 1,546,554 | Ross | July 21, 1925 |
| 1,738,210 | Sargent | Dec. 3, 1929 |
| 1,937,461 | Mylting | Nov. 28, 1933 |
| 2,108,080 | Schultz | Feb. 15, 1938 |
| 2,205,054 | Wemp | June 18, 1940 |
| 2,287,496 | Popper | June 23, 1942 |
| 2,356,338 | Misfeldt | Aug. 22, 1944 |
| 2,391,523 | Sorensen | Dec. 25, 1945 |
| 2,481,541 | Schneider | Sept. 13, 1949 |
| 2,493,240 | Emmert | Jan. 3, 1950 |

FOREIGN PATENTS

| | | |
|---|---|---|
| 544,718 | Great Britain | Apr. 24, 1942 |
| 594,538 | Great Britain | Nov. 13, 1947 |

OTHER REFERENCES

Mark's Handbook, 4th Ed., copyright 1941 (page 156).