L. C. LOEWENSTEIN.

CENTRIFUGAL COMPRESSOR AND THE LIKE.

APPLICATION FILED NOV. 5, 1919.

1,373,896.

Patented Apr. 5, 1921.

3 SHEETS—SHEET 1.

Fig. 1.

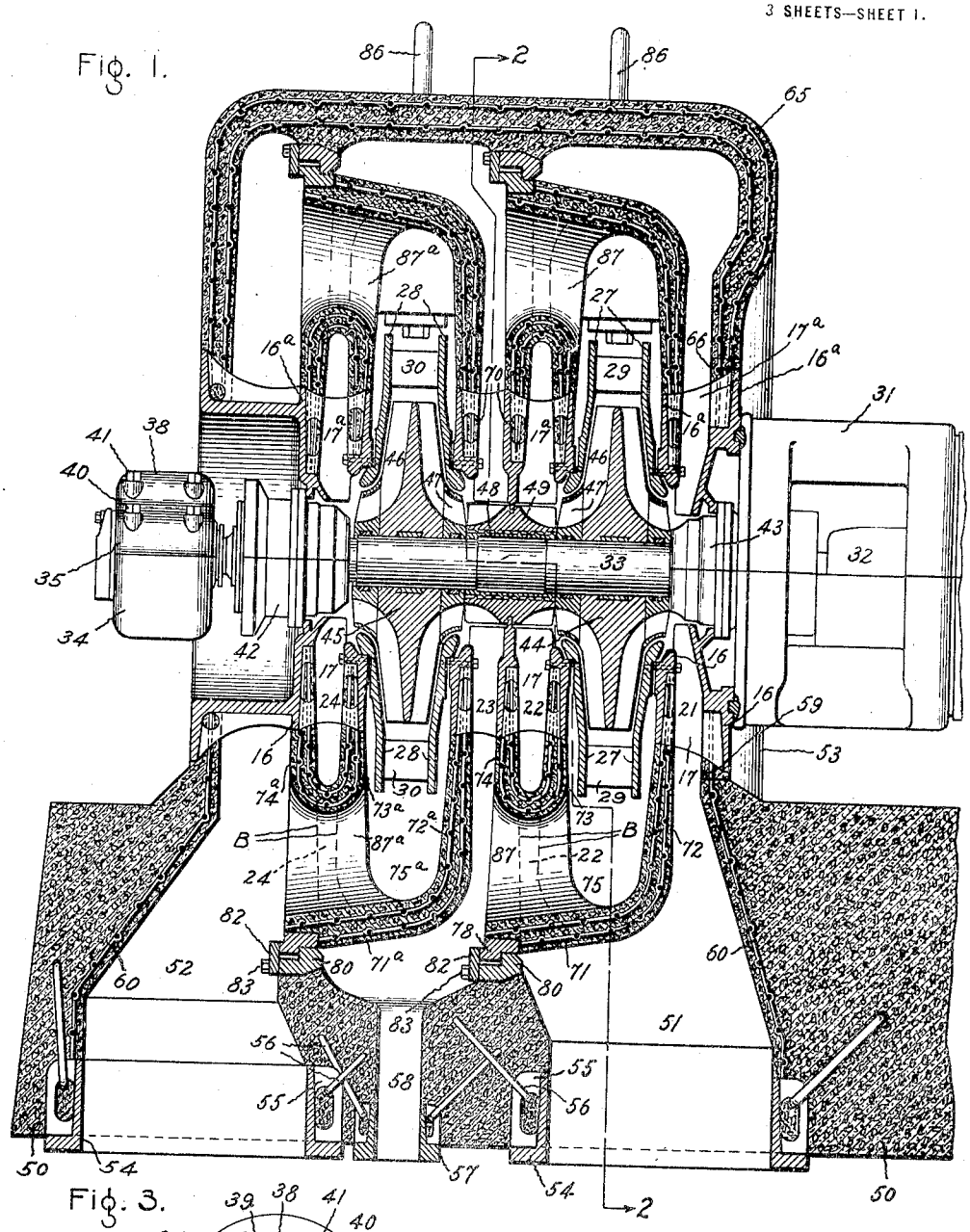
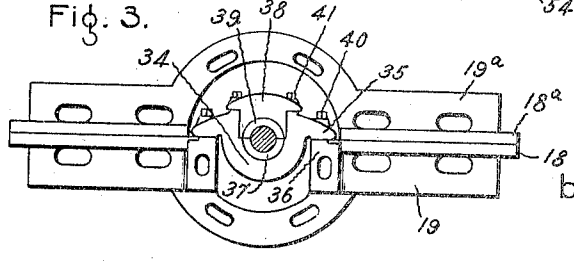


Fig. 3.



Inventor,
Louis C. Loewenstein,
by Albert G. Davis
His Attorney.

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3 SHEETS—SHEET 2.

Fig. 2

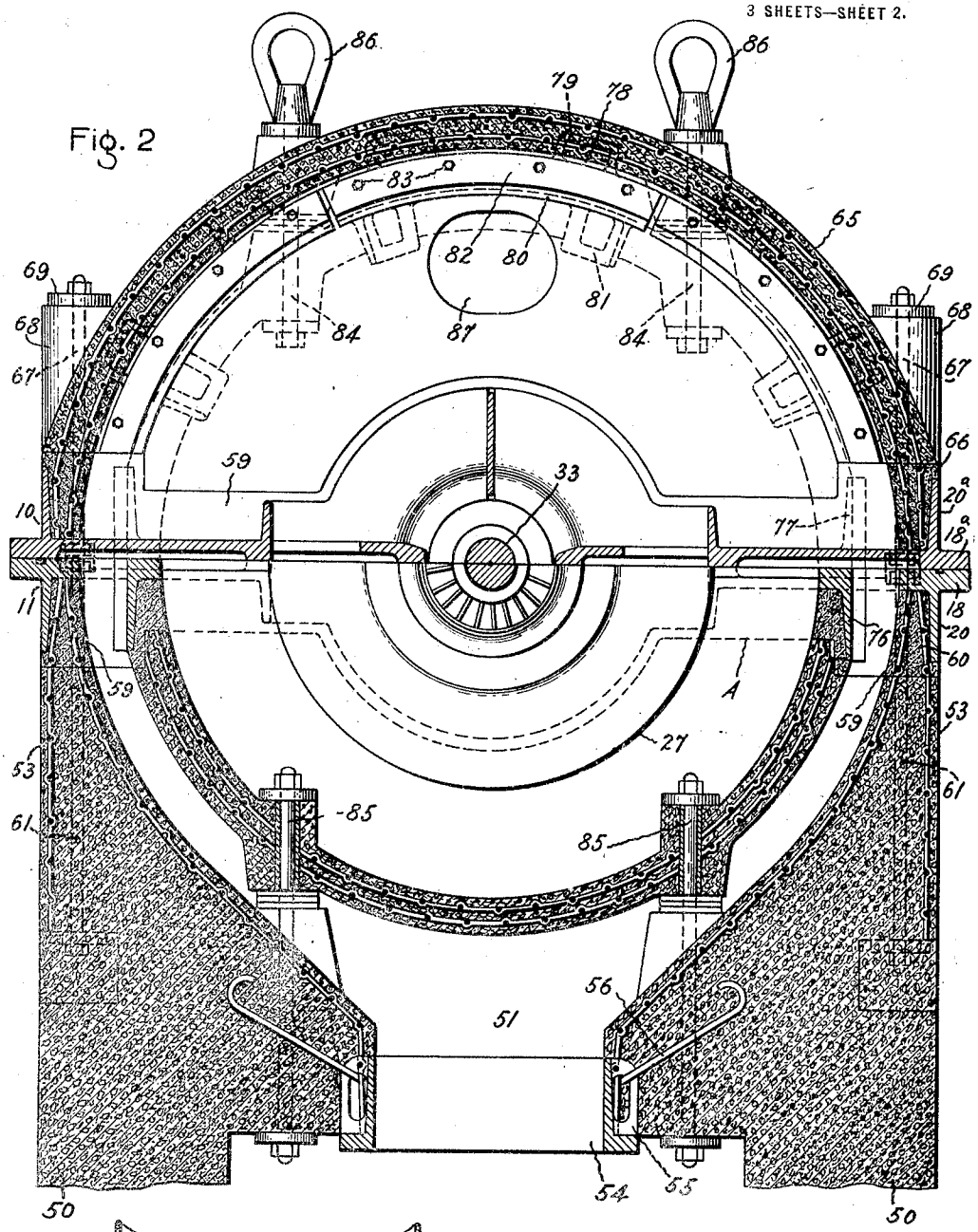
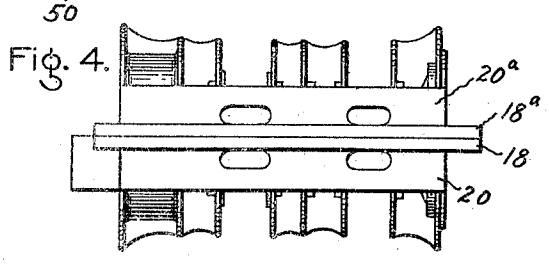


Fig. 4.



Inventor,
Louis C. Loewenstein
by Albert G. Davis
Attorney.

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3 SHEETS—SHEET 3.

Fig. 5.

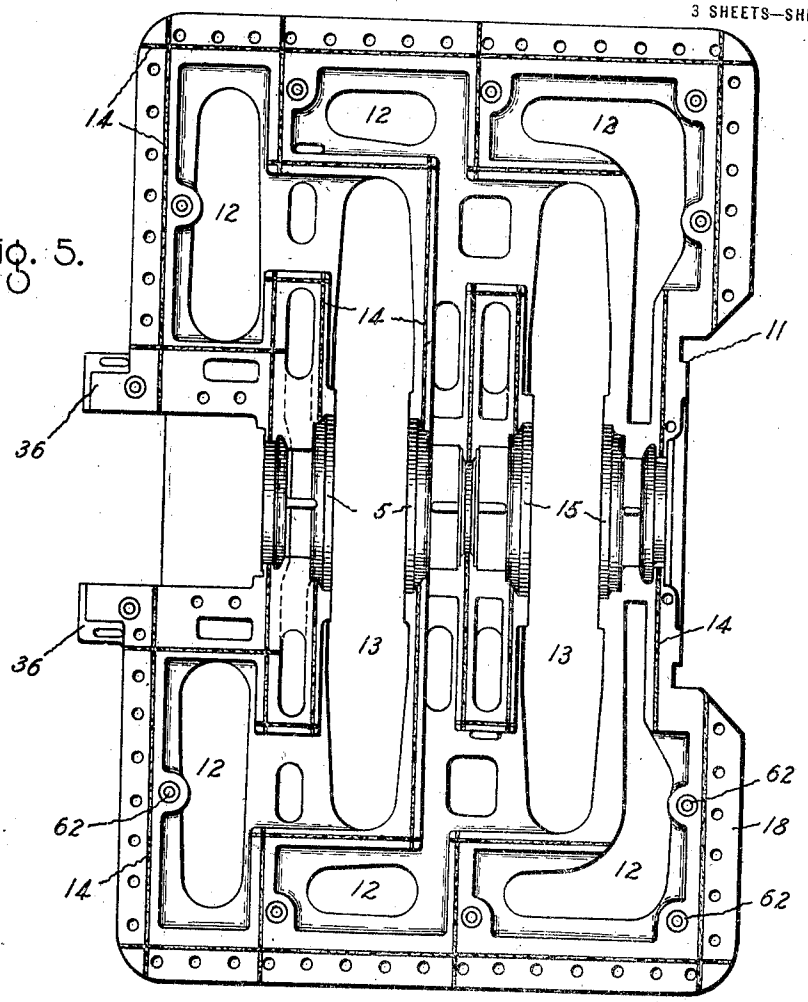
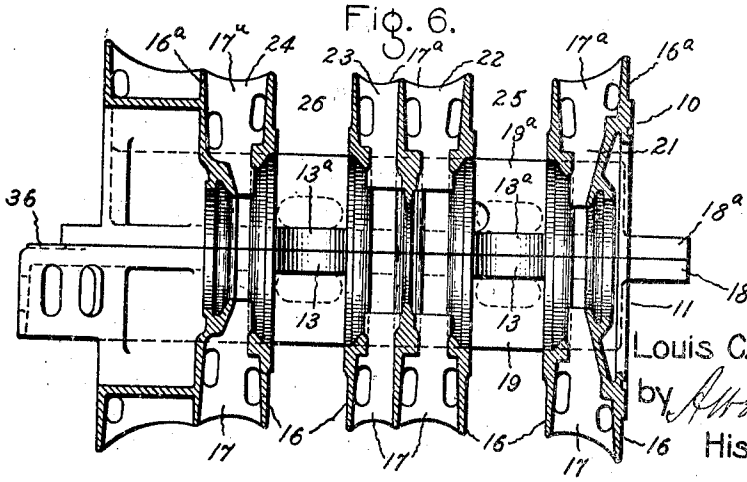


Fig. 6.



Inventor,
Louis C. Loewenstein,
by Albert G. Davis
His Attorney.

UNITED STATES PATENT OFFICE.

LOUIS C. LOEWENSTEIN, OF LYNN, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

CENTRIFUGAL COMPRESSOR AND THE LIKE.

1,373,896. Specification of Letters Patent. Patented Apr. 5, 1921.

Application filed November 5, 1919. Serial No. 335,876.

To all whom it may concern:

Be it known that I, LOUIS C. LOEWENSTEIN, a citizen of the United States, residing at Lynn, in the county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Centrifugal Compressors and the like, of which the following is a specification.

The present invention relates to centrifugal machines such as compressors, pumps, turbines and the like, and has for its object to provide an improved structure wherein the major portion of the machine is constructed of reinforced concrete.

The primary advantage of making the major portion of such a machine, that is, the shell or casing and parts of the diaphragms, of reinforced concrete, is the dispensing with the manufacture, shipping and handling of very large castings and the saving of much time in the construction, since the reinforced concrete portion of the machine can be constructed at the point where the compressor is to be erected. Also there is a saving in cost. However, there are substantial difficulties to be overcome in connection with the use of concrete owing to the fact that concrete structures are likely to shift and settle, which may affect the clearances of the machine, and also due to the fact that it is difficult, if not impossible, in commercial manufacture to obtain accurate dimensions in a concrete structure.

For a consideration of what I believe to be novel and my invention, attention is directed to the accompanying description and the claims appended thereto.

I have specifically illustrated and described my invention in connection with a centrifugal compressor but it will be understood that this is only by way of example and that the features of my invention may be embodied in machines of any character to which they may found adapted.

In the drawings, Figure 1 is a vertical sectional view of a centrifugal compressor embodying my invention; Fig. 2 is a section taken on line 2—2, Fig. 1; Fig. 3 is an end view of upper and lower joint plates which form part of the compressor; Fig. 4 is a side elevation of such joint plates; Fig. 5 is a top plan view on a larger scale of the lower joint plate, and Fig. 6 is a vertical central axial section through the joint plates.

In carrying out my invention I construct the compressor in upper and lower halves to facilitate assembling as is usual; and the central longitudinal portion of the compressor comprises two joint plates, an upper joint plate carried by and forming a part of the upper half of the compressor and a lower joint plate carried by and forming a part of the lower half of the compressor. These joint plates are made of metal and carry the bearings for the compressor shaft and the impeller or impellers and all parts between which it is necessary to provide a clearance. By this arrangement the bearings are spaced by metal and all clearances are metal to metal, and the metal parts are all tied together.

As a result shifting, sinking or cracking of the concrete cannot affect the clearances. A compressor according to my invention may be constructed with one, two or more stages and in the present instance I have illustrated by way of example, a two-stage machine.

Referring to the drawing, 10 indicates the upper joint plate and 11 the lower joint plate. They are in all essentials alike except that the lower joint plate has provisions for supporting an end bearing as will be pointed out hereinafter. Fig. 5 is a top plan view of lower joint plate 11 and referring to this figure and Fig. 6 it will be seen that this plate is substantially flat on its upper surface and is provided with suitable openings 12 for the passage of air and openings 13 in which the impellers run. The surface is raised wherever contact is desired between the upper and lower joint plates; and such raised surfaces are finished and provided with grooves 14 in which packing material is laid to provide tight joints. The raised surfaces are clearly indicated in Fig. 5 and can be followed by noting grooves 14. At the center, semi-circular depressions 15 are provided to accommodate the shaft of the compressor. Projecting from the under side of plate 11 at its transverse central portion are semi-circular integral walls 16 between which are spaced radially extending air-directing partitions 17. Around the edge of plate 11 is a bolting flange 18 and depending from the plate 11 are end flanges 19 and side flanges 20, Figs. 3 and 4.

The upper joint plate 10, as already stated, is substantially a duplicate of the lower plate 11 and corresponding reference

numerals with the exponent "a" added have been applied to corresponding parts. Figs. 6, 3 and 4 show the upper and lower joint plates in position on each other, and when in such position walls 16 and 16ª form circular flanges which define between them annular air passages 21, 22, 23 and 24, in which are the radially extending partitions 17, and annular openings 25 and 26. In openings 25 and 26 are annular side plates 27 and 28 respectively which carry the discharge vanes 29 and 30. Plates 27 and 28 are fastened to the adjacent walls 16 and 16ª by suitable bolts as shown in Fig. 1. Walls 16 and 16ª form the radially inner portions of the diaphragms of the compressor. Carried by the right hand end, (Fig. 1) of joint plates 10 and 11 is one end of a rigid frame 31, the other end of which is carried by the casing of the turbine or other machine which drives the compressor, and supported on such frame is a bearing 32 for one end of the compressor shaft 33. The other end of shaft 33 is carried in a bearing at the left hand of the joint plates. As best shown in Fig. 3 such bearing comprises a pillow block 34 having feet 35 which rest on supports 36 formed as an integral part of joint plate 11. The shaft end rests on a lining 37 in the bottom of a recess in pillow block 34 and is held in position by a cap 38 which projects into such recess and has a bearing lining 39. Pillow block 34 is fastened to joint plate 11 by bolts 40 and cap 38 is fastened to pillow block 34 by bolts 41. Suitable packings 42 and 43 are provided for the shaft where it passes through the casing wall. On shaft 33 are double sided impellers 44 and 45. 46 indicates the vanes of the impellers and 47 the entrance buckets. Between the two stages of the compressor is a diaphragm packing comprising a part 48 carried by the shaft and a part 49 carried by the adjacent diaphragm.

The structure so far described forms what may be termed the metallic part of the compressor and when the bolting flanges 18 of the upper and lower joint plates 10 and 11 are bolted together, it will be seen that I have a rigid metallic structure comprising the bearings, the side plates for the impellers, the discharge vanes and the shaft packings. These form what may be termed the vital parts of the compressor in that they are the parts which carry the shaft and adjacent to which the impellers run.

The remaining portion of the compressor is formed of reinforced concrete and comprises the casing, and the radially outer portions of the diaphragms. The lower half of the casing comprises the concrete supporting abutments 50 in which are the admission conduit 51, the discharge conduit 52, and the side walls 53. The entrance ends of conduits 51 and 52 are defined by metal rings 54 which are provided with perforated holding wings 55 embedded in the adjacent concrete and held by anchors 56. At 57 is a metal ring which defines the outer end of a drain opening 58 leading from between the first and second stages of the machine. The lower half of the concrete casing is connected to the lower joint plate by grouting as indicated at 59. The metal reinforcements 60 for the concrete casing extend up beyond the concrete and are fastened to the joint plate and embedded in the grouting. Joint plate 11 is also fastened to the concrete of the lower half of the casing by a number of bolts 61, (Fig. 2). The openings in joint plate 11 through which bolts 61 pass are indicated at 62 in Fig. 5. This forms a strong connection between joint plate 11 and the concrete.

The upper half of the casing comprises the reinforced concrete wall 65 which is fastened to upper joint plate 10 by grouting 66 and bolts 67 in a manner similar to that described in connection with the lower half of the casing. In connection with the upper half of the casing, there are provided posts 68 through which bolts 67 pass and which form seats for washers 69 located beneath the nuts of bolts 67.

The radially outer portions of the diaphragms are formed of reinforced concrete and they are fastened to walls 16, 16ª by grouting as indicated at 70. The walls of one diaphragm are indicated by reference numerals 71, 72, 73 and 74 and the walls of the other by reference numerals 71ª, 72ª, 73ª and 74ª. These walls define discharge chambers 75 and 75ª for the two impellers and complete the inclosing of air passages 21, 22 and 23 and 24. The joint plates are provided with flanges 76 and 77 (Fig. 2) to which the side edges of the diaphragms are grouted. In the lower half of Fig. 2 the dotted line A indicates the joint between the grouting and the concrete. On the edges of walls 71 and 71ª are fastened arcuate strips of metal 78 held by ears 79 formed integral with strips 78 and embedded in the concrete. Strips 78 are located end to end to form substantially continuous semi-circular rings in the upper and lower halves of the casing and such half rings are fastened to the upper and lower halves of the casing by a clamping means comprising arcuate strips 80 fastened to the halves of the casing by integral ears 81 embedded in the concrete and arcuate strips 82 bolted to strips 80 by bolts 83. As best shown in Fig. 1 strips 78 are bolted between strip 80 and 82. The diaphragms are further supported in the upper and lower halves of the casing by bolts 84 and 85 as shown in Fig. 2. On the upper ends of bolts 84 are ears 86 for use in lifting the upper half of the casing.

The air passages 22 and 24 between diaphragm walls 73, 74 and 73ª, 74ª are crossed by walls forming spaced, axially-extending air passages 87 and 87ª (Fig. 1) and the outer portions of passages 22 and 24 are indicated by the dotted lines B.

The air or other gas being pumped enters the compressor through inlet conduit 51 and circulates around the casing, part of it being fed to the right hand side of impeller 44 through passage 21 and the remainder being fed to the left hand side of impeller 44 through passage 22. The air or gas is discharged from impeller 44 into chamber 75, and from chamber 75 it flows through passages 87 to passages 23 and 24 which conduct it to the two sides of impeller 45. Impeller 45 discharges into chamber 75ª from which the air or gas flows through passages 87ª to discharge conduit 52. This is a known arrangement of multistage compressors and may be taken as typical of any suitable arrangement in connection with which my invention may be used.

The air directing partitions 17, 17ª are for the purpose of directing the air radially to the eys of the impellers and preventing it from taking a circular motion around the shaft, and referring to Fig. 1 it will be noted that the side edges of these partitions are embedded in the grouting so they assist in holding the parts together. They are also preferably provided with openings as shown in Fig. 1 which are filled with grouting to firmly anchor the parts.

In connection with the concrete it will be noted that I reinforce the same in such manner that the reinforcement comes on sides which are under tension and that on sides subjected to compression there is no reinforcement. In this connection I have found that where concrete is under compression it needs no reinforcement and that reinforcement in such places is of little if any value. I accordingly concentrate the reinforcements at places where the walls are under tension.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof, but I desire to have it understood that the apparatus shown is only illustrative and that the invention may be carried out by other means.

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

1. A machine of the character described, having its casing made chiefly of concrete but having means forming a continuous metallic structure which defines the clearances of the machine, and bearings carried by said metallic structure.

2. A machine of the character described, having its casing made chiefly of concrete and split horizontally, but having means forming a continuous metallic structure which defines the clearances of the machine and the split joint of the casing, and bearings carried by said metallic structure.

3. In a machine of the character described, a casing, and a rotating member, said casing comprising a continuous metallic structure having bearings for said rotating member and parts with which said rotating member has clearances, the remaining portion of said casing being made of concrete.

4. In a machine of the character described, a casing having a split joint, and a rotating member, said casing being made chiefly of concrete and comprising a continuous metallic structure which forms the split joint of the casing and carries the bearings of the machine.

5. In a machine of the character described, a casing having a split joint, a rotating member, said casing being made chiefly of concrete and comprising a continuous metallic structure which forms the split joint of the casing and the parts having close clearance with the rotating member.

6. In a machine of the character described, a casing having a split joint, and a rotating member, said casing being made chiefly of concrete and comprising a continuous metallic structure which forms the split joint of the casing and the parts having close clearances with the rotating member and carries the bearings of the machine.

7. In a centrifugal compressor, a casing having a metallic means forming its central longitudinal portion and comprising side plates for the rotating elements and discharge vanes carried thereby, bearings connected to said metallic means, a shaft in said bearings, and concrete means forming the remainder of said casing.

8. In a centrifugal compressor, a pair of longitudinally extending joint plates, side plates and bearings carried by said joint plates, a shaft in said bearings, impeller means carried by said shaft and running adjacent to said side plates, and a concrete structure connected to said joint plates and forming the major portion of the compressor casing.

9. In a centrifugal compressor, a pair of longitudinally extending joint plates, walls projecting from said plates which define annular passages, bearings carried by said plates, a shaft in said bearings, impeller means carried by said shaft, and a concrete structure which forms the casing of said compressor and is fastened to said plates.

10. In a centrifugal compressor, a pair of longitudinally extending joint plates, walls projecting from said plates which define annular passages, bearings carried by

said plates, a shaft in said bearings, impeller means carried by said shaft, a concrete structure which forms the casing of said compressor and is fastened to said plates, and concrete walls fastened to said casing and projecting walls and forming diaphragms for the compressor.

11. In a centrifugal compressor, a casing formed of upper and lower halves, said halves being made of concrete, upper and lower joint plates fastened to said halves, walls carried by said joint plates, defining passages, bearings carried by the joint plates, a shaft in said bearings, impeller means on said shaft, and metallic side plates and discharge vanes for the impeller means carried by said joint plates.

12. In a centrifugal compressor, a casing formed of upper and lower halves, said halves being made of concrete, upper and lower joint plates fastened to said halves, walls carried by such joint plates defining passages, bearings carried by the joint plates, a shaft in said bearings, impeller means on said shaft, metallic side plates and discharge vanes for the impeller means carried by said joint plates, and concrete walls carried by the casing halves and connected to said first named walls to form continuations of said passages.

13. In a centrifugal compressor, a casing and diaphragms formed of concrete, a shaft, impellers carried thereby, and a metallic structure carried by the concrete and comprising side plates and discharge vanes for the impellers and bearings for the shafts.

14. In a centrifugal compressor a casing and diaphragms formed of concrete, a shaft, impellers carried thereby, a metallic structure carried by the concrete and comprising side plates and discharge vanes for the impellers and bearings for the shafts, and metallic reinforcement for said concrete where the same is under tension.

15. A machine comprising a casing, a shaft, and a rotor carried by the shaft, characterized by the fact that to form the casing a metallic structure is provided which comprises parts having close clearances with the rotor and bearings for said shaft, the remainder of said casing being made of concrete.

16. A multistage centrifugal compressor comprising a casing, diaphragms, a shaft, and impellers carried by the shaft characterized by the fact that the casing comprises a central frame of metal which carries the bearings for said shaft and anchoring means for the diaphragms, the remainder of the casing and the diaphragms being made chiefly of concrete.

In witness whereof, I have hereunto set my hand this third day of November, 1919.

LOUIS C. LOEWENSTEIN.