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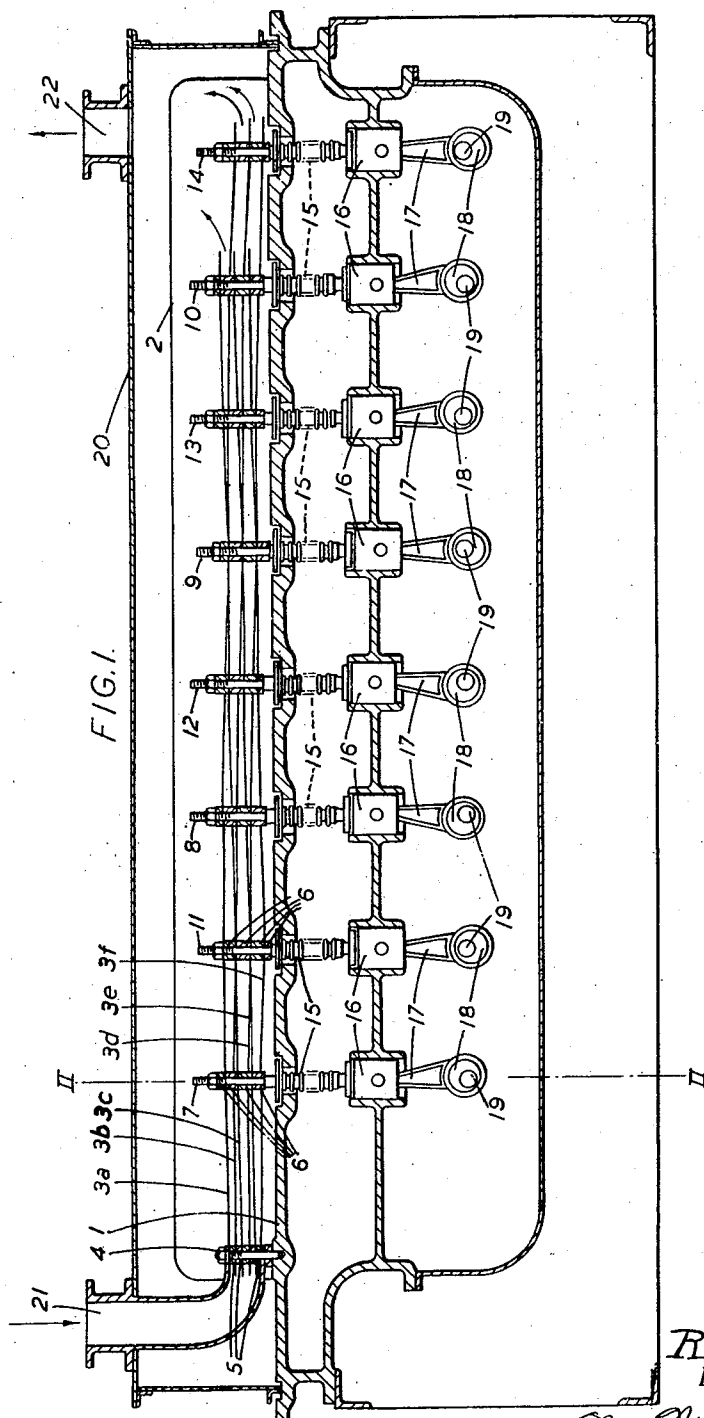
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PUMP FOR GASEOUS WORKING FLUIDS

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5 Sheets-Sheet 1



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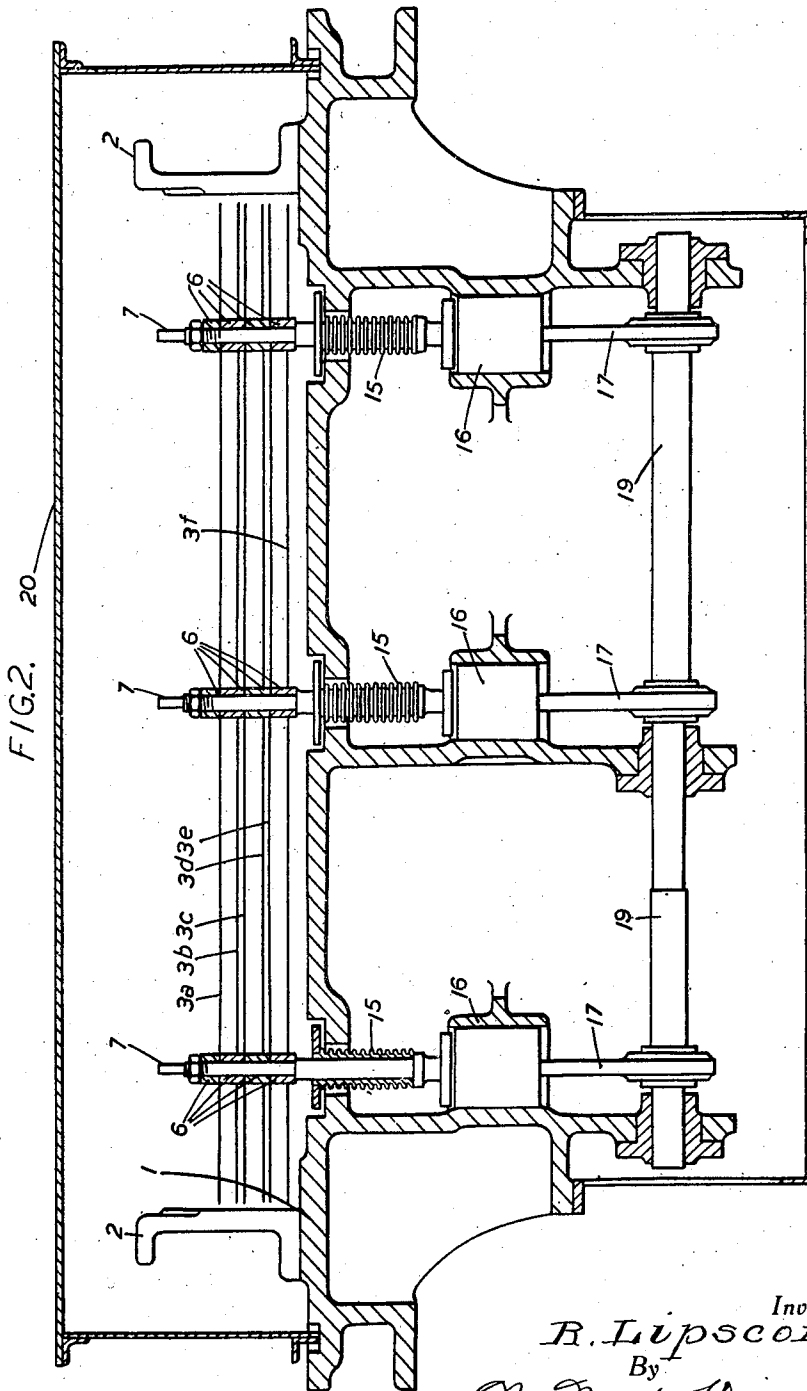
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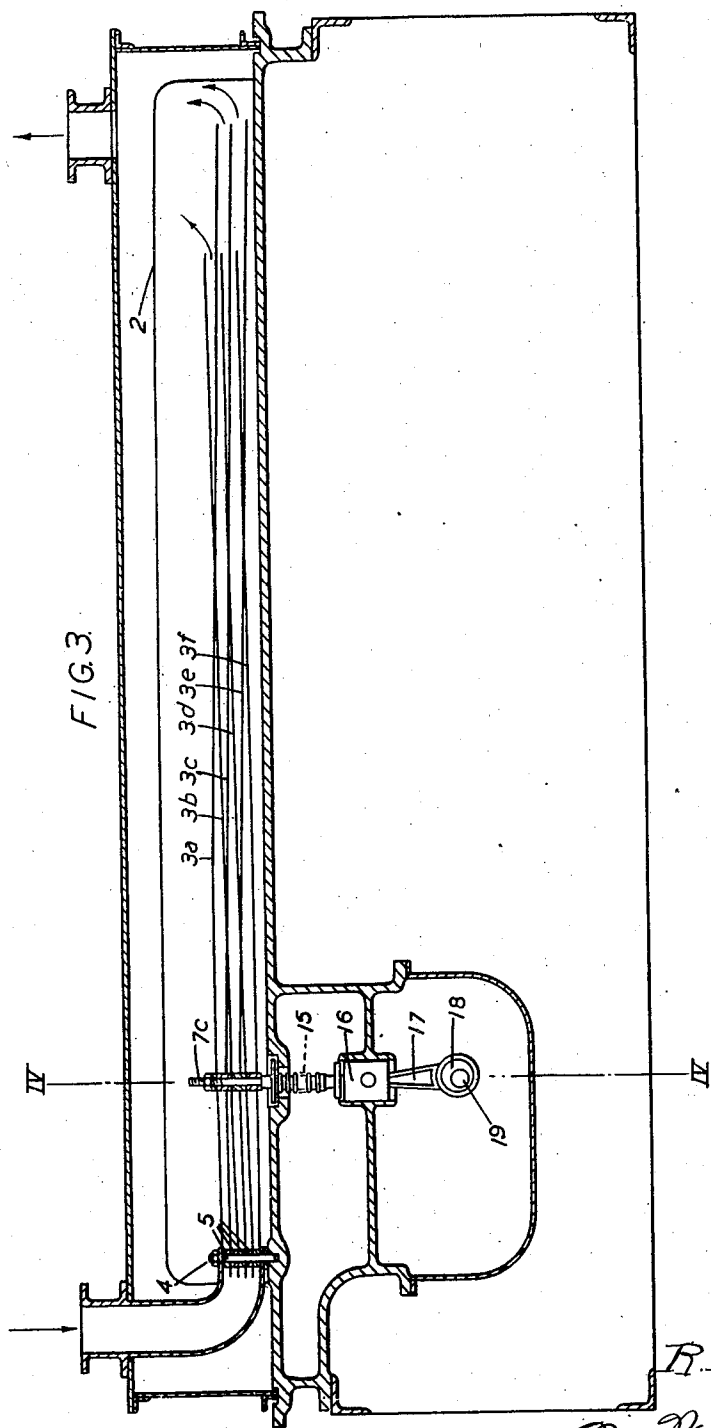
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5 Sheets-Sheet 3



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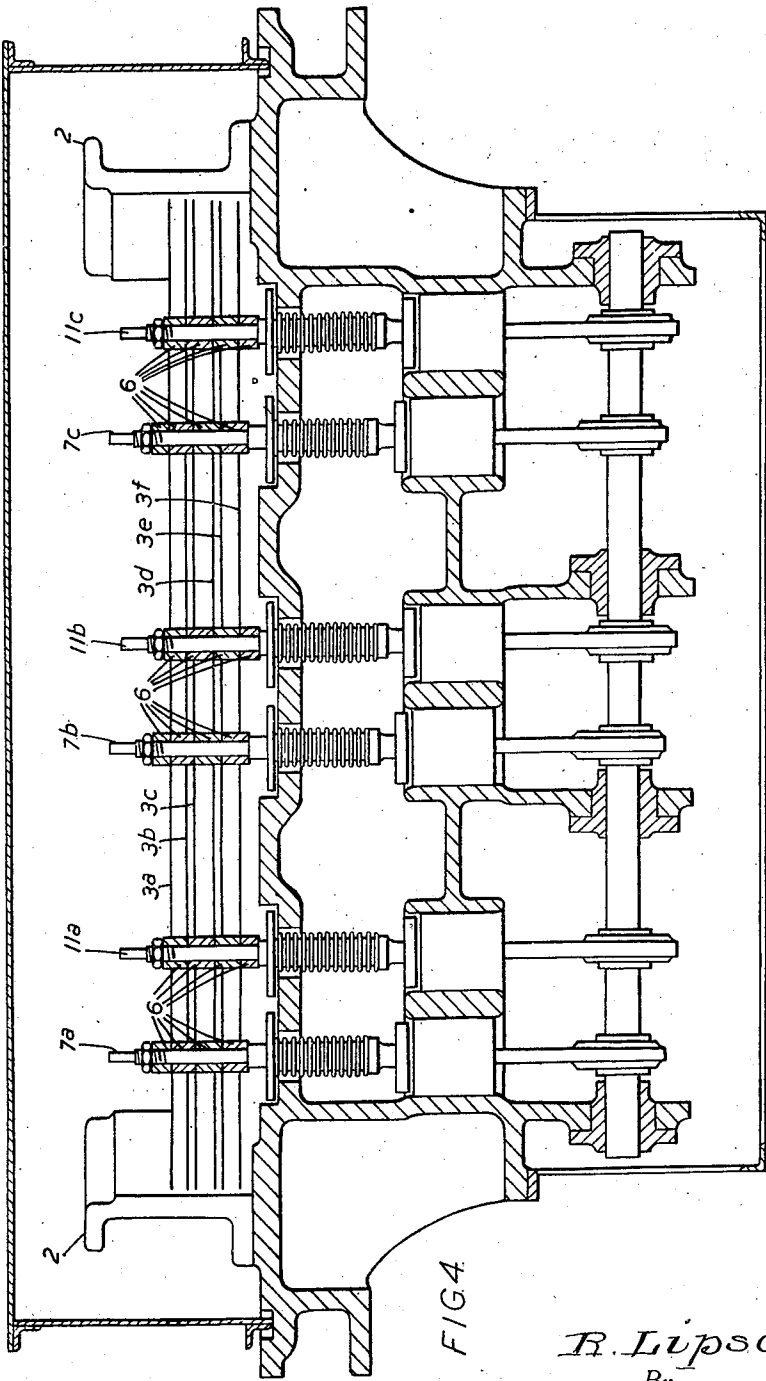
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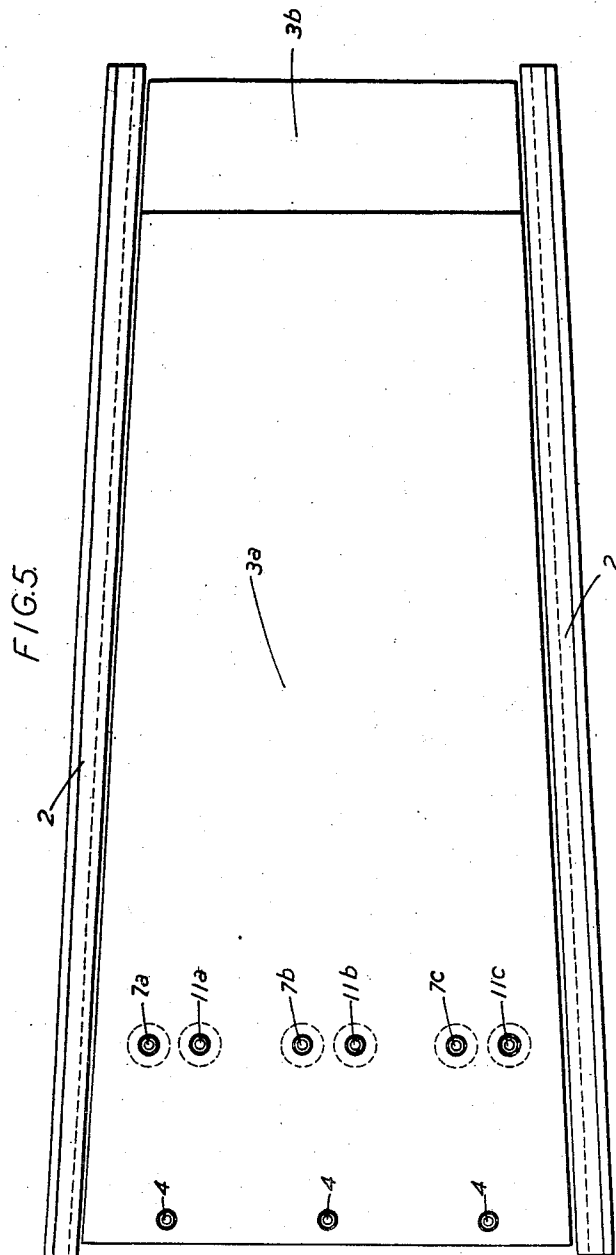
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PUMP FOR GASEOUS WORKING FLUIDS

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PUMP FOR GASEOUS WORKING FLUIDS

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11 Claims. (Cl. 230—1)

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This invention relates to pumps for gaseous working fluids of the type comprising a casing and one or more flexible bands forming a wall or walls of one or more working chambers, the said band or bands being subjected to bending in such a manner that wave-like deformations travel unidirectionally along it or them from one end to the other. In a device of this kind, having a single band if the wave crests maintain contact with a wall of the casing and the edges also only very slightly clear the casing, the casing wall and each wave of the band, i. e. the portion from one crest to the next, form a working chamber which is isolated from the rest of the space within the device and which travels from one end of the casing to the other and will therefore positively displace any fluid within it; by providing an inlet and an outlet communicating with the chamber at the respective ends of the device, the device becomes a positive pump. With a single band use may be made of the wall and therefore of the working chambers on one side only of the band, or, if the crests contact with the walls on opposite sides of the band use may be made of the chambers on both sides of the band. A device having a plurality of bands will operate similarly as regards the spaces between the bands provided that the crests of one band maintain contact with another band or bands; in general the crests of one band will be maintained in contact with the crests of the adjacent bands, so that symmetrical working chambers are formed. A multi-band device may also make use of the space between one outermost band and adjacent wall or between both outermost bands and adjacent walls, provided the crests maintain contact with this wall or walls.

In a known pump of this type, the working chamber is formed by a one-piece flexible tube, one side of which forms the band to which the wave-like movement is imparted. In this construction, however, parts of the tube are subjected to severe alternating bending stresses.

In other known pumps of this type the opposing walls of the operating chamber are separate, one wall being a wall of the casing or a band executing unidirectional wave-like movement and the other being a separate band executing unidirectional wave-like movement. In these machines, however, in the forms already known, either there are rubbing surfaces exposed to the working fluid, or the amplitude of the waves in the bands is not maintained throughout the length of the band sufficiently for crests or troughs of the waves to remain in contact with

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the opposing surface of the working chamber. Where such contact is not maintained the pump ceases to be positive, though a certain dynamic pumping effect may be obtained more particularly in the case of liquids.

The object of the present invention is to provide a positive-displacement pump of the type hereinbefore defined of greater efficiency than the known pumps of this type and which moreover is particularly suitable for operating with noxious gaseous fluids.

The pump of the present invention comprises a casing, and one or more flexible plates which are subjected to bending in such a manner that wave-like deformations travel unidirectionally along it or them from one end to the other with points of maximum displacement in the plate or plates in contact with the wall or walls of the casing and/or with each wave in a plate out of phase with but in contact with the wave opposite to it in each adjacent plate, thereby causing the plate or plates to form one or more working chambers with a wall of the casing and/or between adjacent plates; this is achieved according to the invention by applying oscillatory movements to the plate or plates at intervals throughout its or their length by means of rods projecting into the working space of the casing through gas tight seals and reciprocated by means outside the casing, or by applying an oscillatory movement to one end of the plate or plates and so tapering the plate or plates in thickness and/or width that each wave in a plate maintains contact with the wall of the casing and/or with the wave opposite to it in each adjacent plate.

It is to be observed that since the invention makes use of a flexible plate or plates, the severe bending stresses inherent in the use of a flexible tube or tubes are avoided, but that against this there must be a very slight clearance at the edges of the plate or plates, past which there will be slight leakage into or out of the working chamber. In view of the gas tight seals for the operating rods used in the invention, this leakage is unimportant. The invention further makes it possible for the casing itself to be used as one of the ducts for the fluid being pumped, for instance the outlet, thus simplifying the construction.

By the term "wave" used herein is meant two consecutive half waves.

The arrangement may be such that an uninterrupted succession of the wave-like deformations of the plate or plates is maintained during the operation of the pump.

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The invention will now be illustrated by way of example by reference to the accompanying drawings in which Figure 1 is a longitudinal section of one form of pump. Figure 2 is a transverse section on the line AA of Figure 1, Figure 3 is a longitudinal section of another form of pump, Figure 4 is a section on the line BB of Figure 3, and Figure 5 is a plan view of the plates in Figure 3.

Referring to Figures 1 and 2, reference numeral 1 denotes a bed plate to which are attached two parallel channel members 2 which form the sides of the working chambers. Between these channel members six plates, 3a, 3b, 3c, 3d, 3e, 3f, are mounted so that there is a small clearance between their edges and the channel members. At one end the plates are rigidly secured by bolts 4 (only one of which is seen in Figure 1) and are spaced apart by sleeves 5 on the bolts. The plates 3a, 3c, 3e, are secured between sleeves 6 on the rods 7, 8, 9 and 10 and are perforated so that there is a clearance between them and the sleeves 6 on the rods 11, 12 and 13. Similarly, the plates 3b, 3d and 3f are secured between the sleeves 6 on the rods 11, 12, 13 and 14, and are perforated to clear the sleeves on the rods 7, 8, 9 and 10. The rods 7 to 14 which pass through holes in the bed plate sealed by metallic bellows 15, are connected to cross heads 16 which are given a reciprocating motion through the connecting rods 17 which are operated by eccentrics 18 on the shafts 19. The phases of the eccentrics are arranged to give a wave motion to the plates, such that the waves in each plate are completely out of phase with the waves in adjacent plates. The amplitudes of motion are such that, as shown, the wave crests in each plate are maintained in contact from the line of the rods 7 to that of the rods 10, so that except for leakages past the edge clearances and the clearances round the sleeves on the rods 7 to 10, closed working chambers travel in succession from one end to the other of the plates in the direction to the right in Fig. 1, and in the example illustrated only the working chambers between the plates are used. The bed plate is provided with a cover plate 20, the gaseous fluid entering the working chambers through the rectangular-sectioned duct 21 and being discharged into the casing constituted by the bed plate and the cover plate 20, thence leaving through the pipe 22.

In the pump shown in Figures 3, 4 and 5, the plates 3a, 3b, 3c, 3d, 3e and 3f are tapered in width from the inlet end to the outlet end of the working chambers and the channel members 2 converge so as to leave a small clearance between them and the edges of the plates throughout their length. Plates 3a, 3c and 3e are secured between sleeves 6 on the rods 7a, 7b and 7c, and are perforated so that they clear the sleeves 6 on the rods 11a, 11b, and 11c. Similarly, the plates 3b, 3d and 3f are secured between sleeves 6 on the rods 11a, 11b, 11c, and are perforated so that they clear the sleeves on the rods 7a, 7b and 7c. The rods 7a, 7b and 7c are reciprocated in phase with each other and completely out of phase with the rods 11a, 11b and 11c, so that the waves generated in each plate are completely out of phase with the waves generated in adjacent plates. Beyond the rods 7 the wave motion in the plates is free. Consequently the energy imparted by the plates to the fluid being pumped must come from the supply imparted to the plates by the rods and the energy left in the plates will diminish from the inlet end to the

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outlet end; there will also be a small additional loss due to external and internal friction. If therefore the section of the plates remained constant, the amplitude of the wave motion would diminish from inlet to outlet, but this is compensated according to the invention, by diminishing the section of the plates from inlet to outlet, for instance by tapering them. The degree of taper is chosen with respect to rate of fluid flow required so that the amplitude of the waves generated in the plates remains substantially constant throughout the lengths of the plate. It will be evident that this form of the invention is only suitable where a predetermined and substantially constant rate of fluid flow is required. Instead of tapering the width of the plates, the thickness of the plates may be tapered and the width maintained uniform or a combination of tapering width and thickness may be employed.

I claim:

1. A pump comprising a casing, at least one flexible plate therein, rods projecting into the working space of the casing through gas-tight seals, and attached to the plate at intervals throughout its length, means for reciprocating the said rods to cause wave-like deformations to travel unidirectionally along the plate from the one end to the other with points of maximum displacement in the plate in contact with at least one wall of the casing so as to form a pumping space between said plate and said wall, and an inlet to and an outlet from said casing.

2. A pump comprising a casing, a plurality of flexible plates therein, to each of which are attached at intervals throughout its length, rods which project out of the working space of the casing through gas-tight seals, means for reciprocating the said rods to cause wave-like deformations to travel unidirectionally along the plate from one end to the other with each wave in the plate out of phase with but in contact with the wave opposite to it in each adjacent plate so as to form pumping space between said plates, and an inlet to and an outlet from said casing.

3. A pump comprising a casing, a plurality of flexible plates therein, means adapted to apply oscillatory movements to one end of each plate and to cause wave-like deformations to travel unidirectionally along the plate from one end to the other, with each wave in the plate out of phase with the wave opposite to it in the adjacent plates, each plate being tapered so as to maintain each wave in it in contact with the opposite waves in the adjacent plates, an inlet to said casing, and an outlet from said casing.

4. A pump comprising a casing, at least one flexible plate therein, means adapted to apply oscillatory movements to one end of each plate and so cause wave-like deformations to travel unidirectionally along the plate from one end to the other, each plate being tapered so as to maintain each wave in contact with at least one wall of the casing, an inlet to said casing and an outlet from said casing.

5. A pump comprising a casing, a plurality of flexible plates therein, to each of which are attached at intervals throughout its lengths, rods which project out of the working space of the casing through gas-tight seals, means for reciprocating the said rods to cause wave-like deformations to travel unidirectionally along the plate from one end to the other with points of maximum displacement in the plate in contact with points of maximum displacement in the adjacent plates, an

inlet to said casing, and an outlet from said casing.

6. A pump comprising a casing, a plurality of flexible plates therein, means adapted to apply oscillatory movements to one end of each plate and so cause wave-like deformations to travel unidirectionally along the plate from one end to the other, each plate being tapered so as to maintain points of maximum displacement in it in contact with points of maximum displacement in the adjacent plates, an inlet to said casing, and an outlet from said casing.

7. A pump comprising a casing, a plurality of flexible plates therein, means adapted to apply oscillatory movements to one end of each plate and so cause wave-like deformations to travel unidirectionally along the plate from one end to the other, with each wave in the plate out of phase with the wave opposite to it in the adjacent plates, each plate being tapered in width so as to maintain each wave in it in contact with the opposite wave in the adjacent plates, an inlet to said casing, and an outlet from said casing.

8. A pump comprising a casing, a plurality of flexible plates therein, means adapted to apply oscillatory movements to one end of each plate and so cause wave-like deformations to travel unidirectionally along the plate from one end to the other, each plate being tapered in width so as to maintain points of maximum displacement in it in contact with points of maximum displacement in the adjacent plates, an inlet to said casing, and an outlet from said casing.

9. A pump comprising a casing, an inlet to and an outlet from said casing, a plurality of flexible plates in said casing, to each of which are attached near the inlet end of the pump, rods which project out of the casing through gas-tight seals, means for reciprocating the said rods to cause wave-like deformations to travel unidirectionally from the inlet edge to the outlet edge of the plate with each wave out of phase with the wave opposite to it in the adjacent plates, each plate being tapered in width towards its outlet edge so as to maintain each wave in it in contact with opposite waves in adjacent plates.

10. A pump comprising a casing, an inlet communicating with said casing through a rectangular port, a plurality of flexible plates within said casing, anchored near one of their ends in spaced relationship in the inlet port, means adapted to apply oscillatory movement near the said anchored end of each plate and so cause wave-like deformations to travel unidirectionally along the plate to the other end, with each wave in the plate out of phase with the wave opposite to it in the adjacent plates, each plate being tapered in width towards the said other end to maintain each wave in the plate in contact with the opposite wave in the adjacent plates, and an outlet leading from said casing near the narrower ends of the plates.

11. A pump comprising a casing, an inlet communicating with said casing through a rectangular port, a plurality of flexible plates within said casing, anchored near one of their ends in spaced relationship in the inlet port, to each of which plates are attached throughout its length, rods which project out of the casing through gas-tight seals, means outside the casing adapted to reciprocate the said rods and cause wave-like deformations to travel unidirectionally from the anchored end of the plate to the other end thereof, with points of maximum displacement in the plate in contact with points of maximum displacement in the adjacent plates, and an outlet leading from said casing near the ends of the plates remote from the inlet port.

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