Feb. 18, 1969 E. R. CORNEIL 3,427,986

FLUID PUMP WITH CONTROLLED VARIABLE FLOW

Filed June 27, 1967

Sheet 1 of 3

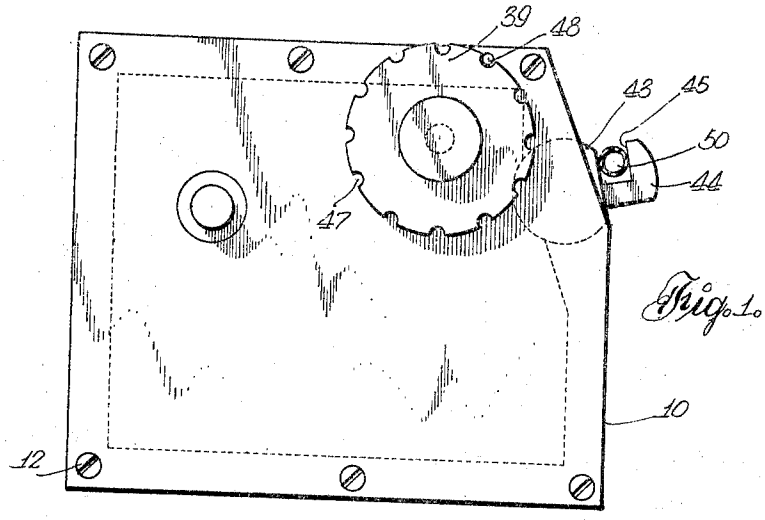


Fig. 1.

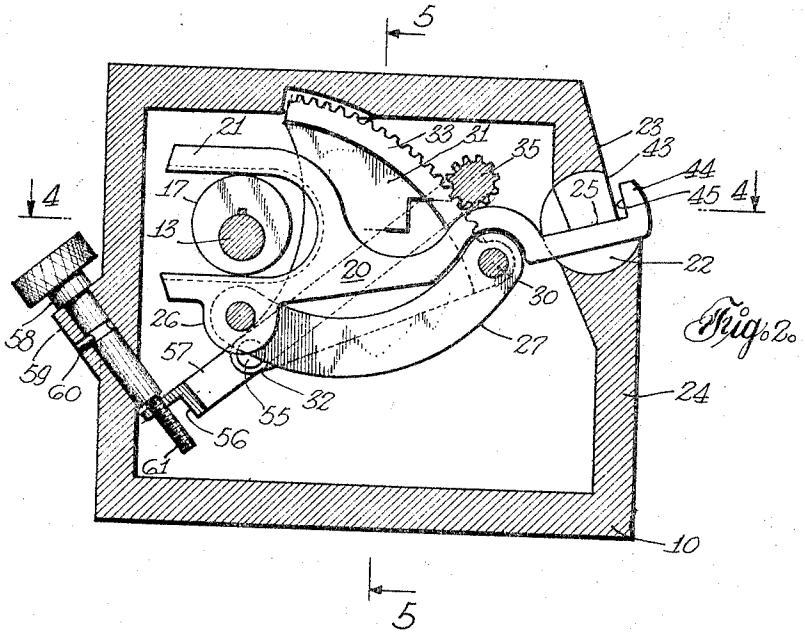


Fig. 2.

Ernest R. Corneil

INVENTOR

BY Wm. Marshall, Macklar & Lamb

PATENT AGENT

Feb. 18, 1969 E. R. CORNEIL 3,427,986

FLUID PUMP WITH CONTROLLED VARIABLE FLOW

Filed June 27, 1967 Sheet 2 of 3

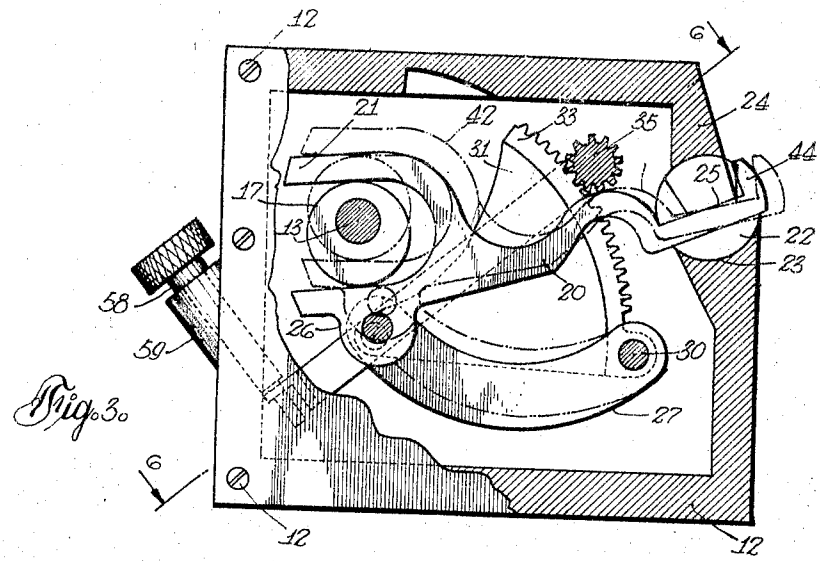


Fig. 3.

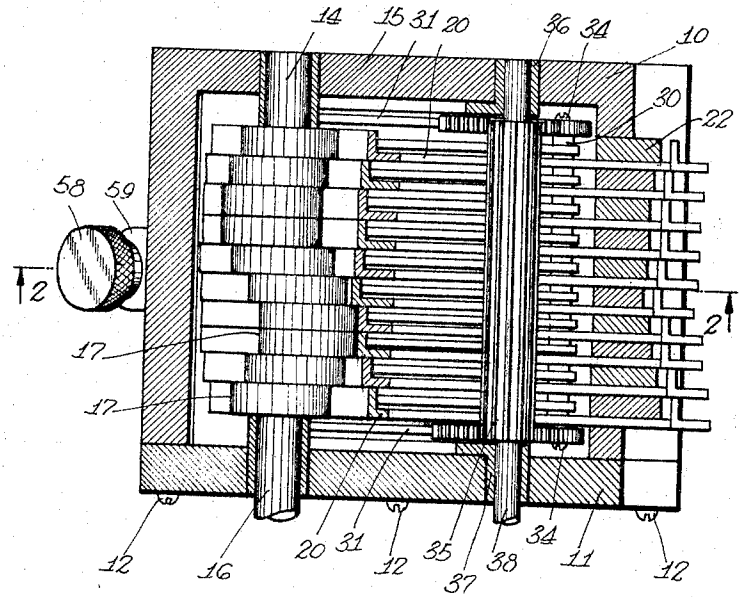


Fig. 4.

Ernest R. Corneil

INVENTOR

BY Weir, Marshall, MacRae & Lamb

PATENT AGENT

Feb. 18, 1969 E. R. CORNEIL 3,427,986

FLUID PUMP WITH CONTROLLED VARIABLE FLOW

Filed June 27, 1967 Sheet 3 of 3

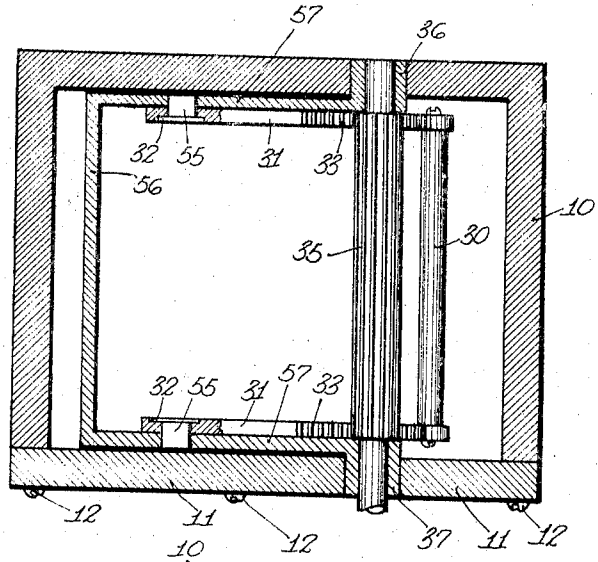


Fig. 6.

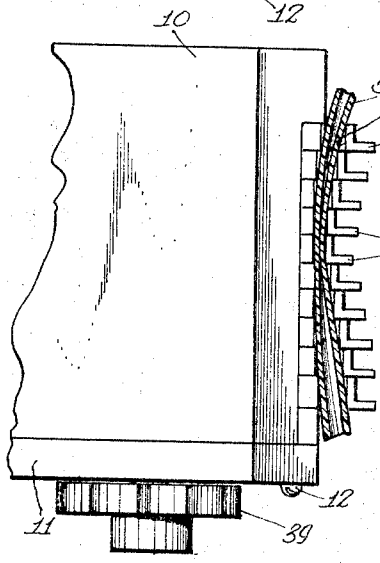


Fig. 7.

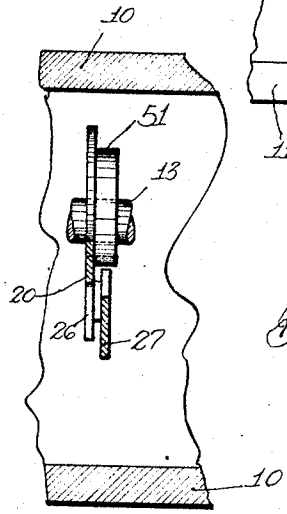


Fig. 5.

Ernest R. Corneil
INVENTOR

BY Wm. Macrae
MacRae & Lamb

PATENT AGENT

United States Patent Office 3,427,986
Patented Feb. 18, 1969

3,427,986

FLUID PUMP WITH CONTROLLED VARIABLE FLOW

Ernest R. Corneil, R.R. 1, Thorold, Ontario, Canada

Filed June 27, 1967, Ser. No. 649,344
U.S. Cl. 103—149 10 Claims
Int. Cl. F04b 43/08

ABSTRACT OF THE DISCLOSURE

Fluid pump in which reciprocating, or oscillating members distort a tube, progressively along a length of the tube to produce a fluid flow. The members are reciprocated about a first centre by a cam or similar action, and constrained by a linkage also to reciprocate about a second centre. By varying the position of the second centre, relative to a line through the first centre and a point of attachment of the linkage to a member, the displacement of the member, and the degree of distortion of the tube, between fully closed and fully opened, can be controllably varied and thus the flow rate varied, with constant speed.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates to fluid pumps of the type in which a flexible tube is progressively distorted to produce a pumping action and is concerned with providing a volumetric flow control, independent of speed of operation.

Description of the prior art

Various forms of pump have been proposed, in which a flexible tube is distorted to produce the pumping action. Hitherto, the rate of flow has been controlled by varying the frequency of the cycle and this necessitates variable speed drives. With electric and other constant speed power units, some form of variable speed gear has to be interposed between the pump and the power unit. Also, for very small flows, a small bore tube is required, as the flow rate is also dependent on the tube bore diameter. To provide a wide range of flow rates, a variety of tubes with differing bores, and wall thicknesses, are required. To date, no pumps of the distortable tube type are available to provide a controlled variable flow at a constant speed from a given flexible tube member.

SUMMARY

The present invention provides a pump, of the flexible tube type, in which the tube is distorted by reciprocating members, in which the extent of reciprocation of the members is controllably variable. The invention also provides, in a modification thereof, means for adjusting the datum of the reciprocating members, to accommodate tubes of differing wall thicknesses.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be understood by the following description of certain embodiments, by way of example, in conjunction with the accompanying drawings, in which:

FIGURE 1 is an external side view of one form of apparatus,

FIGURE 2 is a cross-section, on the line 2—2 of FIGURE 4, with the mechanism at a minimum flow rate position,

FIGURE 3 is a cross-section similar to that of FIGURE 2, but with the mechanism at a position approaching that for maximum flow rate,

FIGURE 4 is a sectional view on the line 4—4 of FIGURE 2,

FIGURE 5 is a cross-section on the line 5—5 of FIGURE 2, through one oscillating member and associated linkage,

FIGURE 6 is a cross-section on the line 6—6 of FIGURE 3, but with the oscillating members and associated cams and linkages omitted for clarity, illustrating an additional feature of the invention, and

FIGURE 7 is a plan view illustrating the distortion of a tube.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Considering FIGURES 1 to 4, the pump comprises a casing, or housing, **10** open at one side and which is closed by a cover plate **11** secured by screws **12**. A cam-shaft **13** is journalled at one end **14** in an end wall **15** of the housing **10**, and journalled at the other end **16** in the cover plate **11**. The cam shaft has a series of uniform cams **17** thereon and an extension **18** for driving by some suitable power source, not shown. The cams **17** are arranged sequentially along the cam shaft **13**, normally with equal relative angular displacement.

Mounted on each of the cams **17** is a reciprocating, or oscillating, member **20**. Each member **20** engages its related cam by a yoke **21** formed at one end of the member. A series of rotatable supports **22** are journalled in a bearing mounting **23** in one wall **24** of the housing **10**. A support **22** is provided for each member **20**, the member slidably retained in a slot **25** in the support.

The cams **17**, on rotation of the cam-shaft **13**, cause reciprocation, or oscillation, of the members **20**, each about the axis of rotation of its related support **22**. The cams do not directly cause movement of the members **20** in a direction parallel to their longitudinal axis, although the yokes **21** permit such movement of the members **20**.

A boss **26** is formed on one side of the yoke **21** on each member **20**. The bosses **26** provide pivotal attachment points for one end of links, or levers, **27**. The other end of each link **27** is pivotally journalled on a shaft **30**. The shaft **30** extends parallel to the axis of rotation of the supports **22** and also to an axis passing through the points of attachment of the links **27** to the members **20**. The shaft **30** is supported in the housing **10** by two parallel, spaced apart, levers in the form of segments **31**. The segments are each pivotally mounted at an apex **32** and the shaft **30** is attached at one end of the arcuate surface **33** of each segment by screws **34**. The arcuate surfaces **33** of the segments are formed to provide arcuate rack gears which mesh with a gear pinion **35** extending across the housing, the gear being rotatably supported in bearings **36** and **37** in the end wall **15** and the cover **11**. One end of the gear **35** is extended as a shaft **38** for attachment of a control dial **39**.

It will be seen that rotation of the gear **35**, by the control dial **39**, will rotate the segments about their pivotal mountings at their apices **32**. Movement of the segments will vary the position of the shaft **30** relative to the axis of rotation of the supports **22** and the axis through the pivotal attachment points of the links **27** to the members **20**.

In operation, cam-shaft **13** is rotated, rotating the cams **17**. Rotation of the cams reciprocates, or oscillates, members **20** about the rotational axis of the supports **22**. Considering the member **20** and link **27**, as shown in FIGURE 2, as the member **20** oscillates about the rotational axis of support **22**, the link **27** also oscillates about the axis of shaft **30**. The relative position of the link and member, in FIGURE 2, is the one giving substantially minimum flow. The axis of shaft **30** is in line with the axis of support **22** and the axis of the point of attachment of the link **27** with the boss **26**. In such a position very little movement of the member **20** along its longitudinal axis occurs.

To produce movement of the members **20**, along their longitudinal axes, the gear **35** is rotated by the dial **39**. This moves the axis of the shaft **30** out of alignment with the axis of the supports **22** and the points of attachment of the links to the bosses. One such position of shaft **30** is shown in FIGURE 3, the shaft approaching the maximum out of line displacement. If now the movements of a member **20** and link **27** is considered, it will be seen that as camshaft **13** rotates, cam **17** will oscillate member **20** about the rotational axis of the support **22**. Link **27** will be oscillated about shaft **30**. However, with shaft **30** displaced out of line with the axis of support **22** and axis of the attachment of the link **27** with boss **26**, two components of movement will be imposed on the boss **26**, one normal to a line connecting the rotational axes of camshaft **13** and support **22** and the other along that line. Thus the member **20** will be reciprocated along its length. The position of member **20** on 180° rotation of the cam **17** is shown in phantom at **42**.

Each support **22** is provided with a flat surface **43** and each member **20** is provided with a lateral extension **44** at its end remote from the yoke **21**. Each extension **44** has a flat surface **45** which faces toward the flat surface **43** on the related support **22**. Reciprocation of a member **20** along its length varies the gap between the opposed flat surfaces **43** and **45**.

A flexible tube **50**, FIGURES 1 and 7, is positioned between the flat surfaces **43**, **45**, and reciprocation of the members **20** distorts the tube. With the cams **17** equally angularly displaced on the camshaft **13** a regular "wave" will travel along the tube progressively distorting the tube to provide a pumping action.

With the position of shaft **30** in FIGURE 2 giving the minimum movement of the member **20** along its longitudinal axis, this represents the minimum pumping action and minimum flow. The position of the shaft **30** as shown in FIGURE 3 is nearly at the maximum displacement and giving nearly maximum movement of member **20** along its longitudinal axis, with corresponding nearly maximum pumping action and flow. Variation of the positioning of the shaft **30**, intermediate the two positions shown in FIGURES 2 and 3, will give variation in pumping action and flow. This variation of the position of shaft **30** is obtained by rotation of the control dial **39**. Suitable indents **47**, formed in the periphery of the dial **39**, and cooperating with a spring-loaded pin **48**, or some similar device, provide a convenient way of varying the pumping action, and flow rate by predetermined steps.

Although only the movement of one member **20** and associated link **27** has been described in detail, the movements of all members **20** and associated links **27** are the same. To provide reasonable bearing surfaces for the members **20**, each yoke is flanged at **51**. The links **27** are positioned between the members **20**, in the spaces provided by the flanges **51**. FIGURE 5 illustrates the position of one member **20** and its link **27**.

Thus, considering FIGURES 1 to 5, it will be seen that rotation of the camshaft **13** will cause a "travelling wave" to move along the tube **50**, progressively distorting it and then allowing it to return to its undistorted shape. By manipulation of the control dial **39**, the amplitude of the "wave" can be controllably varied from substantially zero to a maximum. At the zero condition the tube is distorted into a closed condition and remains so distorted. Movement of the control dial **39** a small amount will result in some small amount of reciprocation of members **20**, the tube being completely occluded at one spot only at any given point of rotation, the rest of the tube being slightly open. At the maximum condition, the tube will be completely occluded at the one position, which can be considered as the trough of the "wave," and will be increasingly opened up to a position which can be considered as corresponding to the peak of the "wave," giving maximum flow. Normally, in the maximum condition, the tube will be completely open, i.e., undistorted at the position considered as the peak of the "wave." However, this is not a necessity, and there may always be some distortion of the tube **50**. No variation in speed of rotation of the camshaft **13** is required for this variation in flow.

It is desirable that some adjustment be available to permit initial adjustment of the gap between the opposed flat surfaces **43** and **45**. The thickness of the wall of tube **50** is likely to vary from tube to tube. It is necessary to completely occlude the tube for maximum pumping activity but at the same time it is desirable to avoid overcompressing the tube to avoid damage.

An additional, optional, feature of the apparatus is the provision of means for adjusting the gap between surfaces **43** and **45**, independently of the cams **17**, members **20** and links **27**. As stated above, the segments **31** are pivotally mounted at their apices **32**. As seen more clearly in FIGURE 6, the segments **31** are pivotally mounted by rivets **55** on an adjustable yoke member **56**. The yoke member is pivotally mounted, at the ends of legs **57**, at the position at which the gear **35** is supported in the end wall **15** and the end cover **11**. Conveniently, the ends of the legs **57** form the bearings **36** and **37** which support the gear **35**. By this arrangement, the yoke member **56** can rotationally oscillate about the axis through bearings **36** and **37**. This also means that the position of attachment of the segments **31** to the yoke member **56** can also rotationally oscillate about the axis through bearings **36** and **37**.

Movement of the yoke will alter the angular position of the segments relative to the members **20** and links **27**. Further, as the segments are also pivotally connected to the shaft **30**, to which all the links **27** are pivotally connected, the geometry of the relationship between members **20**, links **27**, segments **31** and gear **35** will vary with alteration of the angular relationship of the segments.

From a mid-position, the yoke member **56** can be rotated clockwise or anticlockwise. Movement of the yoke member **56** is obtained by a control screw **58** rotatably secured in a boss **59** formed on the housing **10** by a screw **60**. The control screw has a threaded portion **61** at its inner end which engages with a threaded hole in the yoke member **56**. The arrangement is seen clearly in FIGURE 2, the yoke member **56** being at one extreme position of adjustment.

If the control screw **58** is rotated to cause the threaded portion **61** to move yoke **56** anticlockwise as seen in FIGURE 2, then the segments **31** will also be rotated anticlockwise about an axis through the bearings **36** and **37**, and through the gear **35**. This movement of the segments will move shaft **30** anticlockwise about the axis through bearings **36** and **37**. This movement of the shaft **30** will cause the links **27** to move slightly to the right, as seen in FIGURE 2, and will also cause the members **20** to slide slightly to the right, increasing the distance between surfaces **43** and **45**. Thus the control screw **58** will enable the datum gap between surfaces **43** and **45** to be varied. This variation is made without any substantial variation in the operational strokes of the members **20**, which is governed by the gear **35** and the segments **31**.

From the above it will be seen that the invention provides for a variable flow rate, independent of speed. Also, if desired, adjustment can readily be provided to adapt for differing thickness of tube wall and similar variations.

I claim:

1. A pump for fluids, comprising; a housing; a series of members mounted in said housing for reciprocal and oscillatory rotative movement in a series of parallel planes; support means supporting said members towards one end for reciprocation and for oscillatory rotation about a first axis, normal to said planes; a first surface on each of the members, extending transverse to said plane; a series of second surfaces, one opposed to each said first surfaces to cooperate therewith; means adjacent the other ends of said members for sequentially oscillating said members about

said first axis; a series of links extending parallel to said planes, a link to each member; each link pivotally attached at one end to a related member adjacent said other end of said member, said links pivotable relative to the members about a second axis parallel to said first axis; means pivotally connecting the links at their other ends for pivoting movement about a third axis, positioned between said first and second axes and parallel thereto; and means for varying the position of said third axis relative to a plane parallel to and passing through said first and second axes and thus varying the pivotal position of said other ends of said links; whereby oscillation of said other ends of said members pivots said links about said third axis to impart a reciprocal movement to said members, the extent of said reciprocal movement increasing with increase in displacement of said third axis; reciprocation of said members varying the distance between said first and second surfaces for distortion of a flexible tube positioned therebetween to produce a pumping action.

2. Apparatus as claimed in claim **1** wherein the means pivotally connecting the links at their other ends comprises a shaft, the longitudinal axis of the shaft comprising said third axis.

3. Apparatus as claimed in claim **2**, wherein said means for varying the position of said third axis comprises at least one lever, said shaft mounted at one end of the lever, the other end of said lever pivotally mounted in said housing for rotative movement in a plane parallel to the planes of movement of said members, and means for moving said lever about said axis.

4. Apparatus as claimed in claim **2**, said means for varying the position of said third axis comprising; a pair of segmental levers pivotally mounted at their apices in said housing, movable in planes parallel to said planes of movement of said members, said shaft mounted at an end of the segmental levers remote from said apices, a peripheral arcuate surface at said end of each segmental lever; an arcuate rack gear formed on each of said arcuate surfaces; a pinion gear pivotally mounted in said housing, having an axis of rotation normal to the planes of movement of said segmental levers, said gear meshing with said arcuate rack gears; and means for controllably rotating said gear.

5. Apparatus as claimed in claim **1**, wherein the support means supporting said members comprises a series of support members rotatably mounted in a wall of said

housing, a support member for each of said members, said second surfaces comprising surfaces on said support members, one surface on each support member.

6. Apparatus as claimed in claim **1**, wherein said means for sequentially oscillating said members comprises; a cam shaft; and a series of cams on said shaft, sequentially angularly displaced, a cam for each said member.

7. Apparatus as claimed in claim **4**, wherein the means for controllably rotating said gear comprises a control dial, rotatable to any one of a series of predetermined positions, and a spring loaded pin adapted for engagement with said dial.

8. Apparatus as claimed in claim **4**, wherein said segmental levers are pivotally mounted at their apices in an adjustable member, said adjustable member supported in said housing for pivotal movement about the axis of rotation of said pinion gear, and including means for pivoting said segmental levers about the axis of said pinion gear, whereby the position of the pivotal axis of said segmental levers and the datum position of the third axis relative to the first and second axes can be varied.

9. Apparatus as claimed in claim **8** wherein said adjustable member comprises a yoke member having parallel spaced apart legs, said yoke member including bearings at the ends of the legs for pivotal mounting of the yoke member in said housing, said bearings also providing the pivotal mounting for said pinion gear.

10. Apparatus as claimed in claim **9** wherein the means for pivoting said segmental levers comprises a control screw retained in said housing, said screw including a threaded portion engaging in a cooperating threaded hole in said yoke member.

References Cited

UNITED STATES PATENTS

1,922,196	8/1933	Butler	103—148
2,105,200	1/1938	Phelps	103—149
2,877,714	3/1959	Sorg et al.	103—149
2,922,379	1/1960	Schultz	103—148
3,083,647	4/1963	Muller	103—148
3,128,716	4/1964	Stallman et al.	103—149

DONLEY J. STOCKING, *Primary Examiner.*

WILBUR J. GOODLIN, *Assistant Examiner.*