United States Patent [19]

Aghnides

[11] **3,712,548**

[45] **Jan. 23, 1973**

[54] WATER AERATOR

[76] Inventor: **Elie P. Aghnides**, 795 Fifth Avenue, New York, N.Y. 10021

[22] Filed: **Aug. 20, 1970**

[21] Appl. No.: **50,948**

[52] **U.S. Cl.**.....**239/428.5**, 239/DIG. 18
[51] **Int. Cl.**.....**E03c 1/08**
[58] **Field of Search**.....239/428.5, DIG. 18

[56] **References Cited**

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2,998,931	9/1961	Aghnides	239/DIG. 18
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1,338,329	4/1962	France	239/428.5

Primary Examiner—Lloyd L. King
Attorney—William D. Hall, Elliott I. Pollock, Fred C. Philpitt, George Vande Sande, Charles F. Steininger and Robert R. Priddy

[57] **ABSTRACT**

A water aerator having a relatively thin diaphragm with square cross-section holes with a bridge arrangement over the holes on the upstream side to form either one water entrance or two water entrances to each hole. In the case of the bridge arrangement to form two water entrances, the size of one entrace to any hole may be different from that of the other entrance to permit the issuing turbulent jet of water to diverge or converge. The structure contains a casing having an annular enlargement at the downstream end which is unindented.

12 Claims, 14 Drawing Figures

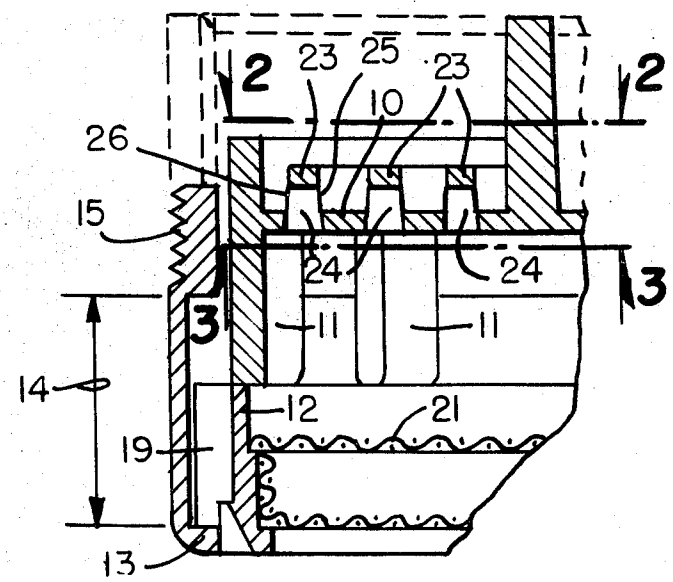


FIG. 1A.

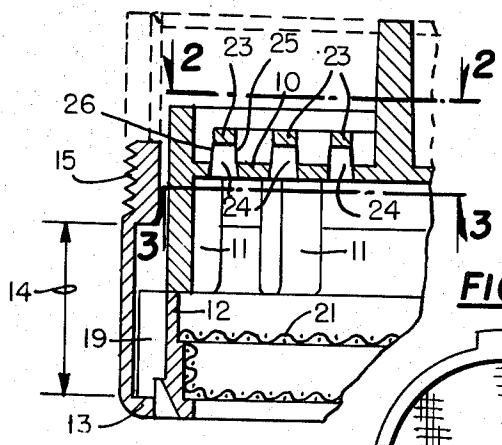


FIG. 9.

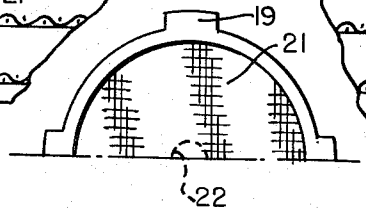


FIG. 1B.

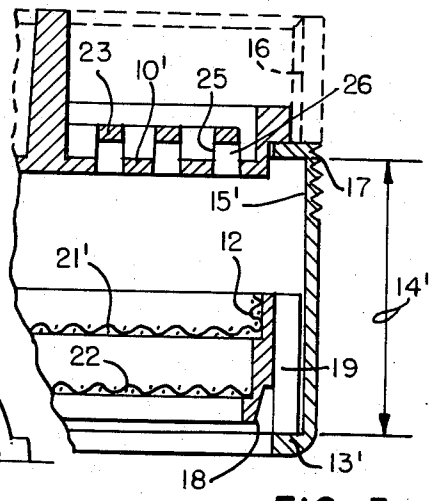


FIG. 2.

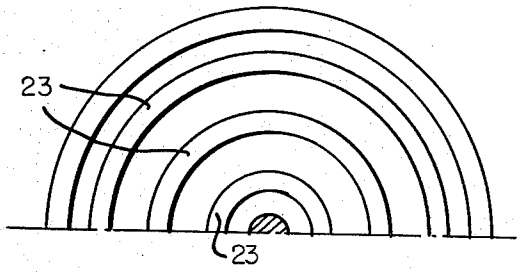


FIG. 3.

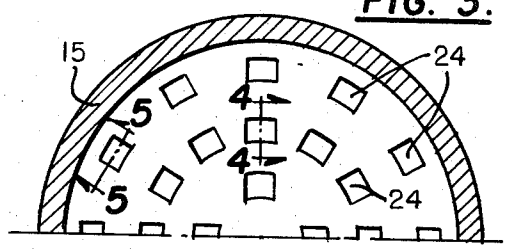


FIG. 4.

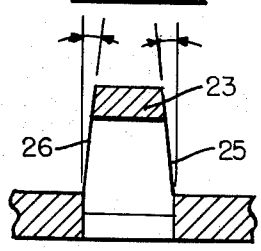


FIG. 5.

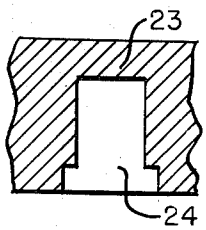


FIG. 7.

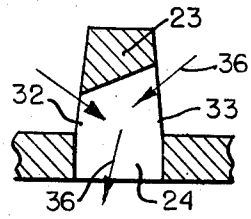


FIG. 8.

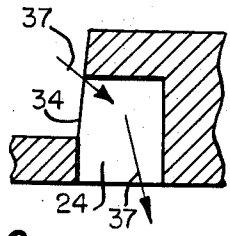


FIG. 10.

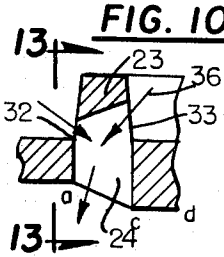


FIG. 11.

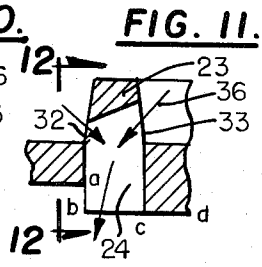


FIG. 6.

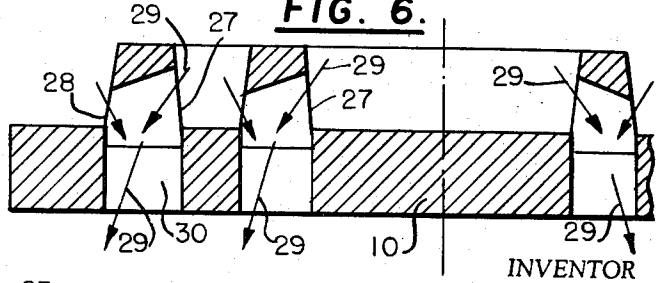
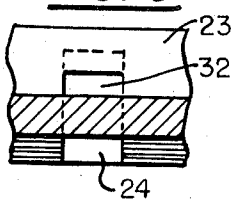


FIG. 13.



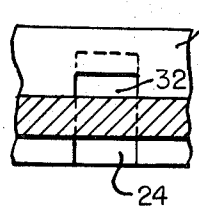


FIG. 12.

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WATER AERATOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to devices for aerating water and in particular to devices for attachment or use on domestic, public and industrial water systems. Aeration devices are now in wide use on the faucets of such water systems to aerate the water and otherwise improve discharge water.

2. Description of the Prior Art

In my prior U.S. Pat. No. 2,998,929, dated Sept. 5, 1961, entitled "Water Aerator," I disclose a diaphragm having a bridge on the upstream side. The diaphragm has elongated vertical chambers through which water flows after two water jets entering from either side impinge on each other in the chambers of these diaphragms. The elongated chambers are constructed to be approximately 2.0 mm high.

In my previous U.S. Pat. No. 3,229,916, issued Jan. 19, 1966, entitled "Aerators Having Enlarged Stream Outlets," I disclosed means whereby an aerator of a given size may deliver a stream of large diameter and be easily cleanable. The aerator disclosed in that patent contains a casing having an annular enlargement at the lowermost end of the inside wall of the casing which is indented.

SUMMARY OF THE INVENTION

The general purpose of the present invention is to provide an aerator which provides a more swollen and turbulent jet adapted either to flow parallel to the axis of the aerator or at an angle to said axis than prior art aerators, thereby producing a considerable increase in aeration of the water and/or controlling the direction of the jet, or both. The invention further provides an improvement in the aerator structure which permits ease of construction and enables component parts to be separated more easily for maintenance purposes.

To attain this, the present invention provides a diaphragm wherein the elongated chamber is eliminated and a thin partition having a thickness in the order of 0.5 mm but not greater than 1.5 mm is used for a cross-section of the chamber of about 1 mm^2. The thin partition has a series of square cross-section holes arranged in a circle around the center of the disk diaphragm. A series of rectangular cross-section rings are arranged over these circles of holes. The rectangular cross-section is indented over each hole to form a bridge structure over the hole. The rings are arranged on the upstream side of the diaphragm and may be formed to permit access to each hole from entrances on both sides of the rings. Alternatively, the bridge may be formed so that each hole has only one entrance arranged to permit the issuing jet of water to diverge. The bridge arrangement having two entrances for each hole is designed so that the access openings to each hole may be tilted or of unequal size to permit the issuing turbulent jet of aerated water to diverge or converge from the center line of the path of flow of the aerator. The unequal size of the holes enables the alteration of the direction from the axis of the aerator of the issuing turbulent jet. The control of the direction of the issuing streamlets may be employed particularly when the diaphragm is used to produce a divergent shower formed by a plurality of independent bubbly streams of the type disclosed in my U.S. Pat. application Ser. No. 839,848.

The present invention further provides a screen holding means arranged in cooperation with arms arranged transverse to the path of flow of the water in an unindented annular enlargement of the casing. The screen holding means is preferably force fit to avoid its loss or its misassembly.

Accordingly, an object of the present invention is to provide aerator means which generate a more swollen and turbulent jet of water than prior art aerators, thereby producing a considerable increase in aeration of the water.

Another object of the present invention is to provide aerator means containing a bridge-type diaphragm which permits an issuing turbulent jet of aerated water to diverge or converge.

A further object of the present invention is to provide an improved aerator structure which permits ease of construction and maintenance.

Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention, when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A is a cross-sectional view of an aerator embodying the concepts of the present invention.

FIG. 1B is another cross-sectional view of another aerator embodying the concepts of the present invention.

FIG. 2 is a top view of the diaphragm used in the present invention.

FIG. 3 is a bottom view of the diaphragm used in the present invention.

FIG. 4 is a sectional view of the openings in the diaphragm taken along line XX of FIG. 3.

FIG. 5 is a sectional view of the openings in the diaphragm taken along line YY of FIG. 3.

FIG. 6 is a sectional view of the diaphragm containing pairs of entrances having dissimilar sizes.

FIG. 7 is a cross-sectional view of the opening in the diaphragm wherein one of the two water entrances to the opening has a size which is different from the other entrance.

FIG. 8 is another cross-sectional view of the openings in the diaphragm having one water entrance for each opening.

FIG. 9 is a view of the screen means used in the present invention.

FIG. 10 is a cross-sectional view of the diaphragm having an increased thickness.

FIG. 11 is another cross-sectional view of the diaphragm having an increased thickness.

FIG. 12 is a sectional view of FIG. 11 taken along lines 12—12.

FIG. 13 is a sectional view of FIG. 10 taken along lines 13—13.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1A, there is shown a cross-sectional view of an embodiment of the aerator which is male threaded but may be female threaded as shown by

dotted lines **16**. The aerator has a diaphragm **10** which is about 0.5 mm. thick. The diaphragm contains legs **11** which are supported by the armed member **12** which, in turn, rests on inturned lip **13**. Lip **13** is formed by the lower end of the enlarged part **14** on the inner wall of the casing **15**.

FIG. **1B** shows a diaphragm **10'** which is similar to diaphragm **10**. Diaphragm **10'** has no legs corresponding to the legs **11** of the diaphragm **10** in FIG. **1A**. The casing **15'** in FIG. **1B** is shown male threaded but may be female threaded as shown by dotted lines **16**. Casing **15'** has a lip **17** whereon the diaphragm **10'** rests. The inner diameter of the casing **15'** in FIG. **1B** above and below the enlarged part is smaller than the corresponding inner diameters of casing **15** in FIG. **1A**. This arrangement in FIG. **1B** permits air to enter between the inner edge of inturned lip **13'** and the lower outside end **18** of member **12**. The press-fit screen means **12** is preferably movable up and down within the enlarged parts **14** and **14'** to facilitate cleaning or it may remain tightly at the downstream end of said enlarged parts. The upper screen **21'** may be friction fit or ultrasonic-fastened. The lower screen **22** is free to move upwards if pushed from below and falls downwards to its normal position when water is emerging from the aerator.

Air enters between the arms **19** of armed member **12** and legs **11** in the operation of the legged diaphragm shown in FIG. **1A**. The screen means **21** may be pressed fit on to the member **12**, and defines an opening **22** in the center as shown in FIG. **9** to permit cleaning.

The thin diaphragm **10–10'** contain a number of concentric rings **23** arrange on the upstream side. A top view of these rings is shown in FIG. **2**. The diaphragm further contains a number of holes **24** arranged in circles around the center of the diaphragm. The holes have square cross-sections of about 1 sq. mm. The thickness of the partition is 0.5 mm and the access openings are 0.8 mm high and 0.75 mm wide. A view of the downstream side of the diaphragm showing the square cross-section holes **24** arrange in circles around the center is shown in FIG. **3**. Sections XX and YY of square cross-section holes **24** taken from FIG. **3** are shown in FIGS. **4** and **5**, respectively. FIG. **4** shows the two entrances **25** and **26** to the hole **24**. And FIGS. **4** and **5** show the bridge arrangement over the hole formed by the concentric rings **23**.

FIG. **6** shows a partial cross-section of a diaphragm **10** embodying the concepts of the present invention having entrances **27** and **28** having dissimilar sizes. The dissimilarity of size coupled with the proper height of chamber **30** permits a jet of water to diverge along the path **29**. The diaphragm of FIG. **6** shows two rows of pairs of holes arranged serially in a circle with each pair of holes being radially aligned and about 1 mm distant from each other. The diaphragm in such arrangement would typically have three rows of pairs of holes with six pairs in the outer row, three pairs in the center row and three pairs in the inner row. The holes are typically 1.14 × 1.14 mm and 1.3 mm high. The dimensions of the 12 smaller holes are typically 0.7 × 0.7 mm and the dimensions of the twelve larger holes are 1.14 × 0.9 mm. The diameter of the circle of the innermost row is typically 8 mm, while that of the outermost row is 31 mm, with the middle row half-way between the rows. The 12 pairs of holes are so aligned that none of these falls on the same radial line. An aerator constructed accordingly is capable of producing a shower of independent and divergent bubbly streams when used in conjunction with a pair of screens having the dimensions 40 × 40 × 0.0085 inch.

FIG. **7** shows a cross-section of holes **24** wherein one of the entrances to the hole is of a size which is different from that of the opposite entrance to the hole to obtain greater divergence and aeration. A jet of water enters the larger entrance **33** and moves along the water jet path **36** emerging from the hole **24** as a turbulent jet. The entrance to the hole facing outwardly from the center of ring **23** may be smaller or larger than the opposite inside entrance depending on whether the issuing turbulent jet is to converge or diverge. With a diaphragm having sixteen holes in three widely spaced rows and suitable for use in shower heads producing independent bubbly streams, it has been found that when entrance **32** has dimensions in the order of 1 mm. of width and 0.7 mm. height and entrance **33** has dimensions in the order of 1.25 mm. of width and 1.2 mm. height, a divergent jet emerges from hole **24**. The outside wall of hole **24** is in the order of 1 mm. wide and the inside wall is in the order of 1.25 mm. wide; with the height of the hole being typically less than 1.75 mm. and preferably about 1.1 mm. or 1.2 mm. The four walls of such a hole form a cross-section of trapezoidal shape, in which the inner and outer walls are arcuated to align with the circle in which a row of such holes is located, the distance between said outer and inner walls being 1.25 mm.

FIG. **8** discloses an alternative embodiment of the diaphragm having only one entrance **34** for the hole **24**. Bridge **23** is formed to enable the issuing jet of water **37** to emerge at an angle to the vertical. A disk with sixteen widely spaced holes of 1.25 × 1.25 mm. cross-section and 0.75 mm. high each, wherein each entrance was 1.25 mm. wide and 1 mm. high, gave distinctly divergent jets.

When on a disk, holes such as those of FIGS. **7** and **8** are radially aligned with water emerging along path **37** from an outer circular row of holes and water emerging along path **36** from an adjacently inner circular row of holes, said radially aligned water jet paths **37** and **36** may be made to impinge and to thereby decrease the screen resistance required to further break up, mix and coalesce the water and air mixture into a coherent bubbly stream. Alternatively, the bridge formation shown in FIG. **7** or FIG. **8** above may be used to cause the emerging jet paths from adjacent rows of holes to impinge to achieve the same result.

FIG. **10** and FIG. **11** are other embodiments of the diaphragm similar to the kind shown in FIG. **7**. The thickness of the diaphragm in FIG. **10**, however, is greater than that disclosed in FIG. **7**, as shown along lines *a*, *c*, *d*, and as further shown in FIG. **13**. The thickness of the diaphragm in FIG. **11** is greater than that disclosed in FIG. **7**, as shown along lines *a*, *b*, *c*, *d*, and as further shown in FIG. **12**. The increased thickness serves mainly as a guide to the issuing jet of water.

In the operation of the embodiment of the invention shown in FIG. **1A**, air enters through the space between arms **19** and legs **11**. Water enters through entrances

25 and 26 and passes through square cross-section holes 24. The inner and outer side walls of said square holes are arcuated and the other two walls may or may not be parallel. They are referred to, for the sake of convenience, as square holes. The issuing swollen and turbulent jet of aerated water will converge or diverge from the center axis of the aerator depending on whether entrance 26 is greater or smaller than entrance 25 of holes 24.

Similarly, in the operation of the embodiment shown in FIG. 1B, air enters through the opening between the inner edge of inturned lip 13' and the lower outside end 18 of member 12. The water passes through entrances 25 and 26 of holes 24. The issuing jet of swollen and turbulent aerated water will converge or diverge depending on whether entrances 26 are greater or smaller than entrances 25.

The thin diaphragm 10–10' with the bridge and entrance arrangement formed by the rings 23 has been found to provide greater aeration of water than prior art diaphragms. The dissimilarity in size of the entrances to the square holes and the degree of thickness of the partition may be proportioned to cause the issuing turbulent jet of aerated water to diverge or converge to the desired degree. For instance, in a disk made to deliver sixteen independent and diverse bubbly streams, eight holes in the peripheral row, four in the middle and four in the center, with center-to-center distances being 30.5 mm, 21.5 mm, and 12 mm, respectively, with holes 1.16 × 1.16 mm with large access openings 1.16 mm high, 1 mm wide, and with small access openings being 0.8 × 0.8 mm, the issuing jets were, at 1.75 mm thickness of the partition, only slightly divergent but gradually more so as said thickness was step-by-step decreased to 1 mm below which the jets were too much broken up to maintain the neat identity of the bubbly streams.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings. For example, the plane of the entrances to the holes may be perpendicular to the plane of the holes or inclined somewhat. It is, therefore, to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What I claim is:

1. An aerator of the type in which an upstream diaphragm directs water streamlets onto a downstream mixing means in the presence of air characterized in that the upstream diaphragm comprises

a member having a thickness in the order of 0.5 mm said member defining a hole therein, said hole having a cross-section in the order of 1 mm^2,

a bridge arranged over said hole, said bridge defining a pair of entrance holes, the size of one of said entrance holes being different from the other entrance hole to thereby later the direction of the issuing jet of turbulent aerated fluid,

whereby the water passing through said entrance and then through said hole to said downstream mixing means is turbulated.

2. The device as described in claim 1 wherein said member comprises a circular disk.

3. The device as described in claim 2 wherein said bridge is in the form of a ring arranged on the upstream side of said diaphragm.

4. The device as described in claim 3 wherein said thin circular disk further contains:

a plurality of square cross-section holes arranged in a plurality of concentric circles around the center of said disk,

a plurality of rings equal to the number of concentric circles and each arranged over a different one of said concentric circles,

a plurality of pairs of entrances equal in number to the number of holes, and

whereby water passes through each of said pairs of entrances and through said holes to said downstream mixing means.

5. The device as described in claim 4 wherein each of said entrances of several of said plurality of pairs of entrances faces inwardly toward the center of said rings and the other entrance of said several of said plurality of pairs of entrances faces outwardly from the center of said rings.

6. The device as described in claim 5 wherein the size of one entrance of a number of said plurality of pairs of entrances is different in size from the other entrance in the pair of entrances of said number of said plurality of pairs of entrances to thereby cause the issuing turbulent jet of aerated fluid to diverge or converge.

7. The device as described in claim 6 wherein the cross-sectional area of said holes is in the order of 1 sq. mm.

8. An aerator of the type in which an upstream diaphragm directs water streamlets on to a downstream mixing means in the presence of air characterized in that the upstream diaphragm comprises:

a member containing a hole, the height of which is less than the longest horizontal distance across said hole,

a bridge arranged over said hole and defining a pair of entrances to said hole with one entrance having a size which is different from that of the other entrance to thereby alter the direction of an issuing turbulent jet of aerated fluid,

whereby water passes through said pair of entrances and through said hole to said downstream mixing means.

9. The device as described in claim 8 wherein said member comprises a thin circular disk.

10. The device as described in claim 9 wherein said bridge is in the form of a ring arranged on the upstream side of said diaphragm and

said thin circular disk contains

a plurality of square cross-section holes arranged in a plurality of concentric circles around the center of said disk,

a plurality of rings equal to the number of concentric circles and each ring arranged over a different one of said concentric circles,

a plurality of pairs of entrances equal in number to the number of holes with the size of one entrance of a number of said plurality of pairs of entrances being different in size from the other entrance in the pair of entrances of each of said number of said plurality of pairs of entrances to thereby cause an issuing turbulent jet of aerated fluid to diverge or converge and be passed to a downstream mixing means.

11. An aerator of the type in which an upstream diaphragm directs water streamlets on to a downstream

mixing means in the presence of air characterized in that the upstream diaphragm comprises

a member having a hole, and

a bridge arranged over said hole and defining a pair of entrances to said hole, the height of said hole being proportional to the difference in size between said entrances to alter the direction of the issuing jet, said height being less than the longest horizontal distance across said hole when said entrances are of equal size.

12. An aerator of the type in which an upstream diaphragm directs water streamlets onto a downstream mixing means in the presence of air characterized in that the upstream diaphragm comprises

diaphragm means having a hole and being sufficiently thin to maintain at least partly an inclined direction of the stream of water flowing through said hole, and

bridge means over said hole to permit the entrance of water therethrough, said bridge means having two entrance openings, one opposite the other, with one of said openings being larger than the other to thereby overcome the impact of the stream of water which passes through the smaller of said openings and thereby causes the issuance of a jet of water through said hole at an angle to the axis of said diaphragm.

* * * * *

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,712,548 Dated January 23, 1973

Inventor(s) Elie P. Aghnides

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

Claim 1, line 11, change "later" to -- alter --

Signed and sealed this 3rd day of July 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

Rene Tegtmeyer
Acting Commissioner of Patents