April 23, 1968 J. C. REIB ETAL 3,378,887

VACUUM SIZER

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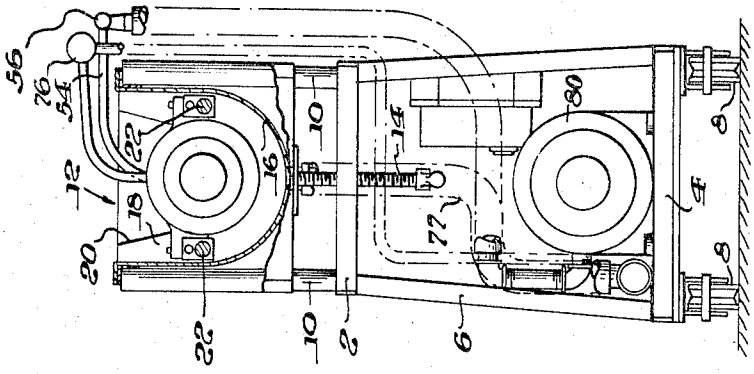


FIG. 2.

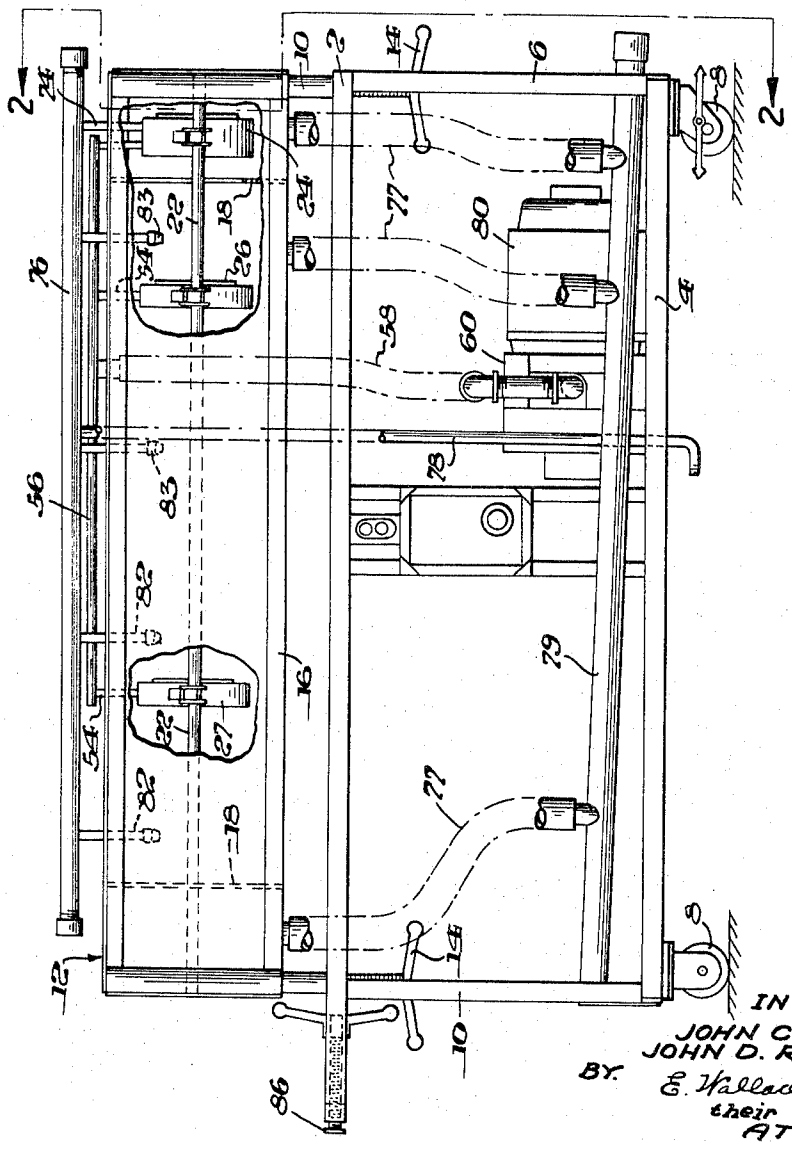


FIG. 1.

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FIG. 3.

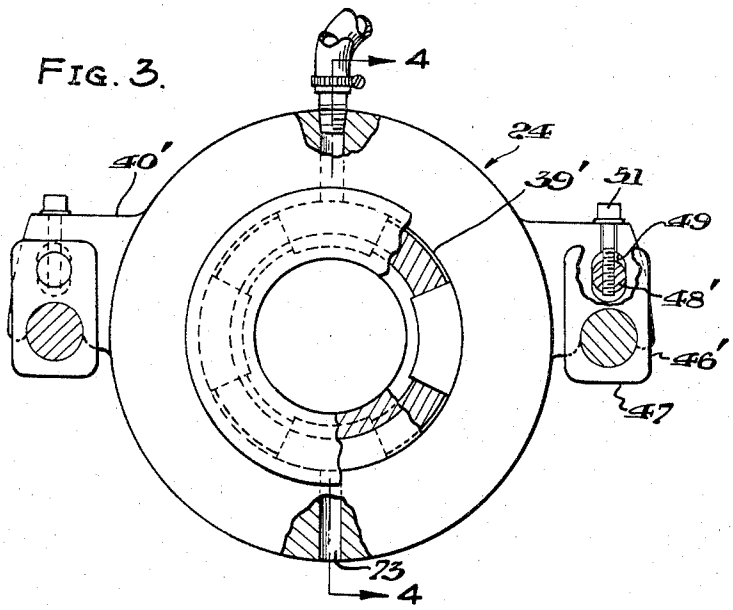


FIG. 4.

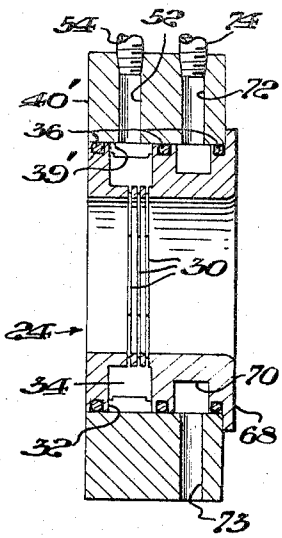


FIG. 5.

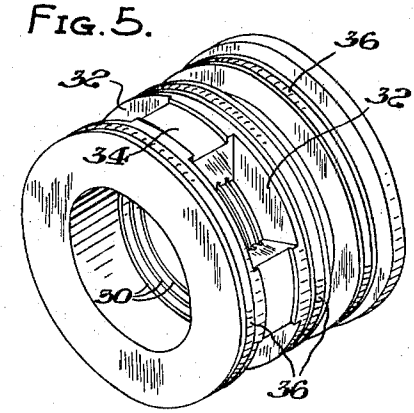
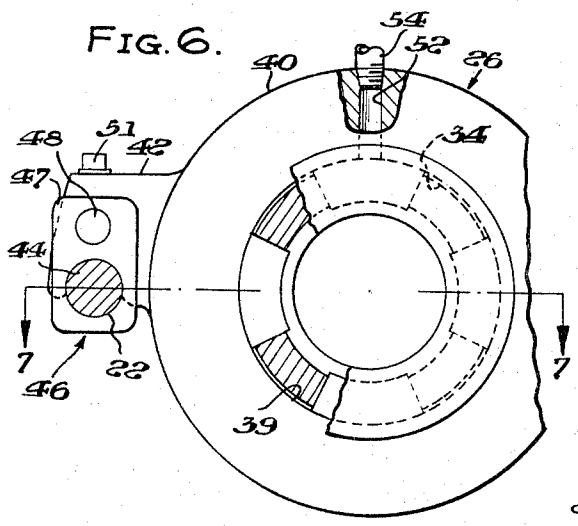


FIG. 6.



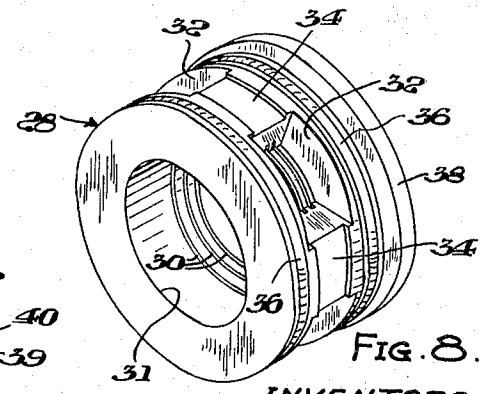


FIG. 8.

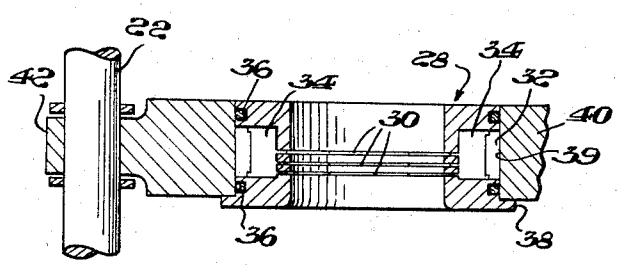


FIG. 7.

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VACUUM SIZER

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6 Claims. (Cl. 18—19)

This invention relates to a vacuum sizer apparatus for forming or shaping tubing or other tubular workpieces of a thermoplastic material.

For many years it has been common practice to pro duce thermoplastic tubing by an extrusion molding process which process is satisfactory for producing the tubing, but which process does not produce a tube to commercially desired dimensions within acceptable tolerances. This difficulty with extrusion processes was recognized by one inventor who proposed to obtain acceptably dimensioned tubes by applying a vacuum through a tube sizing structure to a plastically deformable tube wherein the tube is drawn into engagement with the sizing structure. Such process is known as vacuum sizing and is best described in Patent 3,229,005, issued on Jan. 11, 1966. With the structure according to that patent the tubular shaping or sizing member is of fixed length having an elongated portion for receiving tubing from an extruder in which portion the tubing is progressively sized and cooled. With such progressive cooling the elongated portion for receiving tubing must comprise a tapered bore having a taper suitably related to the shrinkage rate of the tubing. This shrinkage rate varies in response to a number factors including the type of material of the particular tubing being processed and the wall thickness of the tubing as well as the rate and degree of cooling necessary to transform the particular material from a plastically deformable state to a state in which the tubing is no longer plastically deformable. With so many variables it has been found impracticable to form such sizing members in quantity. Accordingly, such sizing members are supplied approximately to size with the user then adapting such sizer to his particular operations. In practice it has been necessary to machine such sizing members for each forming operation on a trial and error basis until a satisfactory forming operation could be achieved with the sizing member. Because of the above cited number of variables involved in the forming of a particular type of tubing, there is little likelihood that the same sizing member will be satisfactory for tubing of a slightly different wall thickness or type of material. For example, a sizing member which is satisfactory for a first plastic material cannot normally be employed for a second plastic material which has a different coefficient of thermal expansion or which is extruded at a different temperature or is being manufactured with a greater or lesser wall thickness. Thus with variation in tubing requirements or physical characteristics it is necessary to use a different sizing member or, if possible, resize the sizing member used for some other sizing operation. Although, in theory, it may be possible to stock a sizing member for each sizing operation to be performed, such stocking is extremely costly in view of the large number of thermoplastic materials which are commercially employed and the large number of commercially desirable wall thicknesses of the tubes.

The apparatus and method of the present invention contemplate the use of a plurality of sizing members each having a short tubing receiving portion as compared to the tubing receiving portion of the above described prior art device. The sizing members of the present invention are axially movable relative to each other and are short enough so that no one of the sizing members need have a tapered bore since the effect of the tapered bore can

be achieved by slight differences in diameter of the bores in the various sizing members and the effective rate of taper can be varied by varying the axial separation between such sizing members. Consequently, with the device of the present invention the effective rate of taper can be matched to the variables existing in the partiuclar tubing being sized without the necessity common to the prior art devices of remachining the sizing members or producing an entirely new sizing member.

The device of the present invention further provides for relatively easy interchange of sizing members should it become necessary to use different sizing members for tubing of a different outside diameter.

These and other objects and advantages of this invention will become more fully apparent upon consideration of the following description and drawings in which:

FIGURE 1 is a side elevational view of a forming apparatus constructed in accordance with the principles of this invention with portions thereof broken away to more clearly illustrate the structure thereof;

FIGURE 2 is an end elevational view of the apparatus as shown in FIGURE 1;

FIGURE 3 is an end elevational view of one sizing member and the support therefor constructed in accordance with the principles of this invention with portions thereof broken away to more clearly illustrate the structure thereof;

FIGURE 4 is a cross sectional view of the sizing member shown in FIGURE 3 taken substantially along the line 4—4 thereof;

FIGURE 5 is a perspective view of the sizing member shown in FIGURE 3;

FIGURE 6 is an end elevational view similar to FIGURE 3 of another sizing member and the support therefor constructed in accordance with the principles of this invention;

FIGURE 7 is a cross sectional view of the sizing member shown in FIGURE 6 taken along the line 7—7 thereof; and

FIGURE 8 is a perspective view of the sizing member shown in FIGURE 6.

Referring to FIGURES 1 and 2, the apparatus of this invention comprises an open sided frame having an upper rectangular frame portion **2** which overlies and is spaced upwardly from a lower rectangular base **4** being rigidly connected to the corresponding corners of the frame portion **2** by substantially vertically upwardly extending legs **6**. As shown the frame portion **2** is slightly narrower than the base **4** so that the legs **6** are inclined toward each other at each end of the base **4**. If desired suitable rollers **8** are rotatably secured to the under side of the base **4** at the corners thereof to permit easy movement of the entire assembly.

Each corner of the frame portion **2** has an upwardly extending tubular post **10** rigidly secured normal to the plane of the frame portion **2** to provide vertical guides for an upper tank **12**. As shown, the tank **12** comprises an upwardly open sided box structure the opposite sides of which engage the inner opposed portions of the laterally spaced pairs of posts **10** and the ends of which are extended laterally to engage the opposed end surfaces of the longitudinally spaced pairs of posts **10**. Tank **12** is vertically adjustably secured to the lower frame work by means of suitable adjusting screws **14** threadedly secured to longitudinally spaced ends of the frame portion **2**, respectively, and abuttingly engaging the bottom plate of the tank **12**. An upwardly open trough member **16** extends longitudinally between and is rigidly secured to the ends of the tank **12**. Trough member **16** is divided into longitudinal sections as desired by means of suitable baffles **18** spaced intermediate the ends of the trough member **16**. Baffles

18 are secured to the length of the inner periphery of the trough 16 and are provided with an upwardly open notch 20 to permit tubing to pass therethrough as hereinafter described. A pair of laterally spaced parallel rods 22 extend longitudinally between and are rigidly secured to the ends of the tank 12 inwardly adjacent the sides of the trough 16 and upwardly adjacent the arcuate bottom portion thereof. Rods 22 are provided for various sizing members which illustratively in FIGURE 1 comprise a double function first sizing member 24 and a pair of single function sizing members 26 and 27 hereinafter referred to as second and third sizing members, respectively, since the tubing element to be sized passes through these members in that order.

A single function sizing member 26 as shown in FIGURES 6, 7 and 8 comprises a cylindrical sizing sleeve 28 having a plurality of continuous parallel grooves 30 extending radially outward from the surface of an axial bore 31 in the sleeve 28. As shown, grooves 30 are axially spaced from each other and located in an axially intermediate portion of the sleeve 28. The intermediate portion of the exterior surface of sleeve 28 is also provided with a number of circumferentially spaced ports 32 which extend radially inwardly from the outer surface of the sleeve 28 with the inner ends thereof spaced radially outwardly of the inner surface of the sleeve 28 by a distance somewhat less than the depth of the grooves 30 so that the ports 32 communicate with the grooves 30. By providing such ports 32, pillar portions 34 are provided between the ports 32 and the outer surfaces thereof with the pillar portions 34 radially inwardly recessed so that the ports 32 are circumferentially interconnected at their outer ends. The outer surface of the sleeve 28 axially outwardly adjacent each axially spaced side of the port 32 is provided with a continuous inwardly extending circumferential groove in which a suitable deformable O-ring 36 is located. One outer end of the sleeve 28 is provided with an outwardly extending annular flange 38 for a purpose to be described.

A formed generally disk shaped holder 40 has an axial bore 39 extending therethrough of a size to receive the sleeve 28 with the flange 38 engaging one side surface of the holder 40 which has an axial dimension such that the other end of the sleeve 28 is flush with the other side of the holder 40. Bore 39 is of a size to deform the O-rings 36 to prevent leakage of ambient air into the ports 32 between the sleeve 28 and the holder 40. As shown, diametrically spaced portions of holder 40 are provided with outwardly extending lugs 42 having downwardly open slots 44 extending therethrough parallel to the bore 39.The diametrical spacing of the slots 44 is equal to the spacing of the rods 22 so that the holder 40 with sleeve 28 inserted therein may be freely instaled over the rod 22 suitably engaging the upper surface thereof and slidable therealong as desired. The holder 40 is releasably secured to the rods 22 by any suitable clamping means such as clamps 46 each of which comprises a pair of end plates 47 slidably receiving the rod 22 and a short cylindrical pin 48 in suitable parallel bores in the end plates 46. A central portion of the pin 48 having a diametrical threaded bore therethrough is suitably received by a suitable elliptical bore 49 (see FIGURE 3) in the lug portion 42 with a threaded retaining element such as cap screw 51 threadedly engaged with the pin 48 so that tightening of the cap screw 51 rigidly secures the slot 44 in engagement with the upper surface of the rod 22. It is to be appreciated that the clamping means 46 can be of any type which releasably secures engagement of the lug 42 with the rod 22.

The third sizing member 27 is entirely similar in construction to the second sizing member 26 having only a slightly smaller bore therethrough for a purpose to be described. The holder 40 is provided with a suitable threaded radial bore 52 communicating between its outer surface and the axial bore 39 at a point aligned with one of the ports 32 so that communication is established between the bore 52 and grooves 30. The bore 52 threadedly receives a fluid conducting tubing 54 which in turn communicates with a multiple conection header 56 suitably conected by a fluid conducting connection 58 to a vacuum pump 60 driven by a suitable motor 80 suitably supported upon the base portion 4 and providing a pressure lower than atmospheric through the connection 58, the header 56, the tubing 54, the bore 52 and the ports 32 to the grooves 30 as shown in FIGURE 1. The grooves of the other single function sizing member 27 are similarly connected by way of the header 56 with the vacuum pump 60.

The double function or first sizing member 24 has similar grooves 30 and ports 32 in a generally cylindrical sleeve 68 similar to the sleeve 28 excepting that it has a greater axial dimension and is provided with a continuous peripheral groove 70 parallel to the ports 32 and axially spaced therefrom with one of the O-rings 36 therebetween to prevent communication between the groove 70 and the ports 32, a third O-ring 36 engaging the surface of the bore 39' in the holder 40' prevents communication of the groove 70 with the ambient air. A suitable radial bore 72 communicates between the surface of the holder 40' and the groove 70 and in turn suitably communicates through a connection 74 with a multiple outlet header 76 which is in turn connected through a suitable conection 78 to a suitable source of water under pressure to furnish water through the connection 78, the header 76, the connection 74 and the bore 72 to the groove 70 for cooling purposes as hereinafter described. A suitable bore 73 in the bottom of the holder 40' provides means for draining the water from the groove 70 into the bottom of the trough member 16 which in turn communicates through a plurality of drain connections 77 with a drain header 79 through which water is drained from the trough member 16 to a suitable place of disposal as may be desired.

The holder 40' is in all ways similar to the holder 40 excepting only for having a greater axial dimension to accommodate the somewhat longer sleeve 68 and is clamped upon the rods 22 in an entirely similar manner having clamps 46' composed of clamp plates 47 and cylindrical pins 48' somewhat longer than the pins 48 with cap screws 51 releasably securing the holder 40' upon the rods 22 in a desired position. The header 76 is provided with a plurality of downwardly extending connections 82 spaced along the header 76 in desired positions and provided with nozzles 83 for a purpose to be described.

A threaded element such as a jack screw 86 is threadedly engaged with a longitudinally extended portion of the frame 2 at the lefthand end of the apparatus as viewed in FIGURE 1 to abuttingly engage a frame portion of a puller mechanism (not shown) for the purpose of longitudinally positioning and stabilizing the apparatus in relationship to such puller mechanism.

In operation of the device of this invention a device for continuous extrusion of plastic tubing in a self-deforming molten state is positioned at the righthand end of the device as viewed in FIGURE 1 and axially aligned with the sizing members 24, 26 and 27 at a distance from the first sizing member 24 found to be suitable for the particular tubing being produced. By techniques well known in the art a first portion of the extruded tubing is threaded through the sizing members 24, 26 and 27 in that order and attached to the pulling mechanism. Water or other fluid cooling medium is forced upward through the connection 78 into the header 76 from which it is supplied through the connection 74 to the groove 70 in the double purpose first sizing member 24 from which it drains through the bottom bore 73 into the trough member 16 and falling by gravity through one of the drains 77 flows out of the apparatus through the drain header 79. The rate of flow and temperature of the water or other cooling medium is controlled so that as the tubing travels through

a first portion of the first sizing member **24** it is cooled to a plastically deformable state defined as that state in which the tubing may be permanently deformed without producing substantially residual internal stresses therein.

The vacuum pump **60**, suitably activated by the motor **80** operated by suitable electrical controls communicating with a device supplying electricity in a well known manner, removes air from the connection **58** and the header **56** producing a partial vacuum therein as is known. The header **56** communicates with the grooves **30** in the sizing members **24**, **26** and **27** through their respective connections **54**, bores **52** and ports **32**. As the tubing passes through the double purpose first sizing member **24** it is first cooled as hereinabove described and then passing into the portion of the member **24** adjacent to the grooves **30** is vacuum sized to an outside diameter equal to the diameter of the bore in the sleeve **68** under the influence of the pressure differential existing between the interior of the tubing which is at atmospheric pressure and the exterior of the tubing at a relative low pressure induced by the vacuum pump connected to the grooves **30** as hereinbefore described. As the tubing leaves the double purpose first sizing member **24** it is still plastically deformable until further cooled by a stream of water from one of the nozzles **83** supplied with pressurized cooling fluid such as water from the header **76** through the connection **82**. As the tubing progresses from the sizing member **24** to the second sizing member **26** it is cooled by the fluid from the nozzle **83** and becomes somewhat smaller in diameter due to thermal contraction. Since some unbalanced forces such as gravity and a stretching force due to the pulling mechanism are being applied to the tubing at this time the cross sectional profile of the tubing may vary from the desired shape as for instance out of roundness or eccentricity of a desirably round tubing. Further finishing is necessary to restore the desired cross sectional profile and this is accomplished in the second sizing member **26** which has a bore slightly smaller in diameter (probably only a few thousandths of an inch) and is therefore suitable to restore the desired cross sectional profile and apply further surface finishing to the tubing which is now cooled to a point where it is only slightly plastically deformable. After passing through the second sizing member the tubing is exposed to spray from one or more of the nozzles or to a current of gas in the case a gaseous cooling medium is being used and after being further cooled and as a result further contracted enters the third sizing member **27** where further surface finishing and restoration of the desired cross sectional profile is accomplished in the same manner. Exiting from the sizing member **27** the tubing passes out of the device of this invention through the puller mechanism.

It is to be appreciated that the principles of this invention can be applied to the use of two sizing members as well as to the use of three, four or more sizing members in that the advantages of this invention reside in the axial movability of the different sizing members in relation to each other so that if a tubing having a different shrinkage rate, i.e., being made of a different plastic material or having a different wall thickness, is to be produced the different sizing members can be given a different spacing which has the effect of applying a different taper to match the changed shrinkage rate.

It is to be noted that should it become necessary to change one or more of the sizing members such change is easy to accomplish with the device of this invention since it involves only the loosening of two cap screws and the disconnecting of the fluid connections for removal of any one of the sizing members.

A preferred embodiment of the present invention having herein been illustrated and described, it is to be realized that variations therein can be made without departing from the broad scope of this invention. It is accordingly respectfully requested that this invention be interpreted as broadly as possible and limited only by the prior art.

We claim:

1. A vacuum sizer comprising, a housing member having a through bore, an open ended sizing sleeve member located within said bore having axially spaced outer surface portions cooperable with spaced surface portions of said housing member to provide air seal regions, one of said members having intermediate said spaced surface portions thereon, a circumferential chamber extending inwardly thereof, externally accessible passageway means in at least one of said members communicating with said chamber, said sleeve having at least one port extending inwardly thereof and in communication with said chamber, said port having the inner end thereof spaced outwardly from the inner surface of said sleeve, and said sleeve having at least one continuous circumferential groove extending from the inner surface thereof and in communication with said inner ends of said port.

2. A vacuum sizer comprising, a housing member having a through bore, an open ended sizing sleeve member located within said bore having axially spaced outer surface portions cooperable with spaced surface portions of said housing member to provide air seal regions, one of said members having intermediate said spaced surface portions thereon a circumferential chamber extending inwardly thereof, externally accessible passageway means in at least one of said members communicating with said chamber, said sleeve having at least one port extending inwardly thereof and in communication with said chamber, said port having the inner end thereof spaced outwardly from the inner surface of said sleeve, and said sleeve having a plurality of continuous circumferential grooves extending from the inner surface thereof and in communication with said inner end of said port.

3. A vacuum sizer comprising, a housing member having a through bore, an open ended sizing sleeve member located within said bore having axially spaced outer surface portions cooperable with spaced surface portions of said housing member to provide air seal regions, one of said members having intermediate said spaced surface portions thereon, a circumferential chamber extending inwardly thereof, externally accessible passageway means in at least one of said members communicating with said chamber, said sleeve having at least one port extending inwardly thereof and in communication with said chamber, said port having the inner end thereof spaced outwardly from the inner surface of said sleeve, said sleeve having at least one continuous circumferential groove extending from the inner surface thereof and in communication with said inner end of said port, a second chamber extending inwardly of one of said members intermeidate said spaced surface portions, and passageway means in at least one of said members connected to said second chamber to provide egress and exit for a cooling medium.

4. A vacuum sizer comprising, a housing member having a through bore, an open ended sizing sleeve member located within said bore having axially spaced outer surface portions cooperable with spaced surface portions of said housing member to provide air seal regions, said sleeve having a circumferential chamber intermediate said surface portions thereon which chamber extends inwardly from the outer surface of said sleeve, externally accessible passageway means in at least one of said members communicating with said chamber, said sleeve having circumferentially spaced ports extending inwardly from chamber and in communication with said chamber, said ports having the inner ends thereof spaced outwardly from the inner surface of said sleeve, and said sleeve having at least one continuous circumferentail groove extending from the inner surface thereof and in communication with said inner ends of said ports.

5. A vacuum sizer comprising, a housing member having a through bore, an open ended sizing sleeve member located within said bore having axially spaced outer sur-

face portions cooperable with spaced surface portions of said housing member to provide air seal regions, said sleeve having a continuous circumferential chamber intermediate said surface portions thereon which chamber extends inwardly from the outer surface of said sleeve, externally accessible passageway means in at least one of said members communicating with said chamber, said sleeve having circumferentially spaced ports extending inwardly from chamber and in communication with said chamber, said ports having the inner ends thereof spaced outwardly from the inner surface of said sleeve, and said sleeve having a plurality of axially spaced continuous circumferential grooves extending from the inner surface thereof and in communication with said inner ends of said ports.

6. A vacuum sizer comprising, a housing member having a through bore, an open ended sizing sleeve member located within said bore having axially spaced outer surface portions cooperable with spaced surface portions of said housing member to provide air seal regions, said sleeve having a continuous circumferential chamber intermediate said surface portions thereon which chamber extends inwardly from the outer surface of said sleeve, externally accessible passageway means in at least one of said members communicating with said chamber, said

sleeve having circumferentially spaced ports extending inwardly from chamber and in communication with said chamber, said ports having the inner ends thereof spaced outwardly from the inner surface of said sleeve, said sleeve having a plurality of axially spaced continuous circumferential grooves extending from the inner surface thereof and in communication with said inner ends of said ports, on a second chamber extending inwardly of said sleeve intermediate said spaced surface portions, and passageway means in one of said members connected to said second chamber to provide egress and exit for a cooling medium.

References Cited

UNITED STATES PATENTS

3,169,272	2/1965	Maxson	264—209
3,182,108	4/1965	Branscum	18—14
3,213,165	10/1965	Pollock	264—95

FOREIGN PATENTS

780,900	8/1957	Great Britain.
880,391	10/1961	Great Britain.

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