

Dec. 13, 1960

W. I. ALHOLM ET AL
GASKET APPLYING MACHINE

2,964,246

Filed April 27, 1956

8 Sheets-Sheet 1

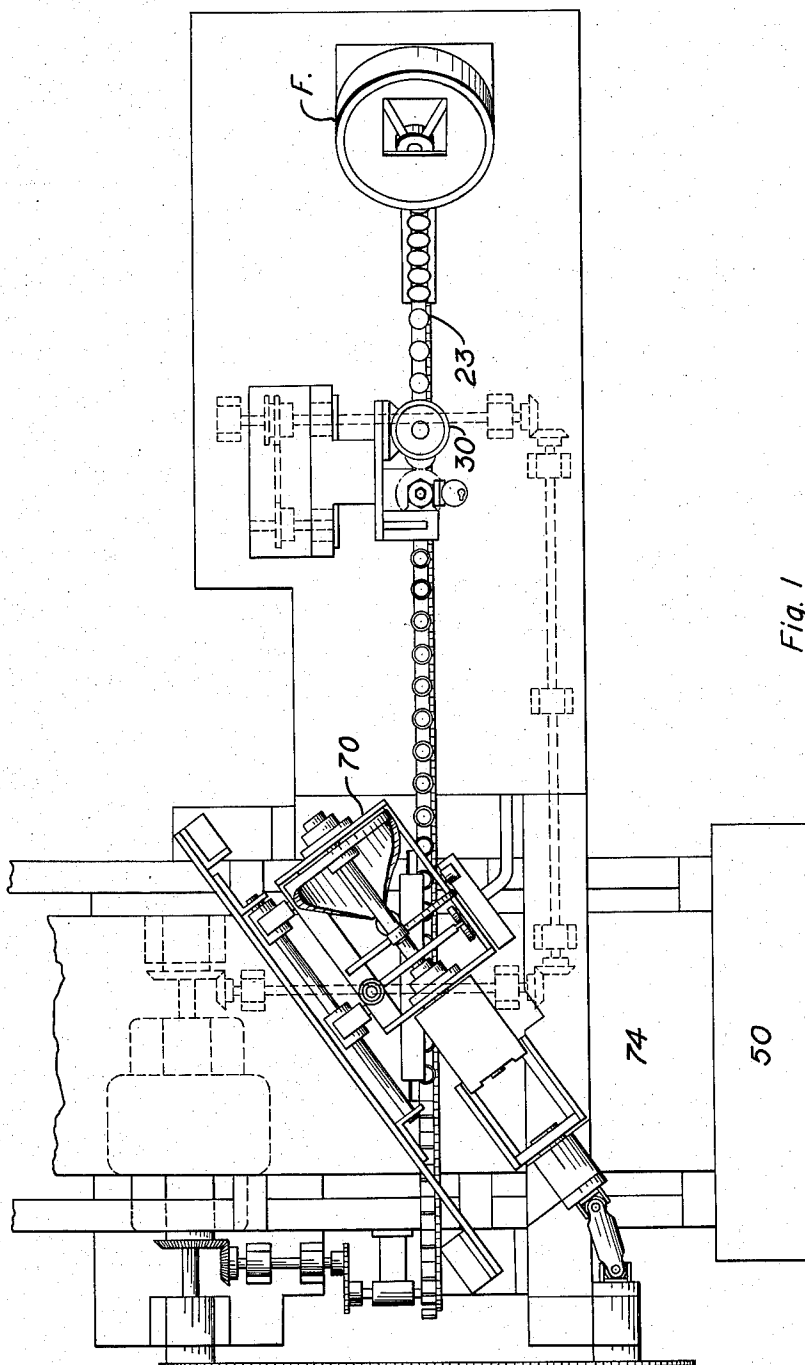


Fig. 1

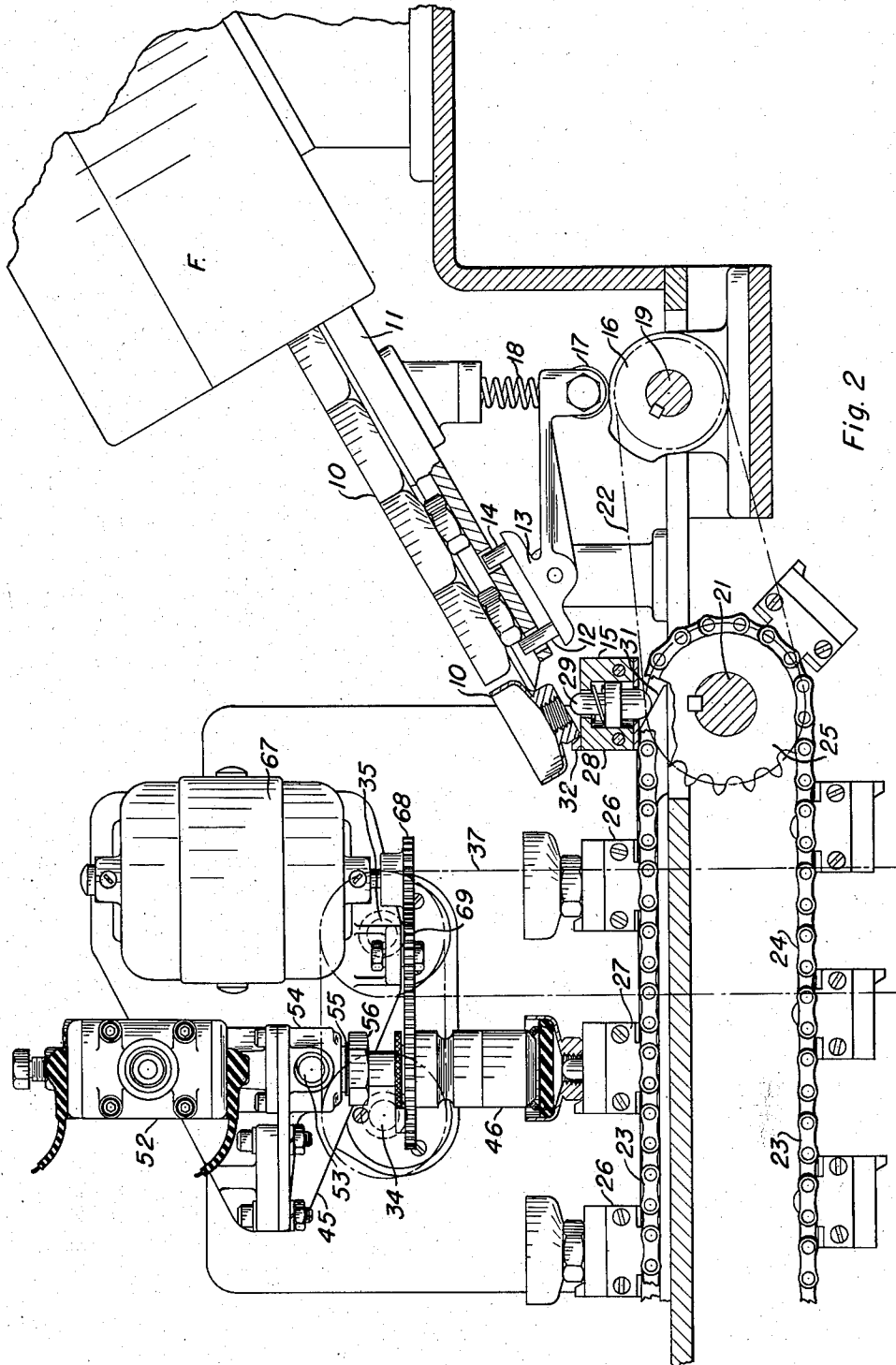
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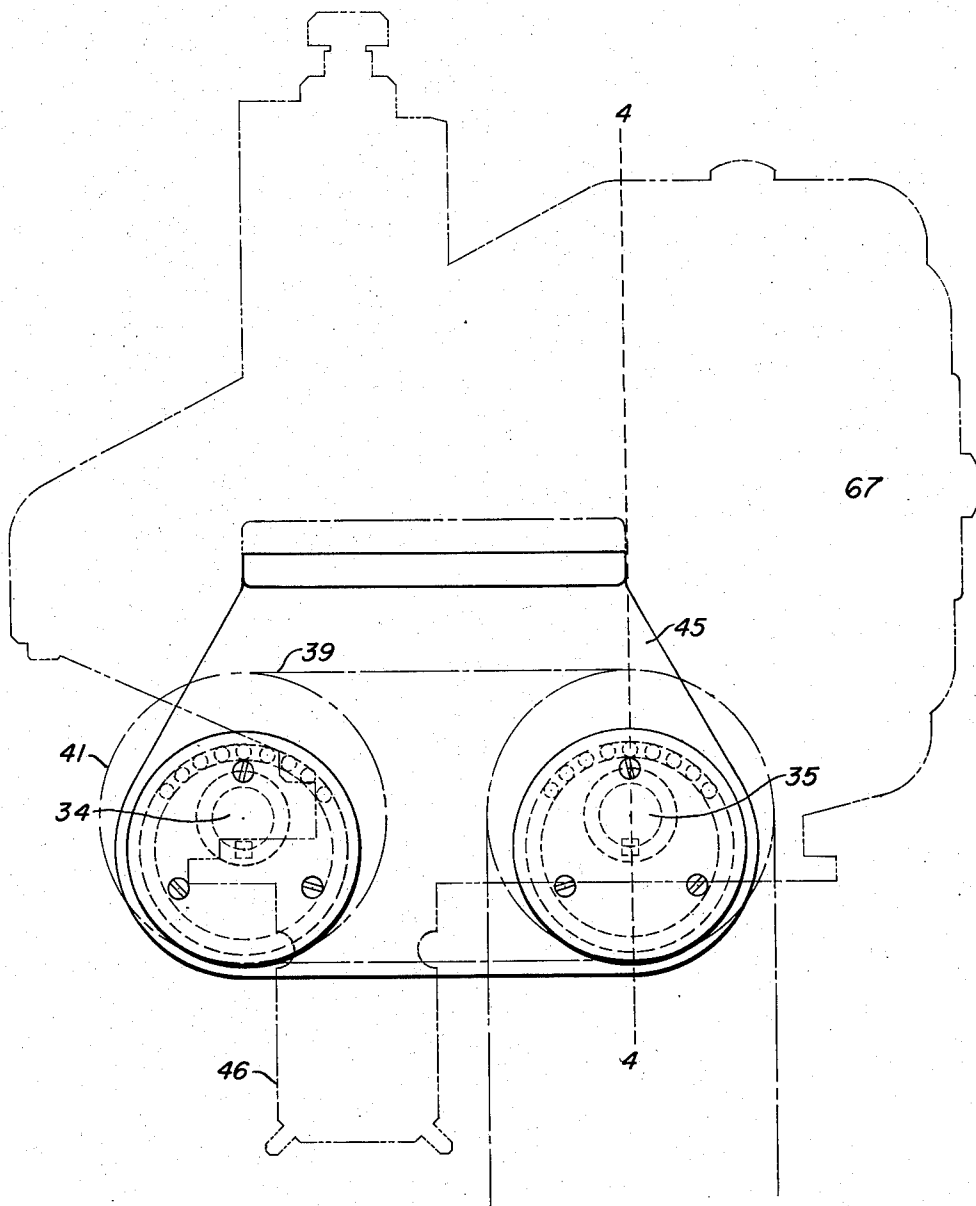


Fig. 3

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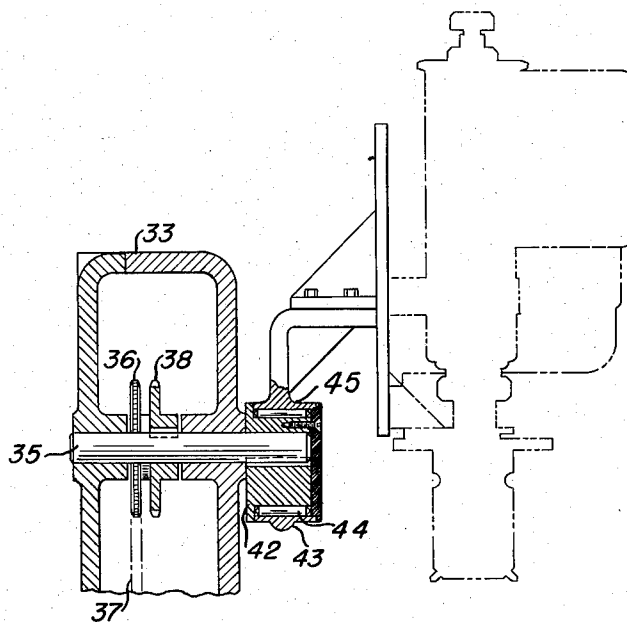


Fig. 4

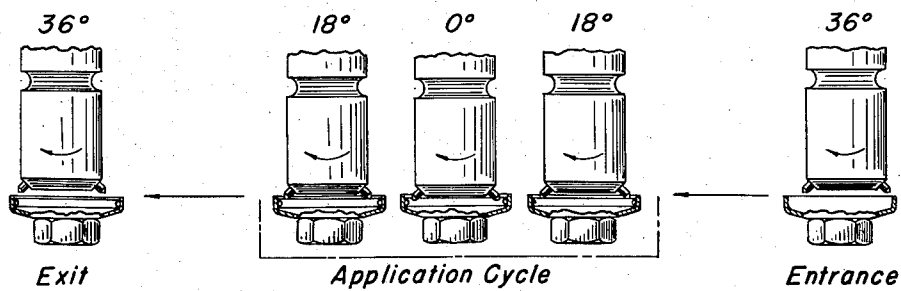


Fig. 5

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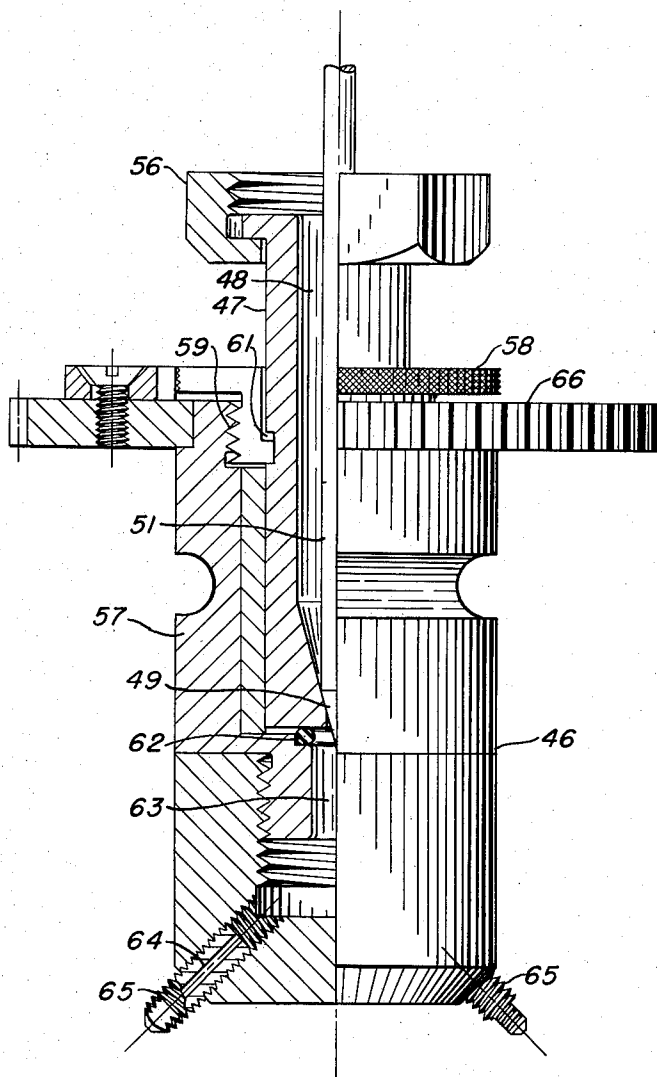


Fig. 6

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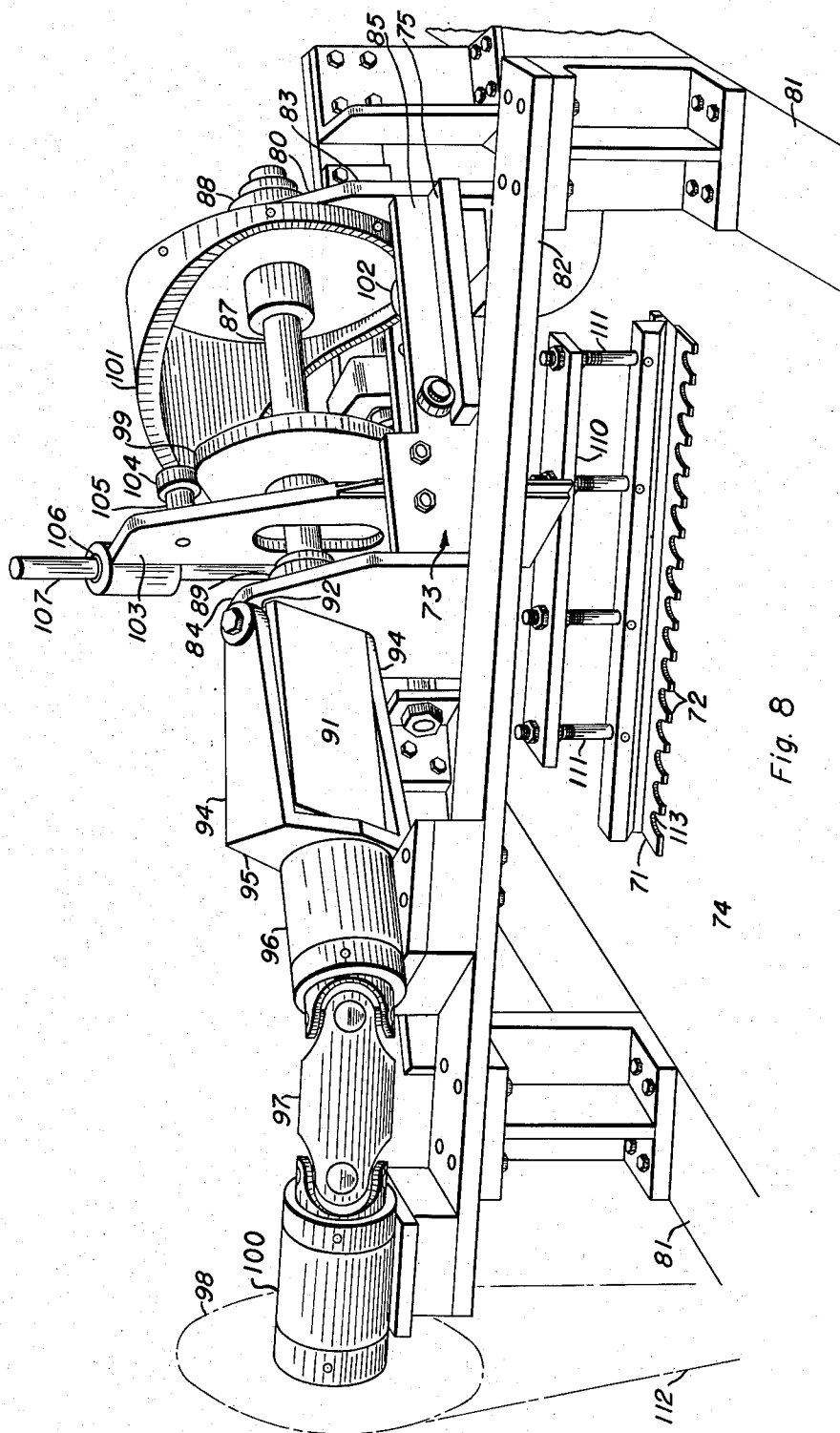


Fig. 8

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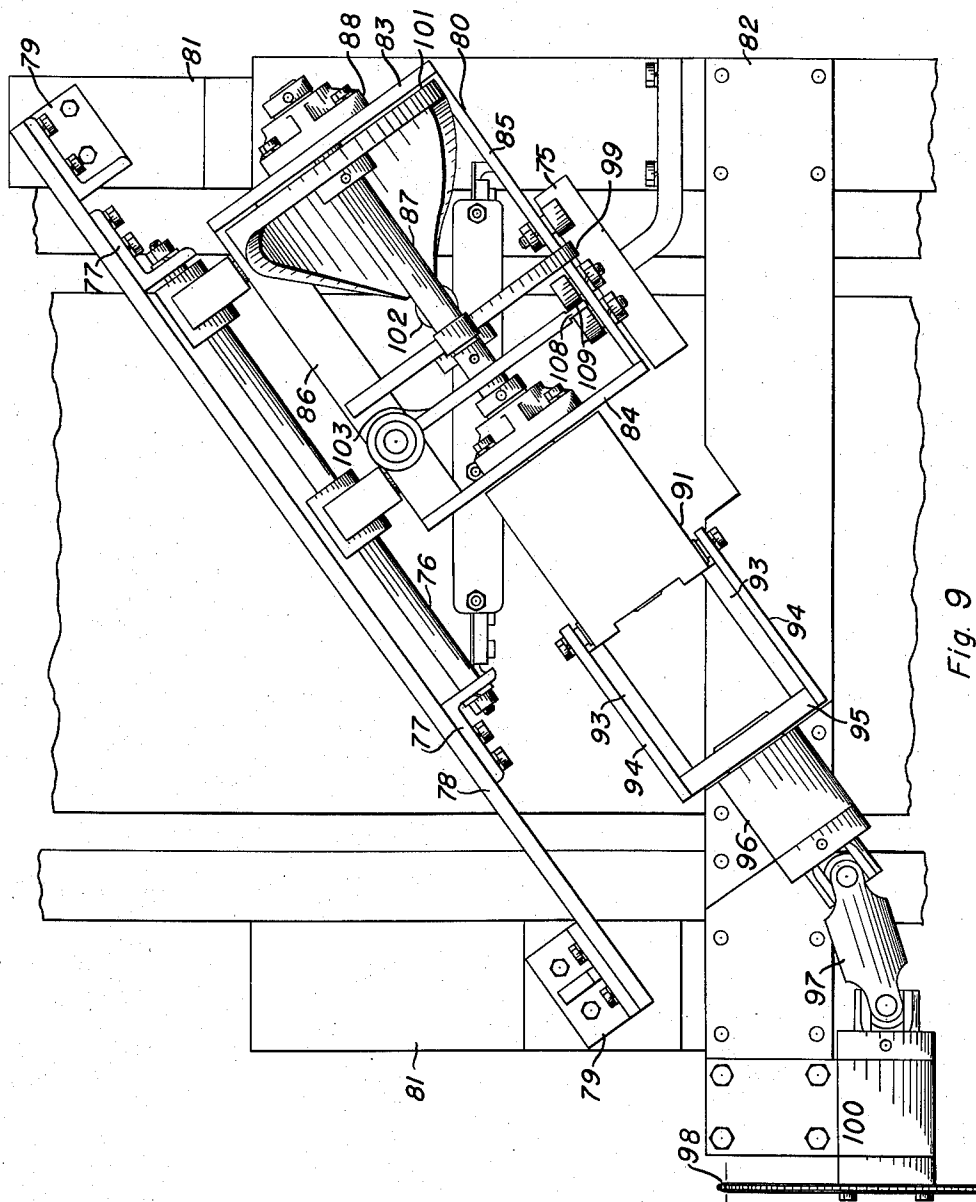


Fig. 9

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GASKET APPLYING MACHINE

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Filed Apr. 27, 1956, Ser. No. 581,066

1 Claim. (Cl. 239—227)

This invention relates to an apparatus for applying gaskets to many types of mechanical elements, among which are instrument bezels and case components, gasketed nuts and fasteners, and "weatherproof" trim and panel fasteners used in the automotive industry.

Previously, the gaskets for such fittings were either molded or were cut from sheet material and then were attached to or inserted in the elements by various expedients. This is an expensive procedure for a high volume industry.

The apparatus is based on the observation that if a gas-free liquid is forced into free air through an open ended capillary, flow ceases instantly without after drip no matter whether the valve which controls the flow of compound be near or remote from the open end of the capillary. It is also based on the observation that substantial increase of gravitational force, such as will come about by spinning a capillary passage about a periphery, will not dislodge gasketing material from the capillary bore. Consequently, although the design of the apparatus requires that the gasketing compound be delivered from a nozzle tip which not only is remote from the needle valve but which also rotates at considerable speed, the compound will neither drip nor "pigtail" from the tip when the valve closes but will follow the commands of the valve exactly.

Our machine forms a gasket in the element itself. It places a liquid composition in the element, and then transports the elements to an oven where the composition is converted to a solid gasketing substance. The gasket can be made to adhere tenaciously to the metal when cured. Therefore, the special adhesive and gasket fastening methods which previously were required are unnecessary. Neither is it necessary for a manufacturer to carry an inventory of a multiplicity of gasket sizes. The liquid compound alone is required and it can form a gasket of any size. Hence, large savings in the cost of production are possible.

In the drawings, the mere structural features of the machine such as the frame, power source, etc. have been omitted or suppressed as much as possible in order that the novel features of our device may be shown clearly and in legible scale.

Fig. 1 is a top plan view of the entire machine,

Fig. 2 is an elevation of the feeder, escapement, carrier, and nozzle of the machine (some portions are shown in cross-section),

Fig. 3 is an elevation showing the eccentric which drives the nozzle and showing also the location of the electropneumatic nozzle and its driving motor,

Fig. 4 is a cross-section through the eccentric on the line 4—4 of Fig. 3,

Fig. 5 illustrates the sequential positions of the nozzle in relation to the workpiece through one gasket-applying cycle,

Fig. 6 is a sectional elevation of the rotary nozzle,

Fig. 7 is a sectional elevation of a modified nozzle

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which permits minute adjustments in the diameter of the gasket to be made,

Fig. 8 is an elevation of the transfer end of the machine, and

Fig. 9 is a top plan view of the transfer mechanism.

THE MACHINE

The machine places the elements (herein called "workpieces") on a continuously moving carrier, places the ring of liquid gasket-forming compound in or on the workpiece by means of a nozzle which rotates continuously but ejects compound intermittently, moves the nozzle linearly synchronously with the carrier while the compound is being applied, then removes groups of workpieces from the carrier and places them on the belt of a curing oven in which the liquid compound is converted into a solid gasketing substance.

The combination of components which secure this mode of operation is best seen in Fig. 1. The feeder which delivers workpieces to the linear and constantly moving carrier 23 is shown at F. The station at which gaskets are applied to the workpieces is shown at 30. The transfer mechanism which removes workpieces from the carrier and places them in ranks upon the extended traveling apron 74 of the curing or fluxing oven 50 is shown at 70. The drawing also shows the shafting, chain and gear arrangements through which power is supplied to the apparatus and by means of which synchronism of operation is secured.

ESCAPEMENT AND CARRIER

(See Fig. 2)

The workpieces 10, in this case a skirted nut with a gasket to be placed on the inner shoulder, are delivered from a conventional nut or crown feeder generally indicated by F and enter the slide 11. (The feeder is a separate apparatus and is separately powered.) Near the bottom of slide 11 a workpiece 10 is stopped by the pin 12 carried on the rocker 13. When the rocker 13 moves, pin 12 drops below the bottom of the slide 11 and releases the workpiece 10 which drops onto carrier chuck 15. The motion of rocker 13 is derived from cam 16 through cam roller 17. Roller 17 is urged against the cam by spring 18. Cam 16 is fixed on shaft 19 which is driven by a sprocket (not shown) and by a roller chain 22 (indicated by the dash lines) from a sprocket fixed to shaft 21. However, as pin 12 falls, pin 14 rises and checks the descent of the following workpiece 10. Consequently, any workpiece 10 about to be placed on a chuck is separated from those above it and may move freely without crowding from above.

The carrier, generally indicated at 23, comprises a roller chain 24 strung between two sprockets 25 and another, not shown. A series of chucks 26—26 are attached to the chain 24 at appropriate and regular intervals. The chucks may be mechanical only, but when the workpieces are formed from steel as is usual, magnetic chucks are used. In that case, the chucks consist of brass chain attachment plates 27 and magnets 28. If the workpiece has a hole or a bore which can be useful in centering, a spring pressed bullet catch 29 is provided which projects above the magnet and enters the bore. When this can be used as a centering device, catch 29 is arranged to move upwardly by the ramp end of bar 31 on which it rides until the chuck has traversed the full length of the bar 31 which terminates near the transfer station. As the catch 29 leaves the bar, it retracts, thus freeing the workpiece. A stop tip 32 is formed on the leading edge of magnet 28, which intercepts workpiece 10 as it slides forward onto the chuck. Thereafter, a workpiece 10 snaps into position over pin 29 by magnetic pull.

NOZZLE AND NOZZLE MOTION

As was stated, carrier 23 moves continuously. Consequently, for the limited times necessary to eject the gasketing compound onto the workpieces, the nozzle must move linearly and at the same effective linear speed as does carrier 23. The mechanism by which this is accomplished is shown in Figs. 3 and 4.

A housing 33 rising from the main frame supports two cross shafts 34 and 35 in appropriate bearings. Shaft 35 is driven by sprocket 36 through the roller chain 37 which is driven by a sprocket (not shown) on the main jack shaft.

Shaft 35 also carries the cam of a conventional cam-operated timing switch which energizes alternately the "open" and "close" coils of the electro-pneumatic valve actuator. Like the actuator itself, the switch is a component of well known apparatus and will not be further described. The shafts are rotated in the same direction and at the same speed by an even speed drive (as indicated by dash lines in Fig. 3) derived from sprocket 38 fixed on shaft 35, roller chain 39, and sprocket 41 fixed on shaft 34. Both shafts carry an eccentric 42 on their inboard ends which are surrounded by needle bearings 44—44, and the eccentric strap portion 43 of the nozzle bracket 45 which supports the nozzle assembly.

Consequently, as the shafts revolve, the nozzle located directly above the carrier 23 "gallops," actually describing a circular path in a vertical plane normal to the workpiece.

Certain relationships must be maintained:

A. The length of the circumferential path of the nozzle tip normal to the workpiece must equal the center to center distance of the chuck spacing on the carrier (or be a simple multiple thereof).

B. The circumferential velocity of the nozzle tip in the plane normal to the carrier must equal the linear velocity of the carrier.

C. The opening and the closing of the nozzle must both occur during the moments when a part of the workpiece lies directly beneath the nozzle.

When these relationships are established, the gasket will be laid down on the workpiece within the permissible tolerance of placement error, because then the length of the arc traversed by the nozzle and the path parallel to the tangent which is pursued by the workpiece are very nearly identical. The inherent error which is due to this difference is shown by the following table:

Placement error (on the following assumptions)

Chuck spacing, 3.6 in. center to center
Linear speed of carrier, 3.6 in./sec.
Circumferential speed of nozzle, 3.6 in./sec.
Dead center of nozzle and chuck meet at lowest point of nozzle path.
Nozzle opens and closes at equal angles at either side of dead center.

d =chuck travel
 d' =nozzle travel
 $\frac{1}{2}(d-d')$ =differential at each end
 t =time
 θ =total angle

θ	3.6 circumference				7.2 circumference			
	d	d'	$\frac{1}{2}(d-d')$	t	d	d'	$\frac{1}{2}(d-d')$	t
0----	0.0	0.0	0	0.00	0.0	0.0	0	0.00
4----	0.04	0.040	0	0.011	0.08	0.080	0	0.022
8----	0.08	0.080	0	0.022	0.16	0.160	0	0.044
12----	0.12	0.120	0	0.033	0.24	0.240	0	0.066
16----	0.16	0.160	0	0.044	0.32	0.320	0	0.088
20----	0.20	0.198	0.001	0.056	0.40	0.396	0.002	0.111
24----	0.24	0.236	0.002	0.067	0.48	0.472	0.004	0.133
28----	0.28	0.276	0.002	0.078	0.56	0.552	0.004	0.155
32----	0.32	0.316	0.002	0.089	0.64	0.632	0.004	0.178
36----	0.36	0.354	0.003	0.100	0.72	0.708	0.006	0.200
40----	0.40	0.392	0.004	0.111	0.80	0.784	0.008	0.222
44----	0.44	0.430	0.005	0.122	0.88	0.860	0.010	0.244
48----	0.48	0.466	0.007	0.133	0.96	0.932	0.014	0.266
52----	0.52	0.502	0.009	0.144	1.04	1.004	0.018	0.288
56----	0.56	0.536	0.012	0.155	1.12	1.072	0.024	0.311
60----	0.60	0.572	0.014	0.166	1.20	1.144	0.028	0.333

In the above table, that section entitled: "7.2 inch cir-

cumference" may be explained by the following circumstance:

Sometimes a considerable volume of compound must be deposited, so much so, in fact, that it could not be made to flow through the nozzle in the time allowed. In such a case, the length of the path of the nozzle tip in the plane normal to the workpiece is made a simple multiple of the center to center chuck spacing distance. Since the nozzle travels at its original circumferential velocity (3.6 inches a second, in the example) the time during which the nozzle may remain open is increased. The table shows that, for example, if the path be made twice as long (7.2"), the open time is doubled; but it then follows that every second workpiece will be skipped and no gasket will be applied to it. The original production rate of the machine is, in this case, maintained by providing a second and identical compound applying head which, in its operation skips those workpieces to which gasketing compound has been applied and applies the compound to those workpieces which have been skipped by the first nozzle.

Fig. 5 illustrates by way of example the nozzle-workpiece relationship in a set up which is appropriate for the skirted nut shown. The figure represents a nozzle rotation which is so timed that the nozzle enters a workpiece 10 from the right approximately 36° before its lowermost position, dropping toward the workpiece as it and the nozzle, with their axes in alignment, move toward the left until approximately 18° before lower dead center. At this point, the nozzle opens, applies compound to the workpiece 10 and continues to do so until 18° past lower dead center, when it shuts off. It clears the workpiece approximately 36° past lower dead center.

When the object 10 has other shapes and sizes, the degree timing of entrance, application, and exit cycles must be changed to those which meet the requirements of the new shape.

THE NOZZLE

The nozzle (Figs. 2 and 6) consists of a rotatable applicator head 46 journaled on shaft 47 the interior bore 48 of which tapers at its lower end to form the seat 49 for the valve needle 51. The valve is actuated by a high speed electro-pneumatic valve actuator. Several such actuating systems are commercially available and, since they are well known, no further description is given.

The liquid gasketing composition is forced either by pneumatic pressure or a pump and by-pass system through a conduit which is connected to orifice 53 which in turn leads into chest 54, the lower end of which is threaded to receive rotary nozzle locking nut 56. The interior top wall of chest 54 is a thick rubber diaphragm bonded to the stem of valve needle 51 to prevent the compound from passing into the air actuator cylinder.

The nozzle head 57 is held on the hollow shaft 47 by the split nut 58 which engages the threaded portion 59 of nozzle head 57 and channel 61 cut into shaft 47. O ring 62 seals the gap between shaft 47 and head 57 and prevents compound from working into the bearing surfaces. When needle 51 lifts, the compound which is under pressure is forced through the needle valve into the bore 63 and out through the bores 64—64 of the adjustable nozzle tips 65—65. Commonly, three tips are used, but the number is a matter of choice. They may be adjusted to accommodate a limited range of workpiece diameters by screwing them in or out. Any major change in workpiece diameter, however, requires that an appropriate size of head 46 be substituted.

The nozzle is caused to revolve by gear 66, which is fastened to the head 57. Its power is derived through pinions 68 and 69 from the miniature motor 67 attached to the moving bracket 45. During the operation of the machine the revolution of nozzle 46 is continuous.

A modification of the nozzle which possesses a wider

adaptability to various workpiece shapes and includes a tip arrangement which gives a precise control of the width of the gasket is shown in Figure 7. The electro-pneumatic actuator 115 is mounted above the chest 116 which is provided with a port 117 through which the compound flows into the interior of the mechanism. The interior upper wall of the chest is formed from a thick rubber diaphragm 118 bonded to the stem of valve needle 124 to prevent compound from passing upward into the air actuator cylinder. Adapter plate 119 is threaded on to the boss 121 which projects from the exterior bottom wall of the chest 116. Nozzle shaft 122 is threaded into plate 119 and is provided with an axial bore 123 large enough to accommodate valve needle 124 and also to provide a passage through which the compound may flow. The lower end of bore 123 terminates in a conical portion to provide a seat 125 for the valve needle.

Two radial ballbearings 126 and 127 are pressed onto shaft 122 and are housed in upper bearing cage 128 and lower bearing cage 129. Axial movement of the bearings is prevented by the lock nut 131 which is threaded onto shaft 122 and by the lock washer 132. Closure packing 133 is seated against the side and lower walls of bearing cage 129 to prevent drainage of bearing lubricant into the bore and to stop compound from backing up into the bearings in the event that the compound should work past the O ring seals 134 and 135 which are held in concentric slots cut in the end face of shaft 122.

The nozzle adapter cap 136 is threaded onto the lowermost portion of the lower bearing cage 129. It is provided with a short axial bore 137 and communicating cross bore 138 which is plugged at each end by screw plugs 139 and 141. (Air is vented from the nozzle assembly when the machine is put into operation by backing out these plugs, then reinserting them when full streams of compound appear.) Compound passes through bores 137 and 138 into bore 142 formed in the adjustable nozzle tips 143 and 144. The bores of these tips may be axial and the portions 145 of the tips which extend into the adapter cap 136 may be concentric with the tip portion, but more flexibility in adjustment to various workpiece shapes may be secured by the arrangement shown in Figure 7 where the bores 142 are inclined about 6° to the vertical and the portions 145 are eccentric with respect to the axis of the tip. Then, tips 143 and 144 may be adjustably set to occupy different positions along the radius of rotation because of their eccentric construction. This permits an appreciable range of adjustment both as to the width of the gasket which is laid down on the workpiece and as to its diameter. Two tips are commonly used, but if more gasket volume is required, three or more tips are used.

If the diameter of the gasket is to be extremely small, only one axially located tip is used in a special adapter cap. The eccentric adjustment which is possible allows the flowing compound to describe the proper small diameter path. If the diameter of the gasket is large, a special adapter cap allowing the tips to be set at a sharp angle to the vertical (as, for example, the tips are located in Figure 6) is used. The nozzle is rotated by means of the ring gear 146 which is fitted onto the shoulder 147 formed on the lower bearing cage. Gear 146 is retained by set screws 148 and meshes with a small pinion which is driven by a miniature motor in the same manner as that illustrated in Figure 2. The nozzle turns continuously during the operation of the machine.

The gasket compound used in the nozzle must be so free of air that no gas pockets can form in the capillary passages leading to the rotating nozzle tips. Similarly, any liquid used in such a compound must have a low vapor pressure at the temperature of application. When these precautions are taken, the fact that the system is sealed leads to the unique effect that neither gravity will cause drain-out, nor will centrifugal force cause throw-out of the material contained in the capillary bores. In-

stead of such effects occurring, shut-off of flow is immediate and is completely commanded by the action of the needle valve. Nor does it matter at what angle to the vertical the nozzles be placed. If their bore diameter be reasonably small they can be placed horizontally, vertically or at any angle in between.

Mathematically, it can be shown that in the case of pure water at 100° F. if the nozzle has a bore diameter of 0.052", a bore length of 1" and a radius of gyration of the nozzle tip of 0.393", no flow will occur due to centrifugal force alone until the rotational speed of the nozzle reaches 219 revolutions per second. If the suspending fluid is hexane and the conditions remain the same, centrifugal throw-out cannot occur until the speed reaches 194 revolutions per second.

As to gravitational drainage, when the needle valve closes, drainage cannot occur without a drop in pressure appearing at the top of the capillary column. Since, in a closed capillary system, the lowest possible pressure at this point is the vapor pressure of the liquid at the ambient temperature, and this is far lower than the atmospheric pressure to which the free end of the capillary is exposed, the differential in pressure is added to the surface tension. Together, these become the force holding the column in the capillary. It can be shown that when nozzles of appropriate bore diameters are used, gravitational drainage is impossible.

The above are the limiting conditions, but since all practicable gasket compounds are non-Newtonian systems having appreciable yield values, the speed of rotation and the diameter of the bore can have higher values without drainage or throw-out occurring. The limits will be set by the flow characteristics of the particular compound, but are always higher than the low limits which have been shown.

The compositions which form the gaskets are modifications of three general types:

(a) Solvent solutions in which an elastomer is dissolved in a solvent which must be evaporated before a solid gasket is formed,

(b) Aqueous dispersions in which particulate bits of an elastomer are suspended in an aqueous carrier and from which water must be evaporated before a solid gasket is formed, and

(c) Plastisols—systems in which particulate bits of resin are suspended in a non-volatile plasticizer and which must be heated to a critical temperature before mutual solution takes place. Thereafter, on cooling, a permanent gel gasket is formed. Modifications often combine characteristics of two types, e.g., solvent dispersions.

Water and solvent must be released slowly, else the ebullition will destroy the continuity and sometimes even destroy the shape of the gasket. Clearly, residence time necessary to drive off solvent or evaporate water in the oven would require an impossibly long structure if the articles were to be fed through the oven seriatim as they appear upon the carrier 23. Consequently, it is as a practical matter, necessary to remove the articles from the carrier and place them in ranks upon a wide moving apron of a continuous curing oven.

TRANSFER MECHANISM

The mechanism by which we accomplish this transfer and rank arrangement on the apron is as follows: The immediate stripper or transfer element is the comb 71, the fingers 72 of which slide inwardly above the chain 24 and between the chucks 26—26 and then lift to engage the workpieces 10 and remove them from the chucks. Thereafter the comb crosses the carrier, lowers to deposit the workpieces on the apron, rises to clear the carrier and returns to its starting position to repeat the operation.

This apparatus consists of a reciprocating carriage 73 set at an angle both to the apron 74 of the oven and to the workpiece carrier 23. It is supported on the way 75

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and the guide rod 76. Rod 76 is hung from brackets 77—77, which in turn are supported by the cross beam 78. Beam 78 is supported by the brackets 79—79 which are fastened to extensions 81—81 of the oven side rails. The drive for the carriage 73 is supported by the transverse beam 82 and this, in turn, is supported by the brackets attached to the extensions.

The carriage comprises end plates 83 and 84 and side members 85 and 86. Shaft 87 is journalled in bearings 88 and 89. The inboard end of the shaft is fastened to a slide block 91 which carries slots 92—92 cut in its side wall and which engage the ways 93—93 formed on the inner surface of the arm 94—94 of yoke 95. Yoke 95 is pinned to a short shaft which passes through the bearing 96 and terminates in the universal joint 97. Joint 97 is connected to the drive sprocket 98 by a short shaft which passes through bearing 100.

Two cams 99 and 101 are fastened to shaft 87. Barrel cam 101 by bearing against cam roller 102, which is journalled on an extension of the main frame, forces the carriage 73 backwards as the cam 101 revolves. The return of the carriage is accomplished by a counter weight which is not shown on the drawing.

Cam 99 raises and lowers lifting plate 103 by bearing on cam roller 104 which is journalled on stud 105 attached to plate 103. Plate 103 is guided at its rear by guide bearing 106 which slides along the vertical guide shaft 107. It is also guided by the tongue 108 which is held between two rollers 109—109 attached to the side frame 85.

The bottom edge of plate 103 is fastened to comb support plate 110 to which the comb 71 is attached by means of the studs 111.

Sprocket 98 is driven by means of a roller chain 112 from a sprocket (not shown) attached to the main drive so that the rate of delivery of workpieces on carrier 23 and the speed at which the take off comb 71 operates will always be correlated.

OPERATION OF TRANSFER

Fig. 8 shows the comb 71 in its lowermost position and at the moment that it has delivered the series of workpieces to the apron 74 of the oven. Beginning at this point, the operation of the transfer device is as follows:

As the sprocket 98 turns, yoke 95 also turns. This causes the slide block 91, shaft 87, and cams 99 and 101 to revolve. However, the rotation of the barrel cam 101, by bearing upon cam follower 102, forces the carriage 73 backwards. At the same time, lifting plate 103 is raised by the revolution of cam 99 acting through cam follower 104, thereby raising comb 71. Because of the angularity of the path of travel of the carriage 73 with respect to carrier 23 and apron 74, comb 71 passes above carrier 23 and above any workpieces that may be carried by it. Further revolution of the shaft lowers the comb so that it comes into its lower position at the rear of the carrier 23 at the correct height to engage all of the workpieces which lie in its path and remove them as it moves ahead. The further revolution of the shaft causes the comb first to rise, lifting the workpieces, and then move toward the center of the

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apron. Workpieces are thus lifted from moving carrier 23 by the comb and are lowered onto the apron 74 in advance of the carrier. Since apron 74 moves, the workpieces slide off from between the teeth of the comb 71. The speed of shaft 87 is set so that a workpiece on carrier 23 which runs continuously will be carried to the far end of the comb in position to be engaged by the first slot 113 at the same instant that the comb 71 is to pick the workpieces up from the carrier. Thus, by correlating the reciprocation of carriage 73 to the linear speed of carrier 23, all of the workpieces are removed from the carrier chain.

We claim:

A gasketing compound applying nozzle for use with apparatus for applying a gasket to a workpiece during limited movement of the workpiece with the nozzle, said nozzle being adapted to apply a measured quantity of gasketing compound to a predetermined location on successive workpieces and comprising a body portion and a rotatable nozzle portion, said body portion having a compound receiving chest, means for supplying compound to said chest, a shaft projecting from said chest having an axial bore extending through said shaft, a valve seat in said bore, a valve member passing through said chest and through said bore, said valve member having a tip adapted to fit said seat, a valve actuating mechanism to actuate said valve member by moving said valve member into and out of engagement with said seat, said nozzle portion being rotatably journalled on said shaft and having a compound receiving passage axially aligned with the axial bore in said shaft, a removable nozzle tip having a plurality of outlet bores equally spaced about said tip and protruding from said nozzle whereby each bore is adapted to supply material for a predetermined portion of a gasket, said outlet bores communicating with said compound receiving passage; power means for rotating said nozzle portion at a predetermined speed, and a fluid-and-air-tight sealing means disposed at the junction between said body portion and said nozzle portion and adjacently surrounding the bore in the body portion and the compound receiving passage in the nozzle portion to prevent the loss of compound from, and the introduction of air into the compound stream passing from the bore of the body portion to the passage in the nozzle portion.

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