Dec. 21, 1943. J. MASON 2,337,259

TUBE TESTING APPARATUS

Filed Aug. 8, 1941 4 Sheets-Sheet 1

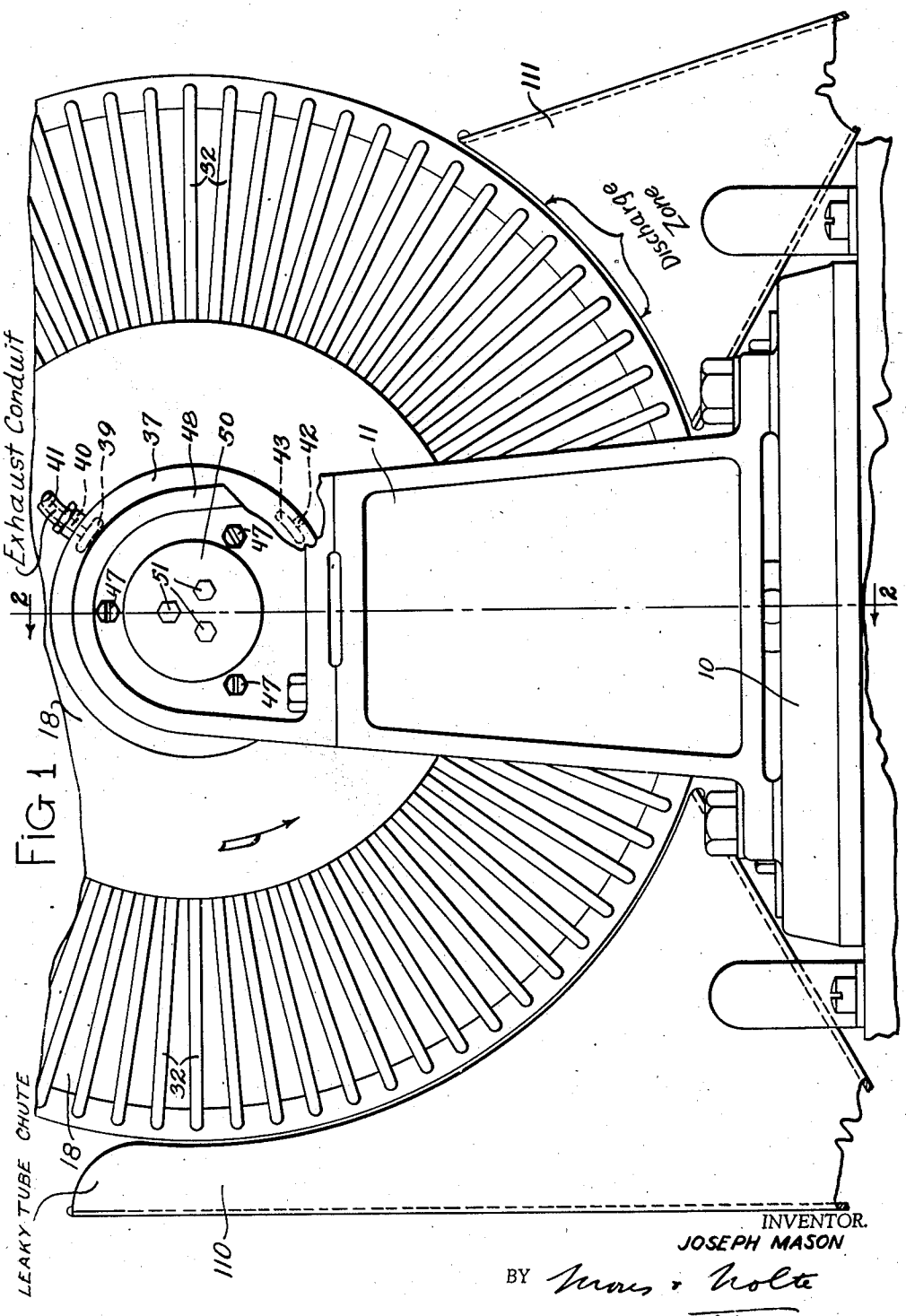

FIG 1

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TUBE TESTING APPARATUS

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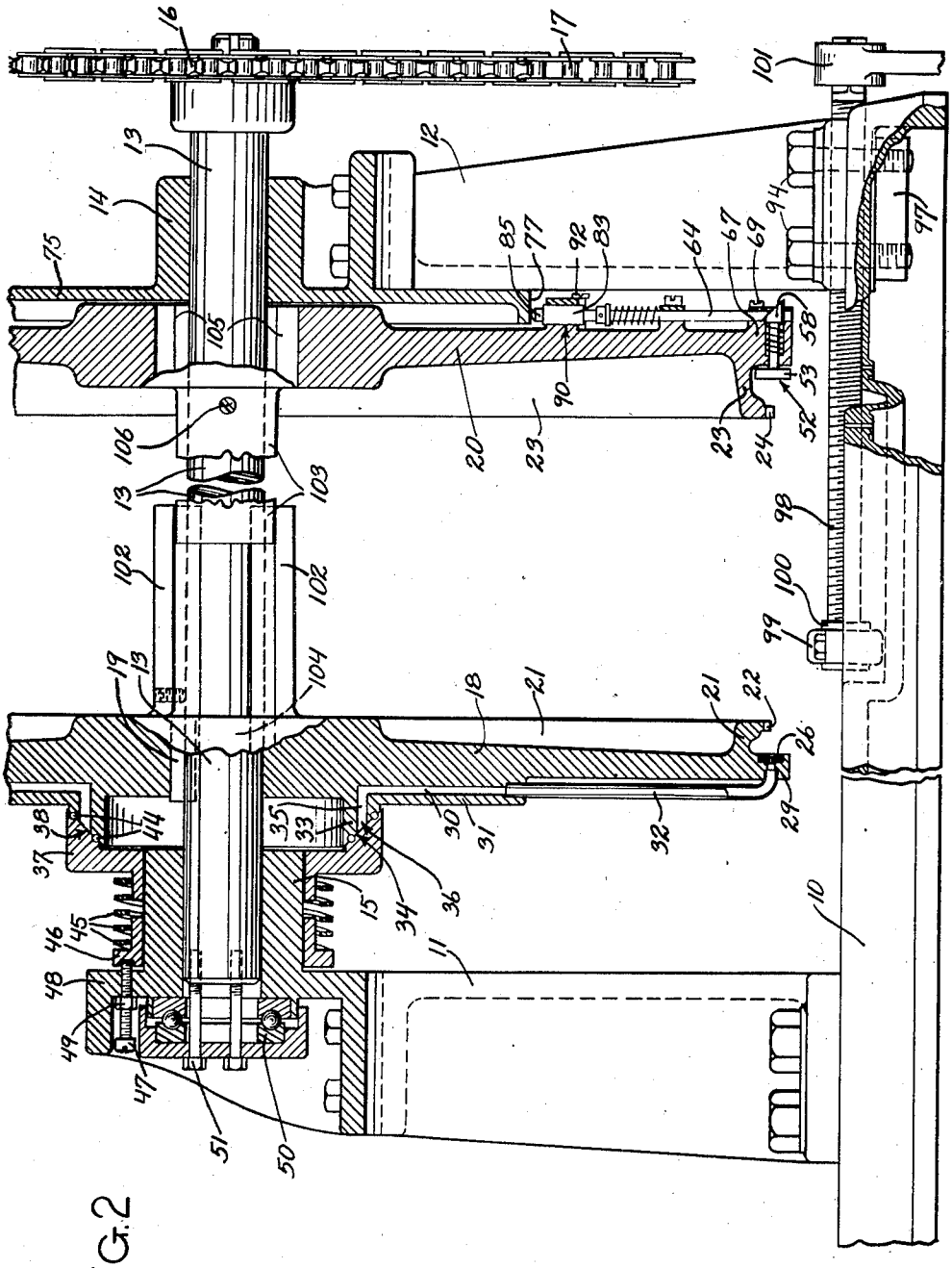

FIG. 2

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TUBE TESTING APPARATUS

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FIG. 4

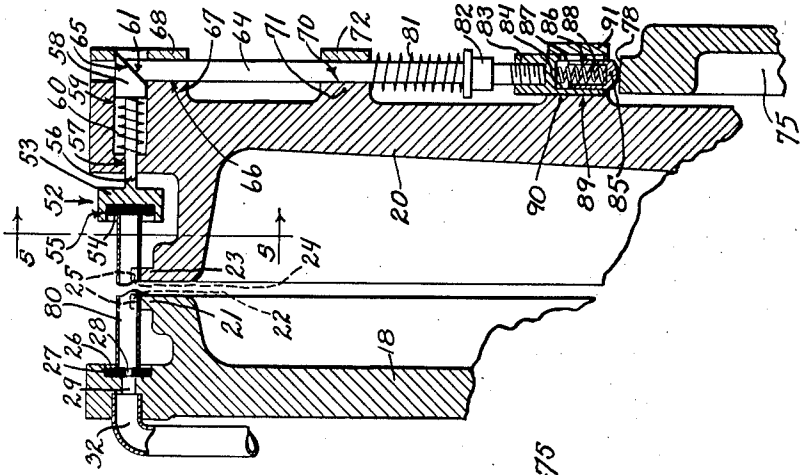
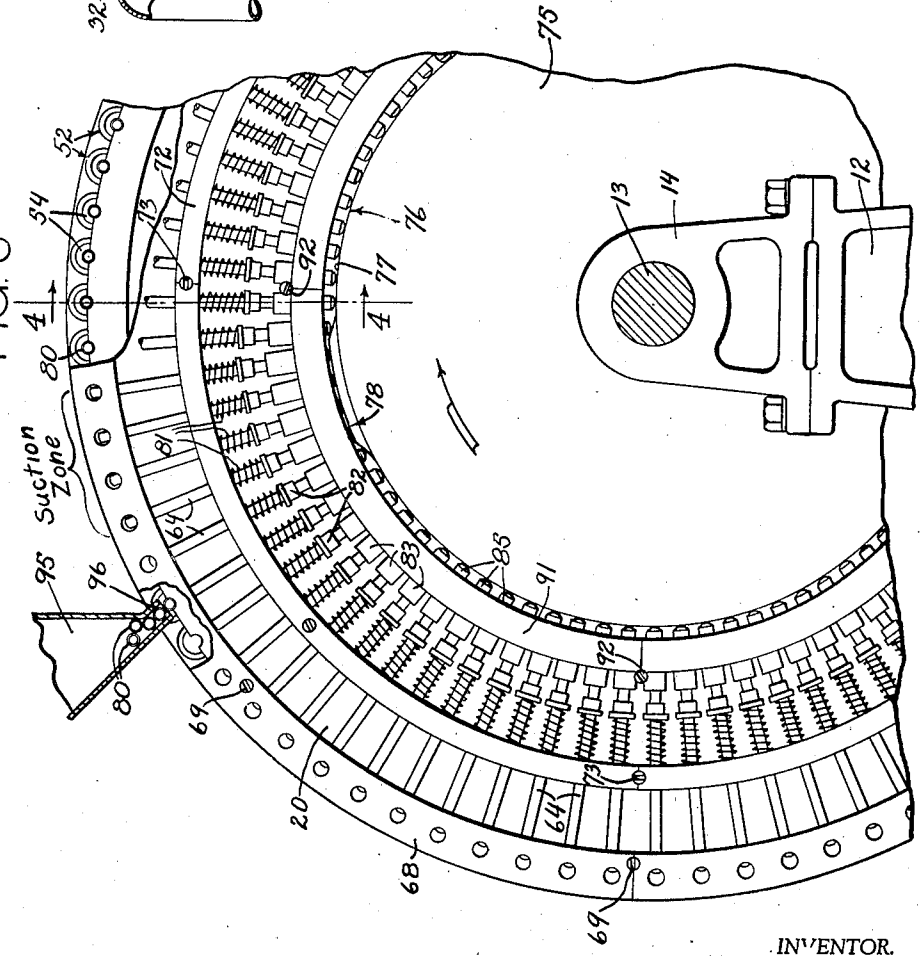


FIG. 3



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TUBE TESTING APPARATUS

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FIG. 7

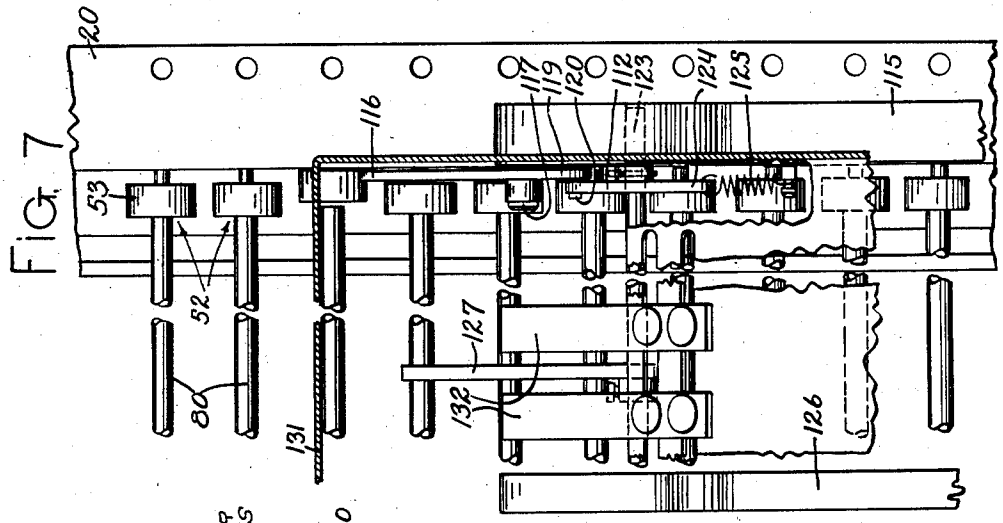


FIG. 6

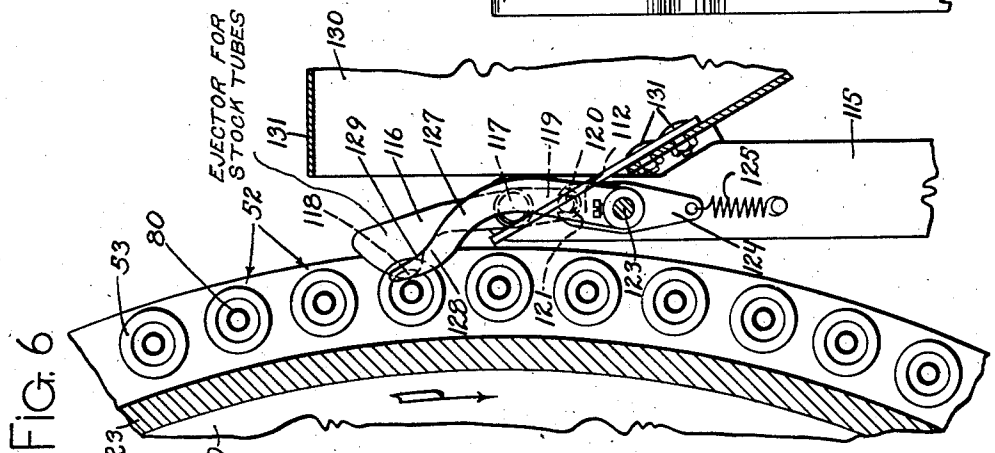
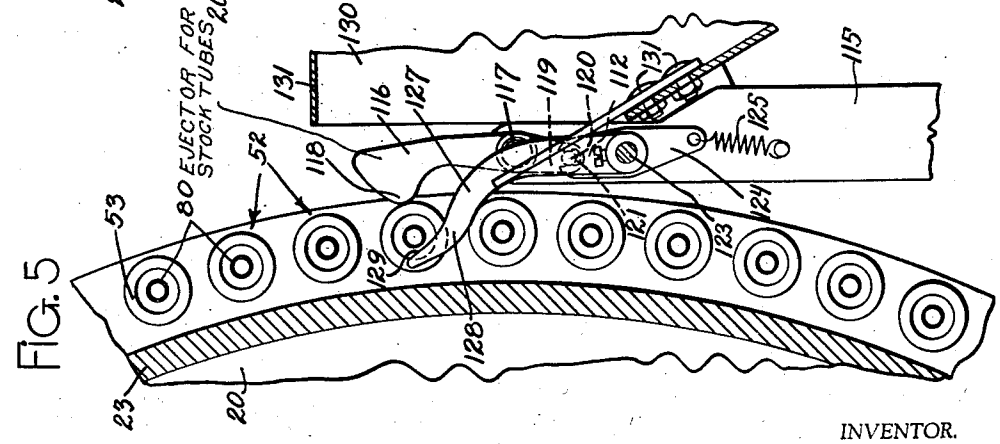


FIG. 5



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Patented Dec. 21, 1943

2,337,259

UNITED STATES PATENT OFFICE

2,337,259

TUBE TESTING APPARATUS

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Application August 8, 1941, Serial No. 405,899

4 Claims. (Cl. 73—51)

This invention relates to improvements in tube testing apparatus and especially to automatic apparatus for subjecting a series of tubular articles to reduced internal pressure to test such articles for leakage, and for automatically discharging the leaky articles and the perfect articles at separate stations. It is primarily applicable to testing machines of the rotary type in which open-ended tubular articles are fed successively to an annular series of receiving stations extending around the periphery of a rotating unit, arranged to subject each article to reduced internal pressure and to release leaky articles for discharge prior to the discharge of perfect articles at a receiving station.

A general purpose of the invention is to improve the construction and arrangement of the mechanism which engages the ends of the articles at each station, reduces the internal pressure of each article and then releases the mechanical pressure on the article-engaging elements, whereby the latter are held in place solely by the reduced pressure in the article, and are released prematurely when leakage through the article raises the internal pressure to that of the external atmosphere.

Mechanism of this type heretofore employed on rotary testing apparatus has been complicated and has generally included objectionable projecting parts and external framework. The present invention provides a compact, simplified structure free from such projections or framework. It also includes a novel arrangement for adjusting the apparatus to accommodate articles of different sizes, as well as an improved construction for ejecting tubes that tend to remain on the rotary structure beyond the proper point of discharge.

Other objects and advantages will appear from the following description considered in connection with the accompanying drawings in which

Fig. 1 is a front elevation of a machine embodying the invention, with parts broken away;

Fig. 2 is a vertical central section on line 2—2 of Fig. 1 with parts broken away and the central shaft portion shown in elevation;

Fig. 3 is a fragmentary rear view of the rotary unit with parts broken away;

Fig. 4 is a enlarged fragmentary radial section on line 4—4 of Fig. 3, showing the tube clamping mechanism;

Fig. 5 is a fragmentary view on line 5—5 of Fig. 4 showing a tube knock-out device for defective tubes in operative position;

Fig. 6 is a similar view with the device in inoperative position; and

Fig. 7 is a side elevation of the knock-out device.

The invention is illustrated in its application to a rotary testing apparatus suitable for testing metal tubes such as those employed in the manufacture of automobile radiators and the like. In this specific embodiment the apparatus includes a base 10 on which the front standard 11 and rear standard 12 are mounted. Horizontal shaft 13 revolves in bearings 14 and 15 on standards 12 and 11 respectively, and is provided at its rear end with a drive sprocket 16 and chain 17 driven from any suitable source (not shown).

The rotary testing unit is mounted on shaft 13 between bearings 14 and 15. It comprises two aligned heads, the front head 18 being fixed to shaft 13 adjacent bearing 15, by key 19, while the rear head 20 is mounted on shaft 13 adjacent rear bearing 14 and is suitably held in place on the shaft adjacent said bearing, as by means hereafter described in detail.

Heads 18 and 20 are provided with registering annular peripheral portions carrying means for initially receiving and positioning successive tubes at a series of stations and means at each station for testing and selectively releasing the tubes. The specific construction for receiving and holding the tubes, shown best in Figs. 3 and 4, includes an inwardly extending flange 21 on front head 18 provided with a series of radial recesses 22 and an inwardly extending flange 23 on rear head 20 provided with radial recesses 24.

Each recess 22 is arranged in axial alignment with a recess 24 to provide a cradle 25 for a tube or other elongated hollow article to be tested, recesses 22 and 24 being preferably shaped to fit loosely around the lower face of each article and to extend along the sides of the article for a sufficient distance to hold the article in place in the cradle until it is engaged by the clamping means, or descends approximately to the level of shaft 13.

The peripheries of heads 18 and 20 are provided with registering pairs of clamp members in alignment with cradles 25, each pair of clamp members including a fixed seat for one end of a tube and a movable seat shiftable into engagement with the other end of such tube located in a cradle 25. In the construction illustrated the periphery of front head 18 is provided with a series of stationary yieldable seats 26 mounted in suitable sockets 27 and each provided with a

central opening 28 communicating with a bore 29 extending through head 18. Each bore 29 is provided with an air-tight connection to a registering radial bore 30 in a projecting boss 31 formed in head 18. In the form shown each pair of bores 29 and 30 is connected through a metal tube 32 extending radially along the outer face of head 18 with its ends seated in bores 29 and 30.

The inner end of each bore 30 is connected with an aperture in the face of a rotary valve member carried by the central portion of head 18. In the form shown the valve member is formed by an annular projection or hub 33 on head 18 provided with a conical outer face 34. Each radial bore 30 is connected through an axial bore 35 with an opening 36 in face 34, the openings 36 forming an annular series.

A suitable cooperating fixed valve member is provided, the form illustrated including an outer valve member 37 slidably mounted on the outer face of bearing 15 and having a conical face 38 fitting tightly against face 34. Valve member 37 is provided with an exhaust aperture 39 in face 38 registering with openings 36 and connected through exhaust passage 40 in member 37 to a suction line 41 extending to a suitable exhaust pump or the like (not shown), and an air relief inlet passage 42 extending through outer valve 37 to the outer air from an aperture 43 in face 38 in register with openings 36. Annular sealing grooves 44, normally filled with oil, may be provided on valve faces 34 and 38 at either side of openings 36 and 39 to minimize the leakage of air.

Means is provided for holding outer valve member 37 in non-rotating position with face 38 held under pressure against face 34 of the inner valve member 33. The construction illustrated for this purpose comprises an expansion spiral spring 45 attached at one end to the valve member 37 and at the other end to a sleeve 46 slidably mounted on the outer face of bearing 15, said spring being interposed between said valve member and said sleeve so as to react from the latter to urge the former against the hub 33. Sleeve 46 is held against rotation and adjustably in position to compress springs 45, as by a plurality of circumferentially arranged screws 47 threaded through flange 48 on bearing 15 and fitting into suitable sockets in sleeve 46, screws 47 being held in adjusted position by lock nuts 49. Shaft 13 is held against the thrust of the springs 45 by a suitable thrust roller bearing 50 engaging the outer face of bearing 15 and connected to shaft 13 by screws 51.

An annular series of axially movable seat members 52 is carried by the periphery of rear head 20 in register with fixed seats 26. Each seat member 52 includes a head 53 provided with a yieldable seat 54 in a suitable socket 55 in the front of the head, and a stem 56 slidable in a bore 57 in rear head 20. A cam bead 58 is mounted on the end of stem 56 and is slidable in an enlarged bore 59, coil spring 60 being arranged in bore 59 and bearing against the inner end of the bore and the inner face of cam head 58 to urge the seat member 52 into retracted position.

Each cam head 58 is provided with a diagonal cam face 61; and suitable radially reciprocating means engaging cam face 61 is provided for shifting the seat member 52 axially into tube-engaging position. The illustrated construction comprises a plurality of radial push rods 64, one for each cam member 58, slidably mounted on the outer face of rear head 20 and actuated by suitable cam means. As shown, each rod 64 is provided with a bevelled end face 65 flush with and slidable along cam face 61 of head 58, and is slidably mounted in a radial guideway 66 in an annular guide flange 67 extending along the outer portion of the rear head 20, the bores 59 being formed through flange 67. The push rods 64 are held in guideways 66 by a removable annular retainer plate 68 which may be sectional and held in place by screws 69, plate 68 being advantageously provided with openings registering with bores 59. Each push rod 64 is also slidable in a guideway 70 in annular guide flange 71 on the outer face of rear head 20 and is held in said guideway by an annular retainer plate 72 which may be sectional and held detachably in place by screws 73.

The inner ends of push rods 64 are maintained in yielding engagement with a stationary disk cam 75 carried by rear bearing 14. The peripheral face 76 of cam 75 is formed with a depressed section 77 positioned to maintain push rods 64 in retracted inactive position and a raised section 78 arranged to shift push rods 64 radially outward against cam heads 58, thereby moving seat members 52 into engagement with tubes 80 seated in recesses 22 and 24.

Suitable means is provided for holding each push rod 64 in engagement with cam 75 and advantageously for providing a yielding connection between cam 75 and seat members 52 to prevent excessive pressure on the tubes 80 through the action of cam 75. In the arrangement illustrated each push rod 64 is provided with a coil spring 81 bearing against the inner face of guide flange 71 and a collar 82 adjustably fixed on the rod, thereby urging such rod inwardly against cam face 76.

Yielding engagement with said cam face is provided by threading each push rod 64 into a cylindrical tip 83 provided with a bore 84 in which a hollow plunger 85 is slidably mounted, the outer end of the plunger being suitably rounded and adapted for sliding engagement with cam face 76.

Plunger 85 is retained in bore 84 as by tongue 86 projecting into longitudinal slot 87 in tip 83, and is urged outwardly by coil spring 88 in bore 84. Spring 88 is sufficiently strong to maintain plunger 85 in its outer position against the pressure of springs 60 and 81 during outward radial movement of push rod 64, being yieldable only under resistance offered by a tube 80 after seat 54 has engaged the end of the tube, thereby limiting the pressure on the tube to that exerted by spring 88. Tips 83 are slidably mounted in guide channels 89 in annular guide flange 90 projecting from rear head 20, and are held in place by annular retainer plate 91 which may be sectional and held detachably in place by screws 92.

Suitable means is provided for feeding tubes 80 successively to successive cradles 25 during rotation of heads 18 and 20, the form illustrated being provided with a hopper 95 having a discharge spout 96 located directly above and in alignment with recesses 22 and 24, the advance face of spout 96 terminating just above the path of the outer surface of a tube properly positioned in said recesses to permit the tube to pass beneath said face, but to retain the succeeding tube during passage of the concentric portions of flanges 21 and 23 intermediate the recesses until the next pair of recesses 22 and 24 come into register with spout 96 and permit the succeeding tube to drop into place in said recesses.

An arrangement is provided for adjusting the distance between seats 26 and seats 54 to adapt the apparatus to handle tubes of different lengths. This is in general accomplished by axially shifting rear standard 12 and head 20. For this purpose standard 12 is slidably mounted on base 10, as by bolts 94 passing through suitable slots in the base 10 into threaded engagement with clamping blocks 97. Adjusting screw 98 is threaded through standard 12 and is rotatably mounted at its inner end in pillow block 99 attached to base 10, collars 100 fixed on screw 98 engaging opposite faces of block 99 and preventing longitudinal movement of screw 98. The projecting outer end of said screw is detachably engaged by a suitable crank 101 for adjusting standard 12 and head 20 when required, bolts 94 being loosened during such adjustment.

A suitable arrangement is provided for maintaining heads 18 and 20 in axial alignment throughout the entire range of axial adjustment, and for holding rear head 20 in position on shaft 13. For this purpose front head 18 is provided with a plurality of tongues 102 extending around shaft 13 and having a close axial sliding fit with tongues 103 extending from rear head 20. Tongues 102 and 103 are of suitable length to overlap when head 20 is at its maximum distance from head 18, and are conveniently formed with registering cylindrical inner and outer faces and with abutting radial side faces.

In order to permit head 20 to be moved close to head 18 in handling very short tubes, the central portion of head 18 may be provided with recesses 104 accommodating the ends of tongues 103 and the central portion of the head 20 may be provided with recesses 105 adapted to receive the ends of tongues 102. Head 20 is suitably held in juxtaposition to bearing 14, during operation as by set screw 106 threaded through a tongue 103 into engagement with shaft 13. Set screw 106 will of course be released during adjustment of the position of head 20.

A feature of the invention is the construction and arrangement of heads 18 and 20 and of the various supports and guides associated with them so that each head and its associated parts may be formed integrally from a single casting. Specifically the casting for head 18 may include flange 21, boss 31, hub 33 and tongues 102, and the casting for head 20 may include flanges 23, 67, 71 and 90 and tongues 103.

Suitable means is provided for receiving separately the perfect tubes discharged at a predetermined station and the imperfect tubes which are discharged prior to reaching said station. In the form illustrated a hopper 110 extends along the descending side of the rotary unit from a point slightly above the level of the axis of shaft 13 to a point adjacent the lowermost portion of heads 18 and 20, in position to receive tubes released by the retraction of seat members 50 due to leakage through the tubes. A hopper 111 for perfect tubes is located adjacent heads 18 and 20 toward the bottom of the rising portion of the unit in position to receive perfect tubes intentionally released by the clamping mechanism.

Under certain conditions a tube 80 may stick in place despite the retraction of the corresponding seat member 52; and knock-out means may be provided for positively discharging such tube from the apparatus. An arrangement of this type may be provided which is suitable both for the discharge of perfect tubes which are intentionally released at the discharge station, and for the discharge of leaky tubes which are prematurely released in advance of said station, or for either purpose alone.

A device of this type is illustrated in its application to the discharge of defective tubes and is shown in Figs. 5 to 7. It comprises a standard 115 mounted on base 10 and carrying a trip arm 116 pivoted on pin 117 to swing at right angles to shaft 13 in a path adjacent the inner face of the peripheral portion of rear head 20, which carries movable seat members 52. A trip extension 118 of arm 116 extends inwardly into the path of heads 53 of the seat members 52 when the heads are in inactive retracted position shown in Figs. 2 and 6; but passes between said heads and the inner face of rotating head 20 when heads 52 are in extended tube engaging position as shown in Fig. 4.

Trip arm 116 is provided with a tailpiece 119 carrying a pin 120 working in a slot 121 in rocking lever 112 fixed to rod 123 and having a tailpiece 124 urged toward head-engaging position shown in Fig. 6 by spring 125 attached to standard 115. Rod 123 is pivotally mounted in standard 115 and in standard 126 on base 10, located adjacent the periphery of rotary head 18. Rod 123 carries a knock-out finger 127 in alignment with the approximate longitudinal center of tubes positioned between seats 26 and 54, finger 127 including an end portion 128 normally lying just outside of the path of tubes 80 but constructed and arranged to extend inwardly between tubes 80, when actuated by trip arm 116, to engage the inner face of the succeeding tube and force said tube outwardly to discharge. For this purpose end portion 128 may be suitably curved inwardly at its lower part to clear the subjacent tube, and recurved adjacent its outer end to provide an outer tube-engaging face 129 which may be inclined downwardly and outwardly across the path of the tubes, thereby serving to impose a gradual outward pressure on descending tubes coming in contact with said face.

A suitable receiver is advantageously located in register with knock-out finger 127 in position to receive tubes forced outwardly by said finger. A modified form of hopper 130 is illustrated, and may be mounted on standards 115 and 126. It is provided with a top 131 to confine tubes that may be thrown outwardly at an angle by finger 127, and may include narrow guide plates 132 on either side of finger 127, detachably mounted on the lower lip of hopper 130 as by bolts 131.

The knock-out mechanism may be located at a point sufficiently below the level of the axis of shaft 13 to permit tubes 80 to be discharged normally by gravity, the knock-out mechanism being effective in that case only on defective tubes that are improperly retained; but the illustrated type of knock-out mechanism may also be positioned at or about the point where defective tubes released by the retraction of seat members will be discharged by gravity, this arrangement permitting a much greater restriction of the zone in which defective tubes are discharged.

In operation, after adjustment of the spacing of heads 18 and 20 as already described, tubes 80 are fed from hopper 95 to successive cradles 25 during the rotation of shaft 13 in the direction indicated by arrows. Seat members 52 are then shifted into engagement with the ends of tubes 80 by the action of section 78 of cam 75 on push rods 64, clamping each tube between seats 26

and 54 which seal the tube ends from the outer air. Immediately after a tube is clamped in place by a seat member 52, air is exhausted through the corresponding valve opening 36 and the connections between said opening and the opening 28 in seat 26 communicating with the interior of the tube. The seat member 52 is positively held in clamping engagement with the tube by cam section 78 acting on the corresponding push rod 64 until the air in the tube is exhausted to a point where said member will be held in engagement with the tube by the reduced internal pressure. Thereafter the push rod 64 is retracted by spring 81 when the plunger 85 rides down over the end of the raised cam section 78.

Exhaust aperture 39 extends along the path of openings 36 for a sufficient distance to maintain suction on each tube until the air pressure in the tube is reduced to the desired point. Thereafter each opening 36 travels past the end of aperture 39 and the suction connection is broken. If the tube is perfect the reduced pressure will hold seat member 54 against the tube and will retain the tube in place until the aperture 36 comes into register with relief aperture 43, through which air will pass from the outer air into the tube, permitting spring 60 to withdraw head 53 and release the tube.

Upon release the tube will be discharged into a suitable receiver such as hopper 111 by gravity or through the action of a knock-out mechanism, the point of discharge being normally located in the lower half of the rotating unit so that the tube will not be held by cradle 25; but this disclosure is not intended to be restrictive, since the means disclosed may be arranged so that the tube, when released by restoring the internal pressure to normal, may remain in cradle 25 until positively ejected by the knock-out mechanism if preferred, by locating the point of release above the level of shaft 13.

The reduced pressure in each tube 80 will tend to draw in air through any leak, thereby gradually raising the internal pressure until spring 60 is able to withdraw head 52, releasing the defective tube. The period during which perfect tubes are held in engagement with head 52 is sufficient to permit the release of defective tubes through leakage prior to reaching the point of intentional discharge of perfect tubes. The receiver 110 for prematurely releasing imperfect tubes extends from about the level of the axis of shaft 13 downwardly along the periphery of heads 18 and 20 in position to receive tubes released at any point prior to the point of discharge of perfect tubes. If a tube is released through leakage in the upper part of the path of rotation it will be held in a cradle 25 until it approaches the level of said axis and is discharged by gravity.

Where an automatic knock-out mechanism is employed the receiver for defective tubes may be restricted in extent as already indicated. In the operation of the knock-out mechanism the clamping heads 53 which are in engagement with tubes as they pass the extension 118 of trip arm 116 normally clear said extension, and knock-out finger 127 remains outside of the path of the tube. When a head 53 has been released by a defective tube and is retracted by spring 60, it engages the extension 118, which is shaped to ride outwardly on the head, rocking pin 120 inwardly and swinging knock-out finger 127 inwardly against the pressure of spring 125 into position between tubes 80 at a point where face 129 of the finger lies within the path of the succeeding tube, where it is held by engagement of extension 118 with head 53 until the tube in register with said head overlies face 129. Extension 118 is shaped to ride inwardly along the further face of head 53 as the latter continues downwardly, moving finger 127 outwardly; and if the tube has been inadvertently retained in place it will be forced out by finger 127 into hopper 130.

I have described what I believe to be the best embodiments of my invention. I do not wish, however, to be confined to the embodiments shown, but what I desire to cover by Letters Patent is set forth in the appended claims.

I claim:

1. An open ended tube testing apparatus comprising a rotary frame, a series of tube testing units on the frame, each including a stationary and a movable tube-end engaging and sealing member; means for shifting said movable member into tube end engaging position so that the ends of the tube are hermetically sealed between the stationary and movable members, means for testing a tube so positioned in each unit including means for reducing the internal pressure in the tube while the movable tube end engaging member is held in tube end engaging position by said shifting means, spring means operable thereafter for withdrawing said movable tube end engaging member from tube engaging and sealing position only when the internal pressure within the tube is not sufficiently reduced to retain said member in tube end sealing position thereby permitting the tube if faulty to fall from the unit, a faulty tube receiver, means beyond said receiver for increasing the pressure within the tube if the same is not faulty thereby to release said movable tube end engaging and sealing member, and a second receiver for receiving the tube if released by the last said means.

2. An open ended tube testing apparatus comprising a rotary frame, a series of tube testing units on the frame, each including a stationary and a movable tube-end engaging and sealing member; means for shifting said movable member into tube end engaging position so that the ends of the tubes are hermetically sealed between respective stationary and movable members, means for testing tubes so positioned in said units including means for reducing the internal pressure in the tubes successively while the tube end engaging members are held in tube end engaging positions by said shifting means, spring means operable thereafter for withdrawing said movable tube end engaging members from their tube end engaging and sealing positions only when the internal pressure within the tubes is not sufficiently reduced to retain said members in tube end sealing positions thereby permitting the tubes if faulty to fall from their units, a faulty tube receiver, means beyond said receiver for increasing the pressure within the tubes if the same are not faulty thereby to release said movable tube end engaging and sealing members, a second receiver for receiving the tubes released by the last said means, and a mechanical tube ejector operable to discharge from their units tubes which adhere to one of the end engaging members after the movable members have been retracted from their tube end engaging and sealing positions, said ejector including a rockable element disposed to be engaged and rocked by said movable tube end engaging members only when the latter are retracted, and a tube ejector element normally out of the path of travel of the tubes in the

units and movable into said path in response to rocking movement of said rockable element by any movable tube and engaging member which may be retracted, thus positively to effect ejection of tubes from units in which the movable tube end engaging members are retracted.

3. In a machine for testing hollow articles each having at least one open end, a rotary carrier for the articles, a testing unit carried by said carrier and including a pair of article end engaging members at least one of which is shiftable into engagement with an open end of the article to urge the article toward the other member and thus close the open end or ends of the article, means operable in response to rotation of said carrier to shift said shiftable member to confine the article between said members and thereafter to release said shiftable member for retraction to release the article, means also operable in response to rotation of said carrier and prior to release of said shiftable members to exhaust air from the article to reduce its internal pressure below atmospheric pressure and then to cease its air exhausting operation, means operable upon release of said shiftable member to retract the latter if and only if the pressure of the air in the article rises to atmospheric pressure, and normally inactive article ejecting means movable to article ejecting position by rotation of said shiftable member with said carrier when and only when said shiftable member is in its retracted position.

4. In a machine for testing hollow articles each having at least one open end, a rotary carrier for the articles, a testing unit carried by said carrier and including a pair of article end engaging members at least one of which is shiftable into engagement with an open end of the article to urge the article toward the other member and thus close the open end or ends of the article, means operable in response to rotation of said carrier to shift said shiftable member to confine the article between said members and thereafter to release said shiftable member for retraction to release the article, means also operable in response to rotation of said carrier and prior to release of said shiftable members to exhaust air from the article to reduce its internal pressure below atmospheric pressure and then to close its air exhausting operation, means operable upon release of said shiftable member to retract the latter if and only if the pressure of the air in the article rises to atmospheric pressure, an actuating member disposed to be engaged and moved by said shiftable member as the latter rotates with said carrier when and only when said shiftable member is in its retracted position, and an article ejecting element normally disposed out of the path of movement of the article and operatively connected to said actuating member for movement into said path to effect ejection of the article in response to movement of said actuating member by said shiftable member.

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