Oct. 15, 1963 A. G. LYNN ETAL 3,107,009

CONTAINER WITH COOPERATING SUPPORT FRAME

Filed March 21, 1960 2 Sheets-Sheet 1

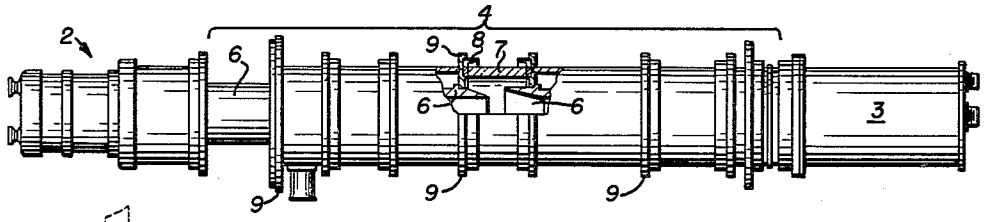


Fig. 1

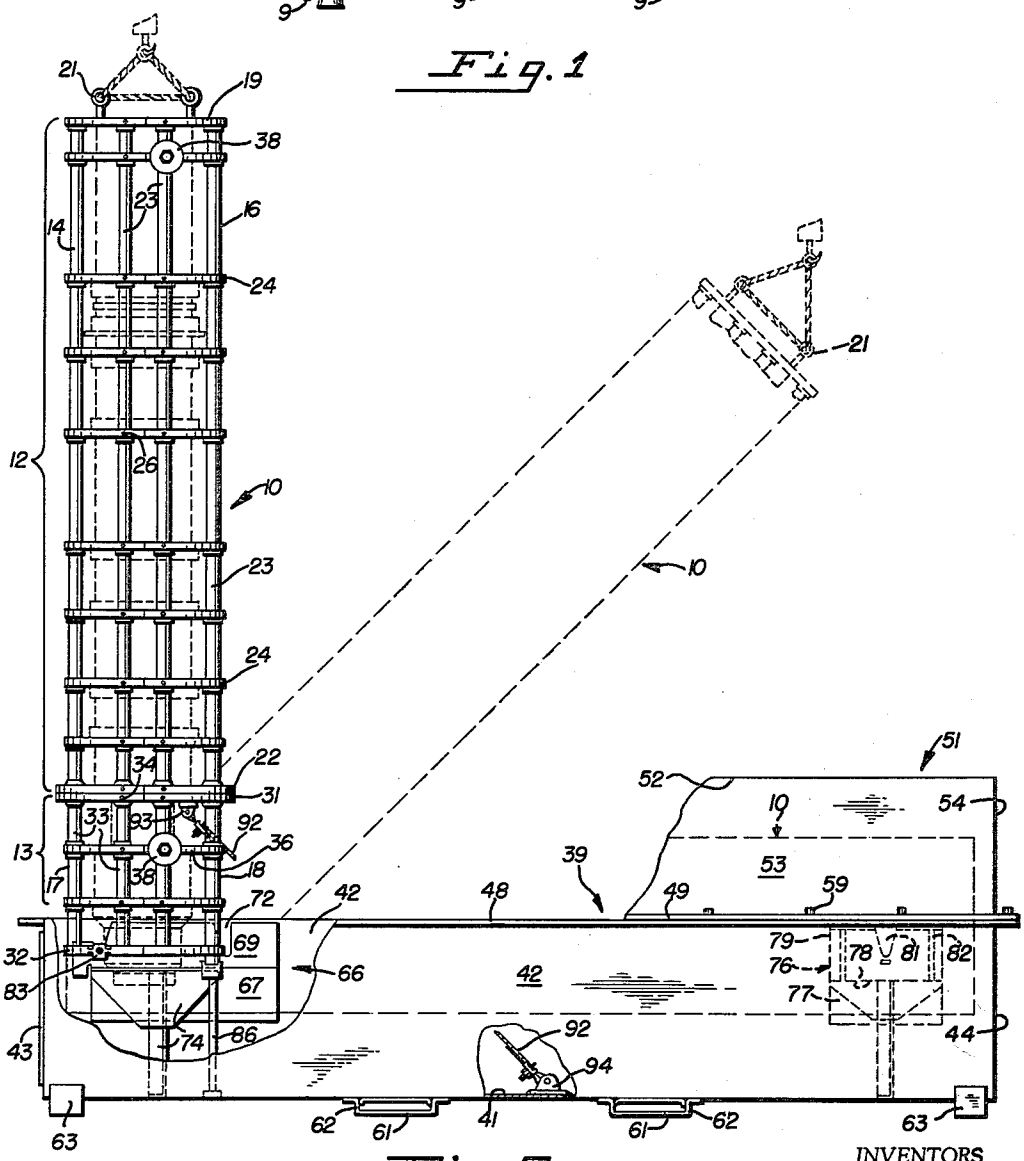


Fig. 2

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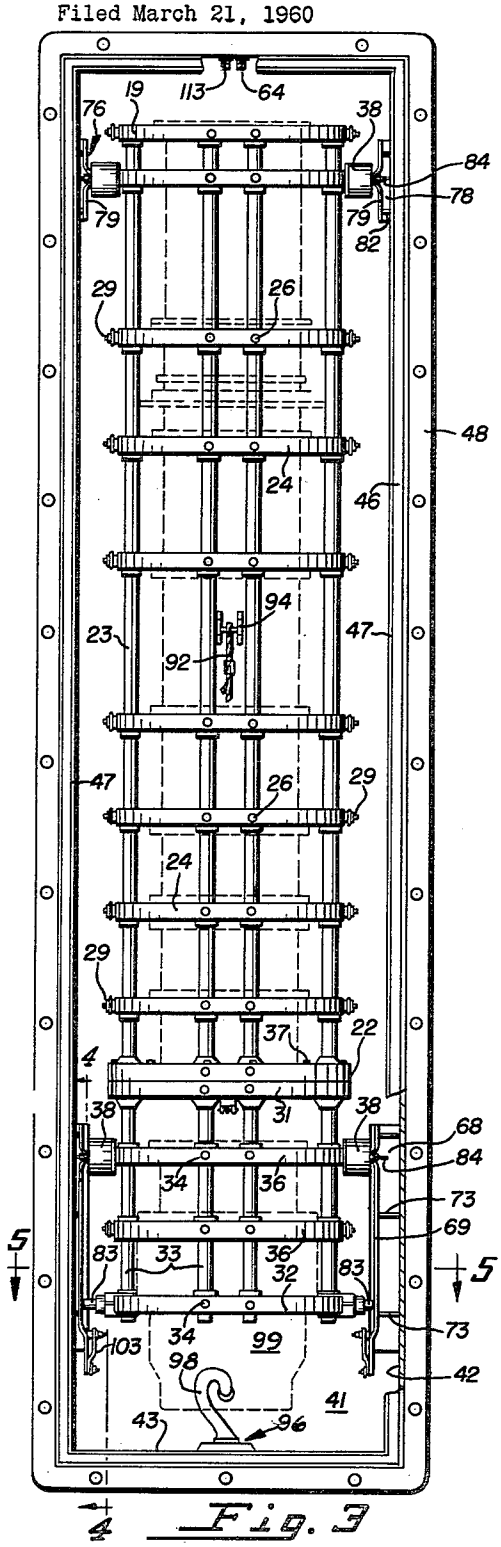


Fig. 3

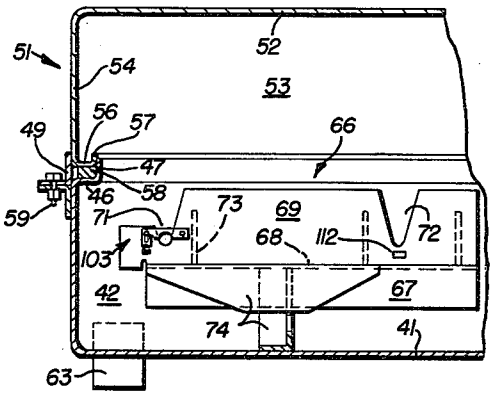


Fig. 4

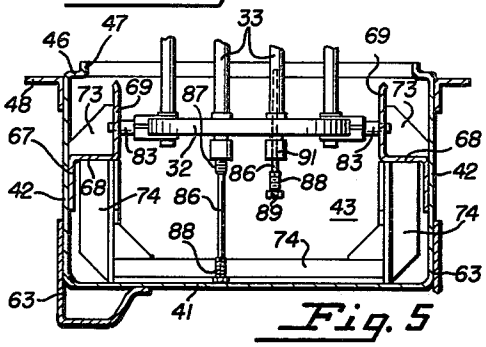


Fig. 5

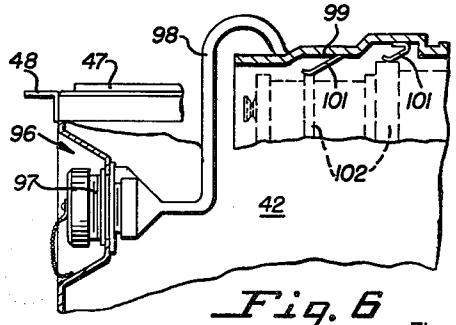


Fig. 6

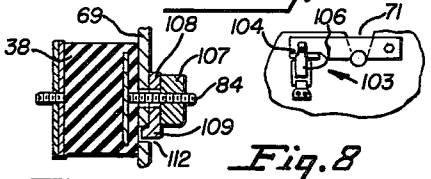


Fig. 8

Fig. 7

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United States Patent Office

3,107,009
Patented Oct. 15, 1963

3,107,009

CONTAINER WITH COOPERATING SUPPORT FRAME

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Filed Mar. 21, 1960, Ser. No. 16,466
12 Claims. (Cl. 206—46)

Our invention relates to means for sealably enclosing and supporting fragile manufactured articles, and more particularly, to a transport case or container cooperating with a support frame to enclose and support fragile electron tubes.

In the electronics industry it has been a continuing problem to devise methods and means for handling and packing tubes which by their nature are extremely fragile and subject to being damaged even by careful handling.

The problem is aggravated by tubes such, for example, as power-amplifier klystron tubes, which can be many feet long while having a relatively small diameter. These tubes are built up of axially aligned alternate metal and ceramic sections having their associated ends integrally united by flexible, hermetically tight unions or seals. The seals are especially designed to relieve destructive stresses imposed on the fragile ceramic sections because of variations in the coefficients of expansion and contraction of the different materials. When evacuated, the axially aligned sections are placed in compression by atmospheric pressure, and the flexible seals and ceramic sections easily support this pressure. The seals and ceramic sections are not designed to withstand tensile stresses imposed by vertically suspending the tube from its upper end, or imposed by laterally directed forces applied between the ends of the tube and which tend to cause misalignment of the tube. So critical is the factor of axial alignment that the metal and ceramic tube components are vertically stacked one upon another during assembly, and must remain in this position when unsupported against laterally directed forces.

It is essential for the efficient fabrication, testing and shipping of these tubes that they be capable of safe inplant mobility and shipment by commercial carriers, either in a vertical or horizontal position, and it is therefore important to provide a rigid, light, easily attachable and detachable device or frame for supporting such electron tubes in either a vertical or horizontal attitude. It has been found that a near ideal support comprises an elongated latticed framework split longitudinally to provide complementary sections releasably attachable to the tube to be supported.

Since implements of this type must be protected against inadvertent and malicious tampering, including direct destructive blows, as well as against adverse climatic conditions encountered during shipment and/or storage, it is accordingly an important object of the invention to provide a sealable shipping container or transport case which cooperates with such a latticed support frame to completely enclose and safely retain the tube isolated from adverse climatic conditions during shipping or storage, while permitting testing of the tube without opening the sealed container.

Tubes of the beam type, such as klystrons, are especially susceptible to shock damage, and it is, accordingly, another object of the invention to provide a shipping container and support frame which cooperate to isolate a beam tube from impact shocks and destructive vibrations.

Still another object of the invention is the provision in a container or transport case with a support frame of means interposed between the container and support frame cooperating to facilitate packing and unpacking of a beam tube in the container.

A still further object is the provision of a transport case of air-tight construction which incorporates means for relieving destructive pressure differentials.

Still another object is the provision of a transport case equipped to maintain constant humidity and providing means for visual indication outside the case of the humidity within the case.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of the invention. It is to be understood that the invention is not limited to the embodiment disclosed, as variant embodiments may be adopted within the scope of the appended claims.

Broadly considered, the support device or frame comprises an elongated, latticed frame adapted to fit snugly around and support the electron tube at axially spaced intervals. The frame is quickly and easily attachable to and detachable from the tube, and rigidly supports the flexibly interconnected tube elements in axial alignment. The tube and frame, so related, are adapted to be enclosed in the transport case, which comprises a rectangular sheet steel container having a hermetically sealable cover. Means on the latticed frame adjacent one end thereof cooperate with means within the container to permit safe stowing of the frame-supported tube within the container. Such means include trunnions fixed on the frame and engageable in slotted brackets fixed in the container. Shock absorbing means interposed between the supporting frame and the container retain the tube and frame resiliently supported therein when in stowed position to minimize destructive vibrations and shocks due to impact of the container with surrounding structures. Means are also provided for effecting a gas-check of the tube, without breaking the seal of the container, to determine whether the tube has been damaged during transit.

Referring to the drawings:

FIG. 1 is an elevational view, partly in section, showing an outline of a klystron tube.

FIG. 2 is an elevational view showing the support frame pivotally supported in the end of the transport case preparatory to being pivoted thereinto. A portion of the transport case cover is shown for clarity of description. The klystron tube enclosed and supported by the latticed frame is shown in dash lines. Intermediate and final positions of the support frame are shown in dash lines.

FIG. 3 is a plan view showing the latticed frame suspended horizontally within the lower support portion of the transport case.

FIG. 4 is a fragmentary vertical sectional view taken in the plane indicated by the line 4—4 in FIG. 3.

FIG. 5 is a fragmentary vertical sectional view taken in the plane indicated by the line 5—5 in FIG. 3. For

clarity, the portion of the support frame illustrated is shown pivotally supported in vertical position, with one of the jack screws used to retain the frame in this position shown extended and another shown retracted.

FIG. 6 is a fragmentary vertical sectional view of the gas-check receptacle in one end of the transport case. The view schematically illustrates the electrical interconnection of the receptacle with the electrode elements of the tube to enable electrical testing of the tube without breaking the seal of the transport case.

FIG. 7 is a sectional view of one of the shock absorbers shown apart from the support frame.

FIG. 8 is an enlarged illustration of the lock latch shown in FIG. 4.

All of the figures are drawn to a scale greatly reduced from actual size.

In greater detail, the support device or frame is particularly adapted to enclose and support a beam type tube such as the klystron illustrated in FIG. 1. Such tubes usually comprise an electron gun **2** at one end, a collector **3** at the other end, and an envelope body portion **4** hermetically interposed therebetween and comprised of axially aligned alternate metal drift tube and ceramic sections **6** and **7**, respectively, integrally and hermetically interconnected by flexible seals **8** designed to accommodate relative displacement of the drift tubes and ceramic sections as a result of thermal expansion and contraction. Radially extending annular metallic flanges **9** are brazed at their inner peripheries to associated drift tube sections **6**, while adjacent their outer peripheries the annular flanges are hermetically brazed to seal flanges **8**.

It is well known that tubes of this type are susceptible to damage caused by forces imposed transversely of the axis of the tube because the flexible seals and ceramic parts are not capable of withstanding such forces. Thus it will be seen that in a tube ten feet long, any lateral deflection at the midpoint of the envelope will result in misalignment of the drift tubes and subsequent undesirable bombardment thereof by electrons. If the lateral deflection is aggravated, rupture of the fragile hermetic seals may occur, resulting in the vacuum within the tube being destroyed.

To obviate this problem, the support device or frame comprises an elongated latticed frame **10**, including upper and lower axially aligned portions **12** and **13**, respectively.

As shown best in FIG. 2, the upper and lower portions are each split longitudinally to provide complementary latticed sections **14** and **16** in the upper portion, and **17** and **18** in the lower portion. Each of the upper sections **14** and **16** comprises an upper arcuate end plate or ring portion **19** having at least one eye-bolt **21** secured therein, and a lower apertured arcuate end plate **22**. The end plates **19** and **22** are held in spaced relation by longitudinally extending parallel stringers or bars **23** having opposite ends extending into and secured in the apertures of the spaced-apart end plates **19** and **22**.

To support and stiffen the stringer-end plate assembly, additional apertured intermediate ring portions or arcuate plates **24** are provided interposed between the end plates. Each of the end plates **19** and **22**, and each of the intermediate plates **24** are preferably cast aluminum alloy heat-treated to provide the requisite degree of toughness, while the stringers or bars are conveniently formed from standard heat-treated aluminum alloy tubing. It has been found that this construction provides rigidity while also being light. Suitable pins **26** extending through the tubes and into the plates secure tubes and plates into a rigid, latticed framework. If desired, the end plate **19** may be circular in form instead of arcuate; however, the latter is preferred.

It will thus be seen that when the latticed complementary upper frame sections **14** and **16** are placed about the upper portion of the tube, the latticed frame sections completely surround and contain the associated portion of the tube. The inner peripheral surface of each arcuate end and intermediate plate is provided with a suitable cushioning layer of rubber or the like adapted to bear against selected outer peripheral portions of the enclosed tube. Thus, in the embodiment disclosed, the arcuate plates are axially or longitudinally spaced to coincide with and bear against the outer peripheries of radially extending annular metallic flanges **9**.

The lower portion **13** of the latticed frame is similar to, but shorter than, the upper portion. Each lower latticed section **17** and **18** comprises apertured arcuate upper and lower spaced ring portions or end plates **31** and **32**, respectively, joined by parallel tubular stringers or bars **33** and secured to the apertured arcuate end plates by pins **34**. As with the upper frame sections, intermediate arcuate plates **36** are provided to lend rigidity to the structure. The lower frame sections are proportioned to enclose the electron gun **2** of the tube, and the end and intermediate plates are provided with a cushioning liner similar to corresponding plates in the upper sections. Valise-type fasteners **29** (omitted in FIG. 2 for clarity) clamp the upper and lower complementary latticed frame sections **14—16** and **17—18** to the body of the tube and to the gun **2**, respectively, and to each other, while cap screws **37**, extending between the arcuate bottom plates **22** of the upper latticed sections and the upper plates **31** of the lower latticed sections, secure the upper and lower frame portions together against relative axial displacement.

As shown best in FIGS. 2 and 3, shock absorbers **38** are provided fixed on opposite sides of the frame adjacent each end to resiliently support the frame and tube in a container or transport case **39**.

The transport case is fabricated from sheet steel welded to provide a lower support portion comprising a rectangular box having a bottom **41** and integral side walls **42** joined at opposite ends by end walls **43** and **44**. Bottom, sides, and ends are integrally welded to form an air- and water-tight container. Along their top edges, side and end walls **42—44** are formed with an inwardly extending integral flange **46** terminating in an integral upwardly extending peripheral guide flange **47**. An angle bar **48** extending peripherally around the rectangular support portion of the case is welded to the side and end walls adjacent the flanges **46** and **47** to stiffen the open end of the container. The angle bar **48** cooperates with a complementary angle bar **49** similarly welded adjacent the open end of a cover portion **51** to retain cover and container portion in sealing engagement. As with the bottom support portion of the transport case, the separable cover therefore is formed with a top **52** welded to side walls **53** which are connected by end walls **54**. The angle bar **49** is welded along the peripheral edge of the walls **53** and **54**, which are provided adjacent the bar **49** with an inwardly extending integral flange **56** having a re-entrant flange portion **57**. As shown best in FIG. 4, when the cover is placed to cover the lower portion of the transport case, the flange **56** is directly opposite and parallel to flange **46** and the space between is filled by a suitable gasket **58**, preferably neoprene, which is compressible between the flanges **56** and **46** by bolts **59** extending between the turned-out flanges of bars **48** and **49**. Additionally, flanges **47** and **57** cooperate by overlapping, as shown in FIG. 4, and thus provide a confined space within which the gasket may be deformed. It will thus be seen that the lower container portion and the cover portion, when placed together and bolted, comprise a very rigid air- and water-tight construction designed to exclude moisture which could condense within the transport case. To facilitate handling the transport case, steel straps **61** are formed to provide flanges **62**, the latter being welded to the outside bottom of the transport case to form channels to receive the tines of a fork lift truck. The straps also serve to form short legs which cooperate

with straps 63 at each end of the transport case to support the case in a level attitude.

In order to maintain a constant level of humidity within the transport case, dessicant bags (not shown) are provided. These bags are secured within the container and contain moisture absorbent material. In order that determination of the humidity within the container may be made without breaking the seal of the container, a humidity gauge (FIG. 3) is provided on one end of the transport case to display an indicator needle visible from the outside of the case. Since it is expected that transshipment of these cases will be effected at high altitudes in rarefied atmospheres, it is important that the pressure on the inside of the transport case vary as little as possible from the pressure on the outside of the transport case. To equalize such differentiating pressures, a two-way pressure relief valve 64 is provided on one end of the case. The pressure relief valve insures that if pressure builds up within the transport case to a dangerous degree, such pressure will be relieved before it does damage to the tube contained within the support frame. Also, in a pressurized atmosphere, if the pressure outside the container builds up to a dangerous level above the pressure on the inside of the container, there is danger that the side walls of the container will collapse inwardly. The two-way pressure relief valve obviates the necessity of providing braces within the inside of the container to support such pressures.

To support the frame within the transport case, two separate pairs of brackets are provided, one pair being welded to the side walls of the transport case adjacent each end thereof. Each of the support brackets 66 adjacent end wall 43 of the transport case comprises a flat plate portion 67 adapted to lie flat against the inner surface of one of the side walls and to be welded thereto. An integral flange 68 extending inwardly from the upper edge of the plate portion 67 terminates in an upwardly extending flange 69 having a pair of spaced slots 71 and 72 extending thereinto. Gusset plates 73 connect the latter two flanges to lend rigidity to the structure and support the flange 69 in an upright position. Additional strengthening ribs 74 are provided to further ensure rigidity in the construction. The pair of support brackets 76 at the opposite end of the transport case is substantially similar to the pair of brackets 66. In each bracket of this pair a flat plate portion 77 lies flat against the associated side wall 42 and is welded thereto. Cantilever flange 78 extends inwardly and is provided with an upwardly extending flange 79 having only one slot 81. Gusset plates 82 lend rigidity to the structure.

To load the support frame into the transport case, it is necessary that the support frame be raised into an upright position by means of a hoist or the like attached to eye-bolts 21. With the support frame and the enclosed tube suspended in an upright position, the support frame is slowly lowered until the trunnions 83 in the lower arcuate plate 32 engage the oppositely positioned slots 71 in the pair of support brackets 66. With the trunnions engaged in the slots, continued lowering of the support frame causes the trunnions to pivot in the slots and the upper end of the support frame to swing downwardly to the right as shown in FIG. 2. In its final horizontal position, shown best in FIG. 3, the frame is supported by threaded studs 84 engaging the slots 72 and 81 in the support brackets 66 and 76. Each of the threaded studs extends outwardly from one of the shock absorbers 38 in order that vertically and horizontally directed forces and vibration will be cushioned by the shock absorbers. It will be noted by reference to FIG. 4 that the slots 71 and 72 in the support bracket 66 at the pivot-end of the support frame are of equal depth, whereas the shock absorbers adjacent the trunnions are displaced therefrom longitudinally of the support frame, so that upon lowering of the frame the trunnions engage the outermost pair of slots 71 before the adjacent shock absorbers engage

slots 72. The shock absorbers adjacent to the trunnions but on opposite sides of the longitudinal center line of the support frame, are spaced longitudinally from the trunnions a distance equal to the spacing between slots 71 and 72. It will thus be seen that as the support frame swings downwardly to the right about the trunnion pivots, the shock absorbers also swing downwardly so that the threaded studs 84 extending outwardly therefrom come into engagement with the innermost slots 72 in the support brackets. After this occurs the studs 84 replace the trunnions as the pivotal support for the frame, and continued pivotal movement of the frame results in the trunnions being lifted out of the slots 71. Upon completion of the downward pivotal movement of the frame, the studs 84 extending from the shock absorbers at the opposite end of the support frame engage the slots 81 in the pair of brackets 76 and the frame lies resiliently supported between the two pairs of brackets.

In the event it is desired to elevate and support the frame and tube in an upright position within the end of the transport case, as shown best in FIGS. 2 and 5, a pair of jack screws 86 are provided. Each of the jack screws is provided with threaded sections 87 and 88 adjacent opposite ends, with a head 89 being provided to turn the threaded sections of each jack screw into an internally threaded adapter 91, fixed on the end of an associated stringer or tubular bar 33 of the support frame. As shown best in FIG. 5, each jack screw may be adjusted to engage the bottom 41 of the transport case by engaging threads 87 with the adapter and thus, with the trunnions which are positioned on the opposite side of the longitudinal center line of the support frame, form a four-point support for the frame, with the transport case acting as a broad and stable base. To ensure stability of the frame in this position, an adjustable guy wire 92, fixed at one end by clevis 93 to the upper plate 31 of the lower frame portion 13, extends downwardly to be connected at its other end to a clevis 94 fixed on the bottom of the transport case. When it is desired to swing the frame into its horizontal position, the jack screws may be retracted by engaging threaded section 88 with the adapter. In this retracted position the jack screws lie enclosed within the associated stringer as shown.

Since it is desirable to test the electron tube before the hermetic seal of the transport case is broken, means are provided in end 43 of the transport case for the passage of electrical conductors. Such means, shown best in FIG. 6, includes a recess 96 formed in the end of the box and having an aperture in its bottom within which is secured an electrical receptacle 97 hermetically sealing the aperture and providing a plurality of conductors enclosed in a flexible conduit 98 extending into the transport case to terminate in a socket 99 fixed over the gun end of the tube. Appropriately positioned terminals 101 within the socket make electrical contact with external terminals 102 on the electron gun. By connecting conventional test equipment (not shown) to receptacle 97 it is possible to gas check the electron tube without breaking the seal on the transport case.

To ensure that the support frame will not shift on the support brackets within the transport case, lock latches 103, shown best in FIGS. 4 and 8, are pivoted on the support bracket flange 69 adjacent the outermost pair of slots 71. The free end of the latch is provided with an inwardly extending hook 104 adapted to be engaged by a lock lever 106 pivoted on the bracket. As shown best in FIGS. 2 and 4, the latch locks the trunnions into the slot and prevents upward movement of the support frame when it is in vertical position. To ensure against movement of the support frame on the support brackets when the frame is horizontal, lock nuts 107 on threaded studs 84 extending from the shock absorbers, are turned down onto the flanges 69 and 79 of the support brackets. A washer 108 under the nut is provided with a lug 109 extending into aperture 112 formed in the flange just below the slot, thus en-

suring that even accidental loosening of the nut will not release the support frame from the brackets.

With the support frame and its enclosed tube firmly supported within the lower portion of the transport case, the cover is now clamped and sealed thereon in order to provide an air- and water-tight container. A conventional humidity gauge **113** fixed in the cover of the transport case provides a convenient means of indicating to an observer the humidity within the sealed container. Upon being sealed, the transport case is shipped to a consumer, and upon receipt, the consumer may test the tube without breaking the seal of the transport case in order to determine whether the tube has been damaged in transit. If damage has occurred, the test will reveal such damage and the tube may be shipped back to the factory. In the event that no damage has occurred, the seal may be broken and the transport case cover removed to permit unloading of the enclosed tube.

To remove the support frame and tube from the transport case after removal of the cover, each shock mount nut **107** is loosened and the special retaining washer **108** is moved along the stud until lug **109** is withdrawn from aperture **112**. By a hoist attached to the eye-bolts at the upper end of the support frame, the frame may be raised to a vertical position, as shown in FIG. 2. In this position, the two jack screws **86**, shown best in FIG. 5, may be lowered until they engage the bottom of the transport case. As previously stated, these, together with the outrigger pivots or trunnions will support the frame in an upright position. To further support the frame and tube any slack in the guy wire is taken up by appropriate adjustment thereof. Normally, the length of the guy wire will be initially adjusted so that the slack will automatically be taken up by adjustment of the jack screws.

If desired, the upper portion of the support frame may now be removed, making the tube accessible for handling by whatever other means the consumer wishes to use. Alternately, the cap screws securing the upper and lower portions may be removed, and the quick disconnect clamps **29** securing the lower sections **17—18** opened. The upper portion **12** of the support frame may now be used to lift the tube out of the lower frame portion (including the socket **99**) which remains in the transport case, the upper portion providing means for in-plant handling. Ideally, and particularly where cost is an important factor, after the tube has been placed in its permanent position, the support frame is placed back into the transport case and the entire package is returned to the manufacturer for use with another tube.

We claim:

1. A transport case for enclosing and supporting fragile devices, comprising a hollow support portion open on one side, a pair of brackets fixed within the support portion adjacent each end thereof, at least one pair of said brackets having corresponding oppositely disposed slots, a rigid frame, trunnion means on the frame pivotally engaging said oppositely disposed slots to pivotally support the frame on said slotted brackets for selective pivotal movement between substantially perpendicular and parallel positions with respect to said support portion, and a detachable cover portion closing the open side of the support portion to isolate the interior of the transport case from the atmosphere.

2. The combination according to claim 1, in which means are provided interposed between the support portion of the transport case and the frame to selectively lock the frame in a perpendicular position.

3. The combination according to claim 1, in which shock absorber means are interposed between the frame and each of said brackets when said frame is in said parallel position to resiliently support the frame in the transport case to isolate a frame-supported device from destructive vibrations.

4. In an apparatus for rigidly supporting and enclosing fragile devices, the combination comprising a rigid frame to support such device, a hollow transport case for enclosing and isolating such frame-supported device from the atmosphere, cooperating slot and trunnion means interposed between the frame and transport case pivotally supporting the frame on the case for selective pivotal movement between substantially perpendicular and parallel positions with respect to the case, said slot means forming an open sided slot which can receive said trunnion means by movement of the slot and trunnion means relative one to the other in a direction normal to the axis of the trunnion means, said open side of said slot being positioned to open in a direction such that said trunnion means can enter said opening when said frame is moved vertically into said case, and means on the frame selectively adjustable to engage said transport case to retain the frame in a vertical position.

5. The combination according to claim 4, in which said means for retaining the frame in a perpendicular position includes a guy wire connected between the frame and the transport case.

6. The combination according to claim 4, in which said means on the frame selectively adjustable to engage the transport case to retain the frame in a vertical position includes a retractable jack screw.

7. The combination according to claim 4, in which means are interposed between the rigid frame and the transport case to releasably lock the rigid frame to the transport case in its parallel position.

8. In a transport case, a plurality of walls for enclosing elongated electronic devices having axially aligned flexibly interconnected laterally displaceable sections, an inflexible frame to retain the flexibly interconnected sections against lateral displacement, means on the frame engaging at least one wall to selectively pivotally support the frame in the transport case, means operatively interposed between the frame and the case to selectively lock the frame against pivotal movement, and conductor means operatively connected to an electronic device supported in said frame, said conductor means extending out of the transport case and energizable to effect an electrical test of an electronic device from outside the transport case.

9. The combination according to claim 8, in which electrical receptacle means are provided on the transport case connected to said conductor means to connect said conductor means to a source of electric power.

10. A transport case for enclosing and supporting fragile devices, comprising a hollow support portion open on the top, a frame for supporting a relatively fragile device therein, a trunnion rigidly attached to said frame adjacent one end thereof, two shock absorbers spaced along said frame and a stud carried by each shock absorber, and means inside said support portion forming a trunnion-receiving slot adjacent one end thereof and two stud-receiving slots spaced along the support portion, said slots being so positioned on said support portion and said trunnion and studs being so positioned on said frame that when said studs engage the bottoms of said stud-receiving slots said trunnion is out of contact with the bottom of said trunnion-receiving slot.

11. A frame for supporting a relatively fragile device therein and adapted for reception in a transport case, said frame comprising a pair of trunnions rigidly attached thereto adjacent one end of the frame and on opposite sides of the frame, a first pair of shock absorbers attached to said frame adjacent the other end of the frame and on the same opposite sides thereof as said trunnions, a second pair of shock absorbers attached to said frame between said first pair of shock absorbers and said trunnions, said second pair of shock absorbers being on the same opposite sides of the frame as said trunnions, and a stud carried by each of said shock absorbers.

12. A frame as claimed in claim 11 further comprising a retractable jack screw on the end of said frame adjacent said trunnions, said jack screw and trunnions being on op-

posite sides of a plane passing through the center of said frame parallel to said trunnions.

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