

Nov. 15, 1966

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3,284,884

ASSEMBLY JIG FOR POSITIONING PHOTOGRAPHIC SHADOW MASKS
IN COLOR TELEVISION PICTURE TUBE FACE PLATES

Filed Feb. 1, 1965

4 Sheets-Sheet 1

FIG. 1

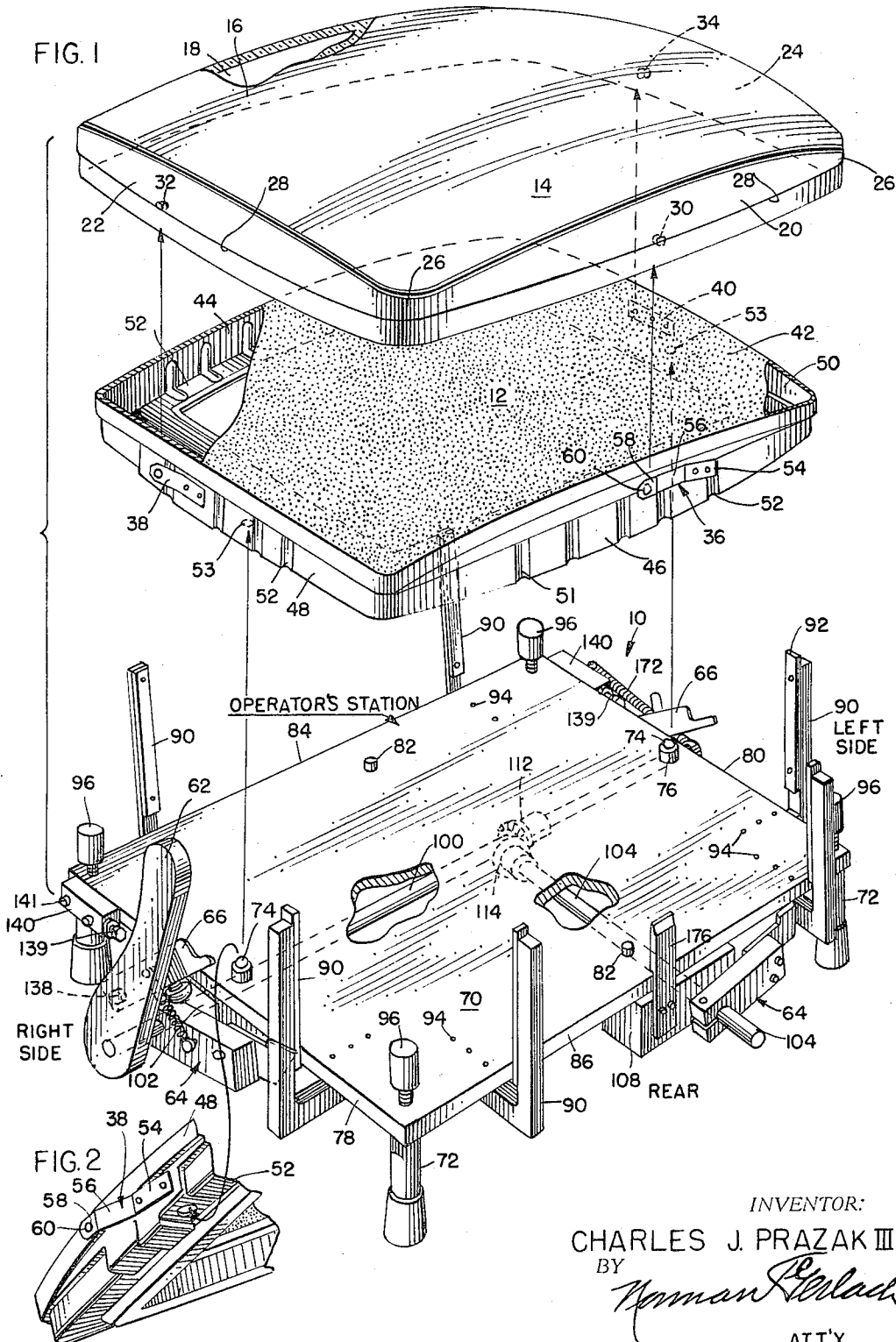


FIG. 2

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4 Sheets-Sheet 3

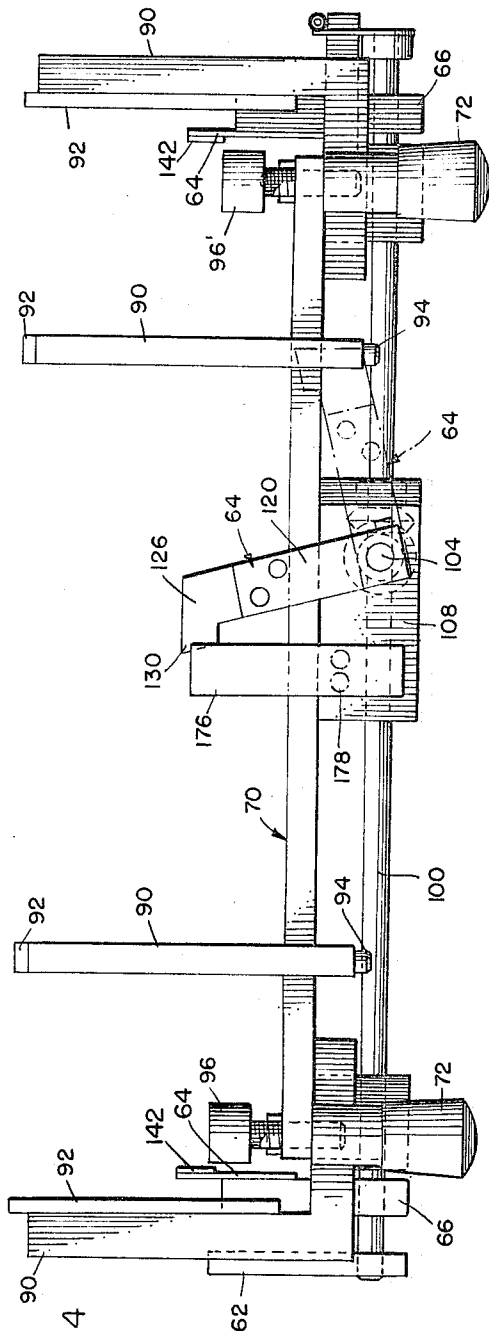


FIG. 4

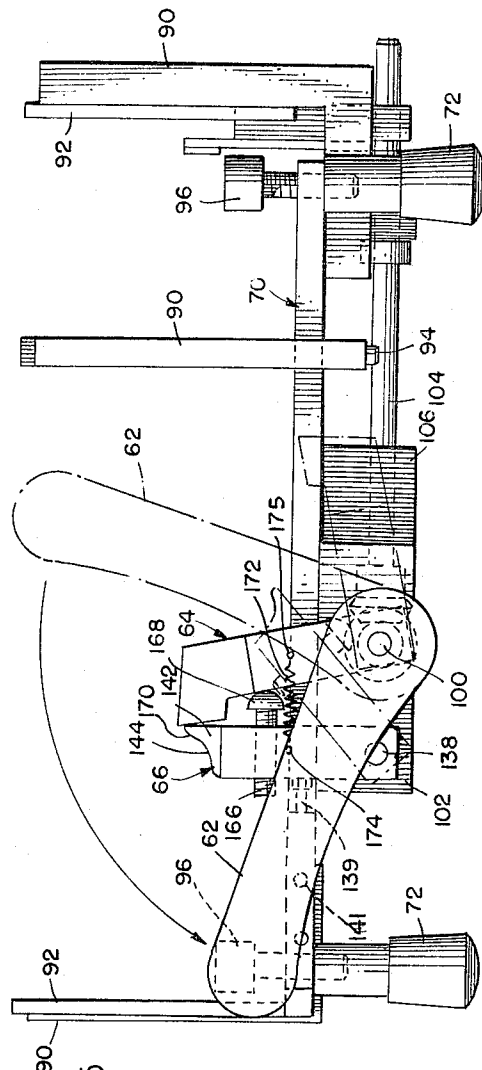


FIG. 5

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4 Sheets-Sheet 4

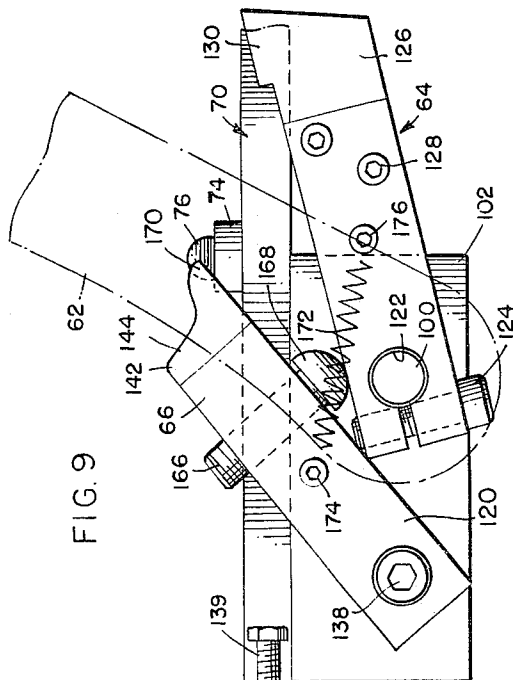


FIG. 9

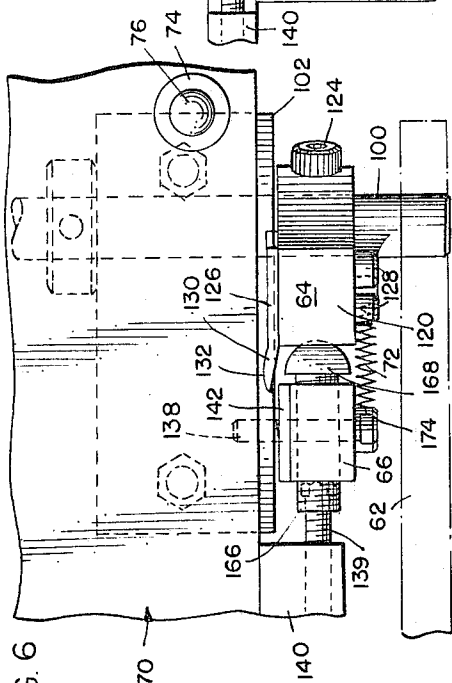


FIG. 6

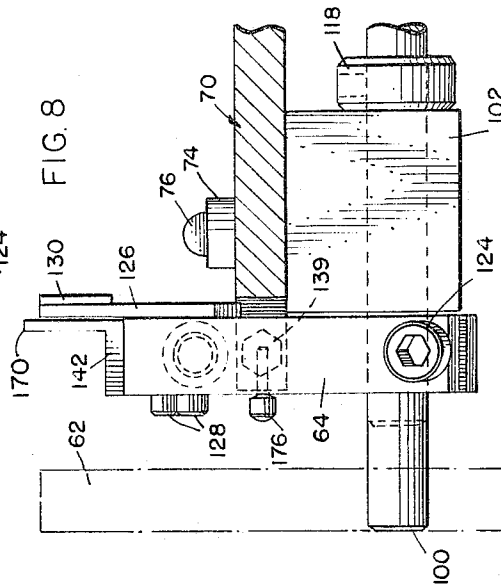


FIG. 8

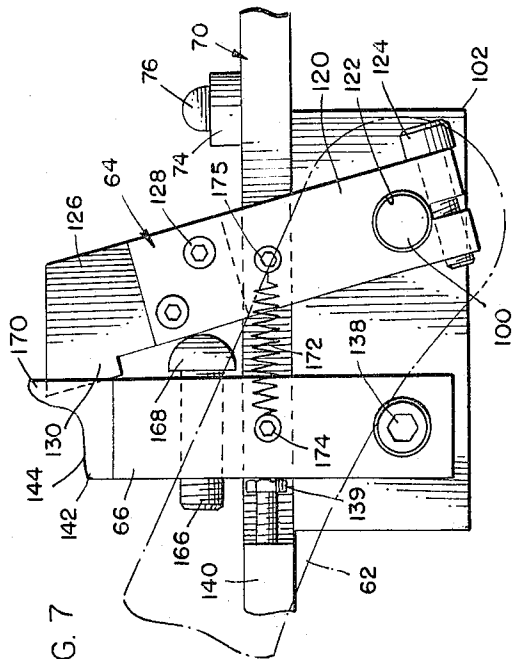


FIG. 7

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3,284,884

ASSEMBLY JIG FOR POSITIONING PHOTOGRAPHIC SHADOW MASKS IN COLOR TELEVISION PICTURE TUBE FACE PLATES

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16 Claims. (Cl. 29—200)

The present invention relates to an assembly jig for facilitating the application of a photographic shadow mask to a color television picture tube face plate, as well as for facilitating the removal of the shadow mask from the face plate after the mask and face plate have been manipulated into connected or assembled relation.

Briefly, and by way of introduction to the present invention, it is explained that in the commercial manufacture of picture tube for a color television receiver three series or groups of closely spaced, extremely small, fluorescent spots or dots are formed by a photographic process on the inside of the glass face plate of the picture tube before the usual glass envelope containing the tube electrodes is applied and connected to the face plate. Each group of dots is responsive to scanning through the picture area in a different primary color and the dots of the three groups are closely interlaced so that selected scanning patterns that are produced by the cathode ray electron beams will produce a color response which is similar to that produced by half-tone color printing in the three primary colors.

Application of the three groups of dots to the inside face of the face plate of the color television picture tube requires three separate photographic operations, each involving, ordinarily, considerable manual handling of the glass face plate. First, a light-sensitive film consisting of a suspensoid of various phosphors in polyvinyl alcohol is applied to the inside concave surface of the face plate so that it is coextensive with the picture area. Thereafter, a shadow mask having a perforated concave front face conforming precisely to the curvature of the concave coated surface of the face plate is installed within the confines of the face plate and fixedly secured therein so that the perforated face of the shadow mask overlies the picture area and is maintained spaced therefrom a small distance. The front face of the shadow mask is provided with an extremely large number of closely spaced minute holes or perforations therein, the number of perforations being on the order of 800 to the square inch. The light-sensitive film is exposed momentarily through the perforations in the shadow mask to a source of light an appreciable distance from the shadow mask and, thereafter, the shadow mask is removed from the face plate and the inside concave surface of the face plate is subjected to a washing operation which removes the shadowed or unexposed portions of the film therefrom and leaves the exposed portions, i.e., the dots adhering to the inside concave surface of the face plate. The face plate is then subjected to a drying operation in order to fix the group of dots. The dots which result from the first photographic operation are responsive to scanning in one primary color, such, for example, as green.

The entire procedure briefly outlined above is repeated, utilizing a suspensoid for the light-sensitive film which results in the creation of dots that are responsive to scanning in another primary color, for example, blue. During the second exposure operation, the remote light source is shifted or displaced a slight distance from its original position to produce a parallax shift of the resultant exposure dots on the film so that the second group of dots

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will not be superposed on the first group but will be properly interlaced therewith. This entire procedure is repeated a third time to produce the third group of phosphorescent dots, this time utilizing a phosphor suspensoid which is responsive to scanning in the third primary color, this is, red. Again, the remote light source that is employed during the third exposure operation is displaced a slight distance for proper interlacing of the last group of dots with respect to the other two groups of dots. After the last face plate drying operation, the three groups of dots are given an aluminum coating by an aluminum evaporation process and this coating is finally covered with a smooth protective lacquer film.

When it is considered that the glass face plate of a color television picture tube is relatively thick and massive and weighs on the order of twenty pounds, it is obvious that an appreciable amount of manual effort is required in the production of the finished or fully processed face plate. The perforated front face of the shadow mask is provided or formed by an extremely thin membrane-like sheet of perforated metal which is extremely fragile and susceptible to deformation at the slightest touch. Therefore, with repeated manipulation of the heavy glass face plate in the vicinity of the shadow mask, and vice versa, there is considerable danger of accidental damage to the extremely thin front face of the shadow mask or to the phosphor-dot coating on the inner side of the face plate.

The assembly jig of the present invention is essentially concerned with minimizing the amount of handling that is necessary to process the face plate of a color television picture tube, utilizing a shadow mask in the manner set forth above. By its use, the danger of damaging the shadow mask is reduced to a minimum, improper or faulty positioning of the shadow mask within the face plate is avoided, motions on the part of the operator are standardized to a routine sequence of operations which may be repeatedly followed by the operator or without deviation so that considerable waste effort is eliminated and the unit time necessary to process a given face plate is reduced to a minimum, and the use of skilled labor is made unnecessary.

Briefly, in carrying out the invention, the picture tube face plate and the shadow mask are provided with plural sets of cooperating locking detent devices which serve, when the two parts are properly assembled, fixedly and securely to lock the parts together in their proper operative relationship for photographic exposure or other purposes. The present assembly jig includes a base plate having means thereon for fixedly supporting a shadow mask in a convenient position for manual insertion thereover of a film-containing picture tube face plate. As soon as the shadow mask is thus positioned on the base plate, a lever is operated whereupon a series of detent-actuators become effective to retract the detent devices on the shadow mask and provide clearance for the detent devices of the face plate during insertion of the latter over the shadow mask. The base plate also is provided with means for fixedly supporting the face plate thereon so that when it is inserted over the prepositioned shadow mask, it assumes approximately the operative position required of it during the subsequent photographic exposure process. In these fixed supported positions of the shadow mask and the face plate, the cooperating locking detent devices on the two parts are disposed in approximate register so that upon manipulation of the lever the detent devices on the shadow mask are released for locking cooperation with the detent devices on the face plate. Thereafter, the face plate and the shadow mask, securely locked together by the detent devices, may be lifted bodily from the assembly jig and transported to the area

where the photographic exposure process is to be carried out. After the exposure process, the assembly is returned to the assembly jig and caused to assume the same position it assumed at the time it was removed therefrom, whereupon the aforementioned lever is manipulated in order again to retract the detent devices on the shadow mask and withdraw or disengage them from the cooperating detent devices on the face plate. Thereafter, the face plate may be lifted from the assembly jig, leaving the shadow mask positioned on the jig for cooperation with the face plate during the next succeeding phase of the same process or with a different face plate next to be processed.

The provision of an assembly jig of the character briefly outlined above constitutes one of the principal objects of the present invention.

It is a further object of the present invention to provide an assembly jig which possesses the features set forth above and in which means are provided whereby any discrepancy in the positioning of one or more of the detent devices on the face plate of the picture tube due to wide manufacturing tolerances, and tending to misalign these detent devices with their cooperating detent devices on the shadow screen, will be automatically compensated for by the operation of certain novel aligning instrumentalities which become effective immediately prior to release of the detent devices to bring the misaligned detent devices into substantially precise registry.

The provision of an assembly jig which is of simple construction and, therefore, is not costly to manufacture; one which is comprised of a minimum number of parts, particularly moving parts and, therefore, is unlikely to get out of order; one which is rugged and durable and will, therefore, withstand rough usage; one which is capable of ease of assembly and disassembly for purposes of inspection, replacement or repair of parts; one which, if desired, readily lends itself to automatic operation; and one which, otherwise, is well-adapted to perform the services required of it, are further desirable features which have been borne in mind in the production and development of the present invention.

Numerous other objects and advantages of the invention not at this time enumerated will become readily apparent as the nature of the invention is better understood.

In the accompanying four sheets of drawings forming a part of this specification, one illustrative embodiment of the invention has been shown.

In these drawings:

FIG. 1 is a rear perspective view of an assembly jig constructed according to the present invention and showing in exploded fashion a television picture tube face plate and a shadow mask poised thereabove preparatory to installation or assembly in the assembly jig;

FIG. 2 is a fragmentary detail perspective view of a limited underneath portion of the picture tube face plate of FIG. 1;

FIG. 3 is a top plan view of the assembly jig;

FIG. 4 is a rear elevational view of the assembly jig with the operative parts thereof disposed in their positions of picture tube face plate release;

FIG. 5 is an end elevational view of the structure shown in FIG. 4;

FIG. 6 is an enlarged fragmentary top plan view of a portion of the structure shown in FIG. 3 and in the vicinity of one of three similar detent-actuating instrumentalities that are employed in connection with, and form parts of, the improved assembly jig;

FIG. 7 is a side elevational view of the structure shown in FIG. 6;

FIG. 8 is a vertical sectional view taken on the line 8—8 of FIG. 3 in the direction indicated by the arrows; and

FIG. 9 is an end elevational view similar to FIG. 5 but showing the one detent-actuating instrumentality in its inoperative position.

Referring now to the drawings in detail and in particular to FIG. 1, an assembly jig embodying the principles of the present invention is designated in its entirety by the reference numeral 10. Its purpose is to facilitate insertion of a shallow dish-like shadow mask 12 into a similarly shaped television picture tube face plate 14 so as to effect a nested relationship of these two parts (12, 14) for photographic-masking purposes, as will be described subsequently.

The television picture tube face plate, as well understood in the art, is formed of relatively heavy glass. It is generally of rectangular configuration and includes a slightly forwardly dished front wall 16, opposed laterally and rearwardly turned side walls 18 and 20, and opposed laterally and rearwardly turned end walls 22 and 24. The four face plate side walls 18, 20, 22 and 24 are continuous and the adjacent ends of these walls merge with each other by means of rounded corner regions 26. The outer surfaces of the four side and end walls of the face plate 14 are undercut in order to provide a narrow, continuous, rearwardly facing, seating ledge or shoulder 28 against which an electrode-containing glass envelope (not shown) is adapted to seat when the various parts of the color television picture tube are assembled immediately prior to tube evacuation operations as is customary in the art. On the inside of each of the three walls 20, 22 and 24 there is provided an inwardly projecting metal locking pin, the three locking pins being designated, respectively, by the reference numerals 30, 32 and 34. These pins have their inner ends embedded in their respective glass face plate walls and are designed for cooperation with respective, exteriorly disposed, locking detent arms 36, 38 and 40 on the shadow frame 12 in a manner and for a purpose that will be made clear presently.

The shadow mask 12 is essentially a masking screen assembly and is of unitary sheet metal construction. In general, the shape of the shadow mask is similar to the shape of the picture tube face plate 14. The shadow mask 12 includes a minutely-perforated front wall 42 constituting a masking screen proper, opposed side walls 44 and 46, and opposed end walls 48 and 50. The side and end walls of the shadow mask are of one-piece or continuous construction and the front wall or masking screen proper is in the form of a cap of extremely thin flexible sheet metal which is telescopically received over the open rim of the structure that is defined by the side and end walls and is spot-welded or otherwise fixedly connected thereto. Although the side and end walls of the shadow mask are somewhat thicker than the front wall 42, they are sufficiently thin that it is necessary to provide rigidifying ribs or corrugations therein for strengthening purposes. A continuous inturned seating or rim flange 52 on the rear or underneath side of the shadow mask 12 further rigidifies the mask. It is formed integrally with, and projects inwards from, the rear marginal portions of the side and end walls of the shadow mask 12 and is designed for seating engagement with certain supporting posts which are associated with the assembly jig 10 and will be described presently. Two locating holes 53 are formed in the inturned flange 52 near the end walls 48 and 50 and midway between the side walls 44 and 46, these holes being designed for cooperation with certain locating buttons which are associated with the assembly jig and also will be described subsequently.

The three detent arms 36, 38 and 40 are mounted, respectively, on the walls 46, 52 and 50 of the shadow mask and they and the cooperating pins 30, 32 and 34 are provided for the purpose of properly locating the shadow mask 12 within the glass face plate 14 and in such nested relationship that the outer convex face of the front wall 42 of the shadow mask 12 will underlie, and be spaced a small distance from, the inner concave face of the front wall 16 of the face plate 14 when the two parts are supported on the assembly jig as hereinafter described.

Each of the three detent arms is in the form of an

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angular strip of flat spring steel stock having a proximate end section 54 which is spot-welded, riveted or otherwise fixedly secured to the associated shadow mask side wall or end wall, as the case may be, a free medial section 56, and a slightly inturned distal end section 58, the latter being formed with a hole 60 therein for reception therein of the associated pin for shadow mask and face plate pin for locking purposes. It is to be noted at this point that the locking pin 30 assumes a central position on the side wall 20 of the face plate 14, while the locking pins 32 and 34 on the face plate end walls 22 and 24 assume off-center positions which are closer to the side wall 18 than to the side wall 20. The three locking pins are thus widely separated and, when they are interlocked with their respective detent arms, an appreciable degree of stable equilibrium is imparted to the picture tube face plate 14 as a whole when it is supported upon the shadow mask while the two parts are disposed within and supported by the assembly jig 10.

By way of further introduction to the nature and function of the assembly jig 10, it is pointed out that the inturned distal end sections 58 of the three detent arms 36, 38 and 40 are normally, in the free state of these arms, spaced outwardly from the side or end walls which they overlie. Their triangular spread is such that when the shadow mask is operatively disposed within the picture tube face plate 14, the holes 60 in said distal end sections 38 encompass the locking pins. With the pins thus encompassed by the holes 60, the face plate 14 and the shadow mask 12 are securely locked together in a predetermined positional relationship necessary for light-exposure purposes, as will be described presently. Obviously, the shadow mask 12 cannot be operatively installed within the face plate unless the detent arms 36, 38 and 40 are inwardly depressed to out-of-the-way positions wherein they will clear the pins 30, 32 and 34. Similarly, the face plate 14 cannot be removed from its installed position with respect to the shadow mask 12 without inwardly depressing the detent arms in order to free the distal end sections 58 from the three locking pins. The function of the assembly jig 10 is to facilitate handling of the shadow mask 12 and the face plate 14, both for purposes of assembly and disassembly thereof. To accomplish this, the assembly jig provides a means for fixedly supporting the shadow mask 12 in the inverted position in which it is shown in FIG. 1 so that the face plate 14, likewise in an inverted position, may readily be telescoped thereover. Immediately prior to such telescopic movement of the face plate, manipulation of an operating handle or lever 62 causes a series of three detent actuators 64 slidably to engage the three detent arms 36, 38 and 40 and simultaneously flex the same inwardly to out-of-the-way positions where they will clear the pins 30, 32 and 34 on the face plate 14 and thus permit free insertion of the face plate over the shadow mask without interference. At the same time that the three detent actuators are moved to their operative positions, two combined guide posts and pin supports 66 are raised from retracted inclined positions to elevated vertical positions wherein they assist in guiding the face plate downwardly as the operator lowers it upon the shadow mask, and also establish pin-aligning rests or supports for the detent pins so that they will become properly aligned with their respective detent holes 60 when the face plate 14 is moved to its final position over the shadow mask 12. As soon as the face plate has thus been positioned over the shadow mask, the operating lever 62 is restored to its original position and the three detent actuators 64 are withdrawn from the three detent arms, thus releasing them and allowing them to seek locking engagement with the three locking pins (now aligned therewith). The combined guide posts and pin supports 66 are also retracted and the assembled face plate and shadow mask may then easily be removed as a unit from the assembly jig for photographic purposes.

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After the photographic exposure has been made, the still assembled face plate and shadow mask are, for purposes of disassembly, returned to the assembly jig where they assume the same relative position with respect to the assembly jig as the position thereof at the time they were removed for photographic purposes. Thus, manipulating of the operating lever 62, as heretofore described, serves again to depress the detent arms and free the face plate from its locking engagement with the shadow mask so that it may be lifted therefrom for photographic development. Upon lifting of the face plate 14 from the shadow mask 12, the latter remains operatively positioned in the assembly jig ready to be picked up by the face plate for such succeeding photographic processes as are contemplated in the manufacture of the color television picture tube.

Before entering into a detailed description of the actuating instrumentalities which are associated with the assembly jig 10, it is here pointed out that whereas the television picture tube front plate 14 has been described with reference to its orientation in actual use, i.e., when operatively installed in a color television receiver so that the wall 16 constitutes the front wall of the tube and faces the audience, and whereas the shadow mask has, for convenience, been described with reference to a similar orientation so that the counterparts of the two structures may readily be correlated, the assembly jig in the following description will be described as being oriented with respect to its position on a work bench and under the control of an operator standing at what may be regarded as the front of the assembly jig and at an operator's station, so labelled in FIG. 1. FIG. 3 being a rear perspective view, the left side of the view actually represents the right side of the jig with respect to the operator's station, and it has been labelled accordingly to avoid confusion. Other labelling in FIG. 1 definitely establishes the orientation of the assembly jig with respect to the operator and will be found helpful in connection with the following description.

Referring now to FIG. 1, and additionally to FIG. 2, the assembly jig 10 involves in its general organization a relatively thick, horizontally disposed base plate 70 which is of rectangular design and has supporting legs 72 at the four corners thereof. Two locating buttons 74 project upwardly from the upper ends of respective cylindrical supporting posts 76, the posts being spaced inwardly a slight distance from the end edges 78 and 80 of the plate 70 and being so positioned on the plate that they will register with the two locating holes 53 in the end portions of the inturned flange 52 when the shadow mask 12 is centered above the base plate of the assembly jig 10. The locating buttons 74 are adapted to project into the holes 53 with the rim regions of the latter resting on the exposed upwardly facing annuli presented by the upper end surfaces of the posts 74 while at the same time the side portions of the continuous inturned flange 52 of the shadow mask rest upon a pair of upstanding posts 82 which are spaced inwardly a slight distance from the front and rear side edges 84 and 86 of the plate 70, and are disposed medially between the base plate side edges 78 and 80. The shadow mask 12, when operatively disposed in the assembly jig 10, finds a four-point support on the posts 76 and 82 and is held by the buttons 76 against shifting movement in any horizontal direction.

Six L-shaped edge guides 90 which are arranged in a rectangular series and are provided with inwardly facing protective strips 92 on the inner surfaces of their vertical parts have the horizontal lower parts thereof connected by attaching screws 94 so that they abut against the underneath side of the base plate 70. Such guides overhang the adjacent edges of the plate and project upwardly above the level of the base plate an appreciable distance as best shown in FIG. 1. These edge guides are provided for the purpose of: (1) guiding the shadow mask 12 in its downward movement when the operator initially posi-

tions it in the assembly jig, (2) guiding the glass face plate 14 in its downward movement when the operator lowers it upon the previously installed shadow mask for purposes of interlock, (3) guiding the assembled shadow mask and face plate upwardly when the operator lifts the interlocked assembly from the assembly jig for photographic purposes, (4) guiding the assembled shadow mask and face plate downwardly when the operator restores the assembly to the jig for purposes of interlock release, and (5) guiding the glass face plate upwardly and out of the assembly jig after it has been released from the shadow mask.

Four upstanding supporting posts 96 which are adjustable for height are mounted at the four corner regions of the base plate 70 and serve to support the four corner regions of the glass face plate 14 after it has been lowered into the assembly jig in assembled telescopic relation with respect to the previously positioned shadow mask 12. Whereas the posts 76 and 82 support, and serve to establish a predetermined elevation for, the shadow mask 12, the four posts 96 similarly support, and serve to establish a predetermined elevation for, the glass face plate 14. The four supporting posts 96 are initially adjusted so that when the glass face plate 14 is operatively supported thereon, the height of the three locking pins 30, 32 and 34 will be substantially equal to the height of the holes 60 in the distal end sections of the detent arms 36, 38 and 40, thus bringing these pins and holes into approximate register. In actual practice, manufacturing tolerances are such that the pins 32 and 34 may not, in all instances, assume the same relative positions on their respective end walls 48 and 50 and, therefore, as will be described in detail presently, the previously mentioned movable pivoted pin supports 66 are provided for establishing accurate elevations for these two pins, if not on their respective end walls, at least in the assembly jig so that they will be brought into register with the holes 60.

Referring now to FIGS. 1 and 3, and bearing in mind the reverse positioning of the assembly jig in FIG. 1, two of the three detent actuators 64 are mounted on the overhanging or projecting end regions of a horizontal main shaft 100 which extends lengthwise of the jig, is located directly beneath the base plate 70, and is supported in depending bearing blocks 102 at the end regions of the base plate. The third detent actuator 64 is mounted on the overhanging or outer end region of a horizontal take-off shaft 104 which extends at right angles to the main shaft, underlies the base plate 70, and is journaled in depending bearing blocks 106 and 108. The various bearing blocks are secured to the underneath face of the base plate by suitable fastening screws 110. A bevel gear 112 on the central portion of the main shaft 100 meshes with a similar bevel gear 114 on the inner end region of the take-off shaft 104 and establishes a driving connection for the last-mentioned shaft. The extreme right-hand end of the main shaft 100 carries the previously-mentioned operating lever 62. A thrust collar 116 on the shaft 104 bears against the inner side face of the bearing block 108 and cooperates with the gear 114 in preventing endwise shifting of the take-off shaft 104, while similar thrust collars 118 in abutment with the inner side faces of the bearing blocks 102 are fixed on the main shaft 100 and serve to prevent endwise shifting of such shaft.

The ends of the main shaft 100 overhang the end edges of the base plate 70 in regions which, for descriptive purposes, may be regarded as locking stations LS1 and LS2 inasmuch as at these regions, the associated detent-actuators 64 are caused to effect interlocking and release of the cooperating detent parts or devices on the end walls of the glass face plate 14 and the shadow mask 12. Similarly, the outer end of the take-off shaft 104 overhangs the rear side edge 86 of the base plate 70 at a locking station LS3 where the associated detent actuator 64 is caused to effect interlocking and release of the cooperat-

ing detent parts or devices on the side walls 46 and 20 of the shadow mask 12 and face plate 14 at the rear of the assembly jig 10.

The three detent-actuators 64 are identical and, therefore, a description of one will suffice for all. Each detent-actuator 64 is in the form of a composite arm which is comprised of a block-like body portion 120 (see FIG. 7) having at its proximate end a split bore 122 which is secured by a clamping screw 124 to the associated shaft 100 or 104, as the case may be. The distal end of the block-like body portion 120 carries a generally L-shaped plate 126 which is secured in position by screws 128 and has an inturned pressing finger 130 which is engageable with the associated detent arm 36, 38 or 40, as the case may be, on the shadow mask 12 for pressing the same inwardly to clear the cooperating locking pin on the glass face plate 14 during assembly or disassembly operations as previously described. The pressing finger 130 makes sliding engagement with its associated detent arm and, accordingly, to prevent binding and enhance the sliding motion of the finger, the operative pressing surface thereof is rounded as indicated at 132.

The operating lever 62 is provided at its proximate end with a bore 134 and is fixedly secured to the right-hand end of the shaft 100 by a pin 136. The disposition of the lever 62 and of the three detent-actuators 64 is such that when the handle is swung rearwards to the raised position wherein it is shown in full lines in FIG. 1 and dotted lines in FIG. 5, the three detent-actuators 64 will assume substantially prone inoperative or retracted positions wherein they are moved out of the locking stations LS1, LS2 and LS3. When the lever 62 is swung forwards to the full-line position of FIG. 5, the three detent-actuators 62 are caused to swing upwards to substantially vertical positions as shown in FIGS. 4, 5 and 7 and, in so swinging, they are projected into the locking stations and make such sliding engagement with the detent arms 36, 38 and 40 on the shadow mask 12 as to press such arms inwardly for pin clearance or for detent-unlocking purposes, as previously described.

It has previously been stated that the positions of the detent or locking pins 32 and 34 on the end walls 22 and 24 of the glass picture tube face plate 14 may vary slightly due to manufacturing tolerances. Thus, an occasion may arise where, if a given face plate were to be seated upon the four supporting posts 96, the pins 32 and 34 may be disposed below the level of the holes 60 in the distal end sections 58 of the associated detent arms 38 and 40 with the result that improper pin and hole registry obtains. To remedy such a situation, the combined guide posts and pin supports 66 are provided. Accordingly, each combined guide post and pin support 66 is in the form of a block-like member, one end of which is pivoted on a horizontal stud 138 (see FIGS. 5, 7 and 9) so that the member (combined guide post and pin support) is capable of swinging movement between a retracted inclined inoperative position wherein it rests against the adjacent detent actuator 64 as shown in dotted lines in FIG. 5 and in full lines in FIG. 9, and an extended or raised substantially vertical operative position wherein it is best shown in full lines in FIGS. 5 and 6. The raised operative position of each guide post and pin support 66 is determined by the provision of a horizontal stop screw 139 (see FIGS. 1, 3, 5 and 7), such screw being threadably received in a supporting block 140 which is secured by screws 141 to the adjacent end edge of the face plate 70.

The upper or distal end of each combined guide post and pin support 66 is formed with an outwardly projecting extension 142 of reduced thickness; and the upper or outer edge of such extension provides a cradle 144 which is adapted to receive thereon one of the locking pins 32 or 34, as the case may be, when the combined guide post and pin support 66 is in its fully raised operative position. Motivation of the two combined guide post and pin supports 66 is derived from the motion of

the adjacent detent actuators 64. Accordingly, a transverse thrust pin 166 (see FIGS. 5, 6 and 7) is threadedly received through each combined guide post and pin support 66 and is provided with an enlarged rounded head 168 which is designed for camming engagement with the opposed side of the adjacent detent actuator 64 during the raising movements of the latter. Thus, each time the detent actuators 64 move to their raised position, the two combined guide posts and pin supports 66 are forced from their inclined inoperative positions to their vertical operative positions.

The extreme upper ends 170 of the extensions 142 function as guide posts when the combined guide posts and pin supports 66 are in their raised operative positions and they assist the various edge guides 90 in guiding the glass face plate 14 downwardly during manual manipulation of installation thereof over the shadow mask 12, as well as in guiding the face plate 14 upwardly during manual removal thereof from the assembly jig 10. These extensions 142 enter the confines of the glass face plate 14 and bear outwardly against the inside faces of the end walls 22 and 24 when the face plate is lowered telescopically upon the shadow mask 12.

Restoration of the combined guide posts and pin supports 66 to their inclined inoperative positions wherein they bear against the adjacent detent actuators 64 is effected by means of coil springs 172 (see FIGS. 5, 6 and 7) which are connected at their ends to pins 174 and 175 on the detent actuators and the combined guide posts and pin supports respectively. Thus, upon movement of the detent actuators 64 to their retracted positions, the combined guide posts and pin supports 66 are pulled from their raised operative positions and caused to assume their inclined inoperative positions.

The particular detent actuator 64 at the locking station LS3 (see FIGS. 1 and 4) in the rear region of the jig assembly 10 does not have associated therewith one of the combined guide posts and pin supports 66. As a counterpart of such combined guide posts and pin supports, there is provided a stationary upstanding guide post 176 which has its lower end secured by screws 178 on the outer side face of the bearing block 108. The guide post 176 projects upwardly above the level of the base plate 70 an appreciable distance and is adapted to enter the confines of the inverted glass face plate 14 and bear outwardly against the side wall 20 when the face plate is telescopically received over the shadow mask 12.

From the above description, it is believed that the nature and operation of the present assembly jig 10 will be readily understood and that only a brief description of the operation of the assembly jig will suffice for a full understanding of the invention.

As previously indicated, the assembly jig 10 is operated twice during each of the three primary color phase treatments of the face plate 14 which result in the placement of the three interlaced series or groups of fluorescent dots on the inside of the front wall 16 of the face plate. In each phase, the assembly jig is prepared for reception therein of the shadow mask 12 by swinging the operating lever 62 rearwards to its raised position whereupon the shafts 100 and 104 will be rotated so as to retract the three detent actuators 64 and the two combined guide posts and pin supports 66. The shadow mask 12 is then positioned in the assembly jig where it is supported on the four posts 76 and 82 and located in an exact position by the locating buttons 74. The operating lever 62 is then pulled or swung forwards and the shafts 100 and 104 are thereby actuated to shift the three detent actuators to their raised operative positions wherein they engage the spring-biased detent arms 36, 38 and 40 on the shadow mask and flatten them against the adjacent walls of the shadow mask, thus moving them to a position wherein they will not interfere with the locking pins 30, 32 and 34 on the face plate 14 when the latter is telescoped over the shadow mask. At the same time that the detent actu-

ators 64 at the locking stations LS1 and LS2 are moved toward their raised positions, they engage the enlarged heads 168 of the thrust pins 166 and force the two combined guide posts and pin supports to swing upwards to their raised operative positions with the result that the cradles 144 that are associated therewith move to positions wherein they will receive the detent or locking pins 32 and 34 on the glass face plate 14 when the latter is positioned over the shadow mask and accurately align these pins with the holes 60 in the distal end sections 58 of the associated detent arms 38 and 40. The glass face plate 14 is then manually positioned over the shadow mask 12. If proper manufacturing tolerances obtain, the face plate will be supported upon the four posts 96, but if either of the detent or locking pins 32 and 34 assumes an elevation lower than its intended elevation, such pin will come to rest upon the adjacent cradle 144 and thus be maintained in accurate register with its associated and cooperating detent arm on the shadow mask 12. The actuating lever 62 is then again swung rearwards so that the shafts 100 and 104 are rotated so as to retract the three detent actuators 64 and thereby release the three detent arms 36, 38 and 40, thus causing interlocking thereof with the detent or locking pins 30, 32 and 34 to the end that the shadow mask 12 becomes fixedly secured within the face plate 14. The assembly of the face plate and its contained shadow mask is then lifted from the assembly jig and subjected to photographic exposure or any other operation. After photographic exposure, the assembly of the face plate and its contained shadow mask are returned to the assembly jig for unlocking and separation purposes. The assembly is restored to the assembly jig in the same position that it assumed at the time it was removed therefrom and the operating lever 62 is again pulled forwards so that the detent actuators 64 and pivoted combined guide posts and pin supports 66 are raised, thus flexing the three detent arms 36, 38 and 40 to their out-of-the-way positions where they release the detent and locking pins 30, 32 and 34, respectively, so that the glass face plate 14 is free to be raised from the assembly jig, leaving the shadow mask 12 in position thereon.

The invention is not to be limited to the exact arrangement of parts shown in the accompanying drawings or described in this specification as various changes in the details of construction may be resorted to without departing from the spirit or scope of the invention. Therefore, only insofar as the invention has particularly been pointed out in the accompanying claims is the same to be limited.

Having thus described the invention what I claim as new and desire to secure by Letters Patent is:

1. An assembly jig for effecting application of a shadow mask to a color television picture tube face plate during an assembly operation, and subsequent removal of such shadow mask from the face plate during a subsequent disassembly operation, the shadow mask and face plate being provided with walls which remain spaced from each other when the application is effected, the wall of the face plate being provided with a plurality of inwardly projecting fixed detent pins thereon, the wall of the shadow mask being provided with a corresponding number of spring-biased cooperating locking detent arms movable when the shadow mask is disposed on the face plate between normal operative locking positions wherein they engage the detent pins in locking relationship and inoperative out-of-the-way positions wherein they release the detent pins, said assembly jig comprising: means for positioning and supporting the shadow mask, and thereafter positioning and supporting the face plate when the latter is received over the shadow mask during the assembly operation, a plurality of detent actuators, one for each detent arm on the shadow mask, and movable between retracted positions wherein they are out of engagement with the detent arms on the shadow mask, and

advanced positions wherein they engage the detent arms and move them to their out-of-the-way positions to allow the face plate to be telescoped over the shadow mask during the assembly operation and removed from the shadow mask during the subsequent disassembly operation, and means for moving said detent actuators between their retracted and their advanced positions.

2. An assembly jig as set forth in claim 1, and wherein the detent actuators are in the form of elongated arms having their proximate ends pivotally attached to the base plate and their distal ends slidably engageable with their respective detent arms on the shadow mask during movement of the detent arms toward their final operative advanced positions for depressing said arms to their inoperative out-of-the-way positions.

3. An assembly jig as set forth in claim 1, and including, additionally, a series of four vertically adjustable upstanding supporting posts mounted on said base plate and engageable with the open rim of said face plate for supporting and prepositioning the same to attain approximate horizontal registry between the detent pins on the face plate and their respective detent arms.

4. An assembly jig as set forth in claim 1, wherein the detent arms on the shadow mask are in the form of inherently-biased spring-pressed arms having detent holes in the distal ends thereof for reception therein of said detent pins, and wherein the detent actuators are in the form of elongated arms having their proximate ends pivotally attached to the base plate and having their distal ends slidably engageable with their respective detent arms on the shadow mask during movement thereof toward their final operative advanced positions for depressing said latter arms to their inoperative out-of-the-way positions, said assembly jig further including a series of four vertically adjustable upstanding supporting posts mounted on the base plate and engageable with the open rim of said face plate for supporting and prepositioning the same to attain proximate register between the detent pins on the face plate and the holes in their respective detent arms.

5. An assembly jig for effecting rim-to-rim telescopic application of a photographic shadow mask to a color television picture tube face plate during an assembly operation, and subsequent removal of such shadow mask from the face plate during a subsequent disassembly operation, the shadow mask and face plate being provided with walls which remain spaced from each other when the application is effected, the wall of the face plate being provided with a plurality of inwardly projecting fixed detent pins thereon, the wall of the shadow mask being provided with a corresponding number of spring-biased cooperating locking detent arms movable when the shadow mask is disposed on the face plate between normal operative locking positions wherein they engage the detent pins in locking relationship and inoperative out-of-the-way positions wherein they release the detent pins, said assembly jig comprising: a base plate adapted initially to receive, preposition and support the shadow mask thereon, and thereafter receive and support the subsequently positioned face plate thereon when the latter is received on the shadow mask during the assembly operation, a plurality of detent actuators mounted on the base plate, one for each detent arm on the shadow mask, and movable between inoperative retracted positions wherein they are out of engagement with the detent arms on the prepositioned shadow mask, and operative advanced positions wherein they engage the detent arms and move them to their inoperative out-of-the-way positions to allow the face plate to be positioned on the shadow mask during the assembly operation and removed from the shadow mask during the subsequent disassembly operation, a plurality of pin supports mounted on the base plate, one for each detent pin on the face plate, and movable between retracted positions wherein they are out of register with their respective detent pins when the face plate is posi-

tioned on the base support and operative pin-supporting positions wherein they are in such register, means for moving said detent actuators between their retracted and their advanced positions, and means for moving said pin supports simultaneously between their retracted and their operative pin-supporting positions.

6. An assembly jig as set forth in claim 5 and wherein said means for moving the pin supports comprises inter-engaging means on the detent actuators and pin supports for translating movement of the former to the latter.

7. An assembly jig as set forth in claim 5 and wherein the detent actuators are in the form of elongated arms having their proximate ends pivotally attached to the base plate and having their distal ends slidably engageable with their respective detent arms on the shadow mask during movement of the detent arms toward their final operative advanced positions for depressing said arms to their inoperative out-of-the-way positions.

8. An assembly jig as set forth in claim 5, wherein the detent actuators are in the form of elongated arms having their proximate ends pivotally attached to the base plate and having their distal ends slidably engageable with their respective detent arms on the shadow mask during movement of the detent arms toward their final operative advanced positions for depressing said arms to their inoperative out-of-the-way positions, and wherein said means for moving the pin supports comprises inter-engaging means on the detent actuators and pin supports for translating movement of the former to the latter.

9. An assembly jig as set forth in claim 5, wherein the detent actuators are in the form of elongated arms having their proximate ends pivotally attached to the base plate and having their distal ends slidably engageable with their respective detent arms on the shadow mask during movement of the detent arms toward their final operative advanced positions for depressing said arms to their final out-of-the-way positions, and wherein said pin supports likewise are in the form of elongated arms having their proximate ends pivotally attached to the base plate and having at their distal ends supporting shoulders for the detent pins, said pin supports, when in their retracted positions, being positioned in the paths of movement of the detent actuators and being engageable by the latter when the same are moved toward their advanced positions, for movement in unison therewith toward their pin-supporting positions.

10. An assembly jig for effecting rim-to-rim telescopic application of a photographic shadow mask to a similarly inverted cup-shaped color television picture tube face plate during an initial assembly operation, and subsequent removal of such shadow mask from the face plate during a subsequent disassembly operation, the shadow mask and face plate being provided with continuous depending marginal walls which remain spaced from each other when the application is effected, the marginal wall of the face plate being provided with a plurality of inwardly projecting fixed detent pins thereon, the marginal wall of the shadow mask being provided with a corresponding number of spring-biased cooperating locking detent arms movable when the shadow mask is disposed within the face plate between normal operative locking positions wherein they engage the detent pins in locking relationship and inoperative out-of-the-way positions wherein they release said detent pins, said assembly jig comprising: a flat substantially rectangular horizontal base plate adapted initially to receive, preposition and support the shadow mask thereon, and thereafter receive, preposition and support the subsequently applied face plate thereon when the latter is telescopically received over the shadow mask during the assembly operation, a main shaft mounted for rotation about an axis on said base plate and having its opposite ends overhanging a pair of opposed side edges of the base plate, a take-off shaft similarly mounted on the base plate and having one end overhanging an edge of the base plate, means operatively

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connecting the other end of the take-off shaft to the main shaft for rotation in unison therewith, a detent actuator mounted on each overhanging end of each shaft and movable between an inoperative retracted position wherein it is out of engagement with a respective detent arm on the shadow mask and an operative advanced position wherein it engages the detent arm and moves it to its inoperative out-of-the-way position to allow the face plate to be telescoped over the shadow mask during the assembly operation, and removed from the shadow mask during the subsequent disassembly operation, and an operating lever disposed on the overhanging end of one of said shafts.

11. An assembly jig as set forth in claim 10, wherein said operating lever is disposed on one end of the main shaft, wherein the take-off shaft extends at a right angle to the main shaft, and wherein the means for connecting the take-off shaft to the main shaft for rotation in unison therewith comprises a pair of mating bevel gears on the two shafts.

12. An assembly jig for effecting rim-to-rim telescopic application of an inverted cup-shaped generally rectangular photographic shadow mask to a similarly inverted cup-shaped generally rectangular color television picture tube face plate during an assembly operation, and subsequent removal of such shadow mask from the face plate during a subsequent disassembly operation, the shadow mask and face plate being provided with continuous depending marginal walls which remain spaced from each other when the application is effected, the marginal wall of the face plate being provided with a plurality of inwardly projecting fixed detent pins thereon, the marginal wall of the shadow mask being provided with an intumed lower rim flange having a pair of spaced apart locating holes formed therein and with a corresponding number of spring-biased cooperating locking detent arms movable when the shadow mask is disposed within the face plate between normal operative locking positions wherein they engage the detent pins in locking relationship and inoperative out-of-the-way positions wherein they release said detent pins, said assembly jig comprising: a base plate adapted initially to receive, preposition and support the inverted shadow mask thereon, and thereafter receive, preposition and support the subsequently applied inverted face plate thereon when the latter is telescopically received over the shadow mask during the initial assembly operation, a series of four spaced apart upstanding supporting posts on said base plate end engageable with the intumed lower rim flange on the shadow mask for supporting the latter on the base plate, the upper ends of two of said posts being provided with locating buttons thereon designed for entry into said holes in the rim flange for locating the shadow mask in its prepositioned relationship on the base plate, a second series of vertically adjustable spaced apart upstanding supporting posts on the base plate and engageable with the open rim of the face plate for supporting and prepositioning the same to attain approximate horizontal registry between the detent pins on the face plate and their respective detent arms, a plurality of pin supports mounted on the base plate, one for each detent pin on the face plate, and movable between retracted positions wherein they are out of vertical register with their respective detent pins when the face plate is positioned on the base support and operative pin-supporting positions wherein they are in such vertical register, a plurality of detent actuators mounted on the base plate, one for each detent arm on the shadow mask, and movable between inoperative retracted positions wherein they are out of engagement with the detent arms on the prepositioned shadow mask, and operative advanced positions wherein they engage the detent arms and move them to their inoperative out-of-the-way positions to allow the face plate to be telescoped over the shadow mask during the initial assembly operation and removed from the shadow mask dur-

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ing the subsequent disassembly operation, means for moving said detent actuators simultaneously between their retracted and their advanced positions, and means for moving said pin supports simultaneously between their retracted and their operative pin-supporting positions.

13. An assembly jig as set forth in claim 12 and wherein the means for moving the pin supports comprises interengaging means on the detent actuators and pin supports for translating movement of the former to the latter.

14. An assembly jig as set forth in claim 12 wherein the detent actuators are in the form of elongated arms having their proximate ends pivotally attached to the base plate and having their distal ends slidably engageable with their respective detent arms on the shadow mask during movement of the detent arms toward their final operative advanced positions for depressing said arms to their final out-of-the-way positions, and wherein said pin supports likewise are in the form of elongated arms having their proximate ends pivotally attached to the base plate and having at their distal ends supporting shoulders for the detent pins, said pin supports, when in their retracted positions, being positioned in the paths of movement of the detent actuators and being engageable by the latter when the same are moved toward their advanced positions for movement in unison therewith toward their pin-supporting positions.

15. An assembly jig for effecting rim-to-rim telescopic application of an inverted cup-shaped photographic shadow mask to a similarly inverted cup-shaped color television picture tube face plate during an assembly operation, and subsequent removal of such shadow mask from the face plate during a subsequent disassembly operation, the shadow mask and face plate being provided with continuous depending marginal walls which remain spaced from each other when the application is effected, the marginal wall of the face plate being provided with a plurality of inwardly projecting fixed detent pins thereon, the marginal wall of the shadow mask being provided with a corresponding number of spring-biased cooperating locking detent arms movable when the shadow mask is disposed within the face plate between normal operative locking positions wherein they engage the detent pins in locking relationship and inoperative out-of-the-way positions wherein they release said detent pins, said assembly jig comprising: a base plate adapted initially to receive, preposition and support the inverted shadow mask thereon, and thereafter receive, preposition and support the subsequently applied inverted face plate thereon when the latter is telescopically received over the shadow mask during the initial assembly operation, a plurality of combined guide posts and pin supports mounted on the base plate, one for each detent pin on the face plate, and movable between retracted positions wherein they are out of vertical register with their respective detent pins when the face plate is positioned on the base support and operative pin-supporting positions wherein they are in such vertical register, said combined guide posts and pin supports being in the form of elongated arms having their proximate ends pivotally attached to the base plate and having at their distal ends supporting shoulders for the detent pins, the distal ends of said elongated arms also being provided with upward extensions which serve as guide posts when the combined guide post and pin supports are in their operative pin-supporting positions, a plurality of detent actuators mounted on the base plate, one for each detent arm on the shadow mask, and movable between inoperative retracted positions wherein they are out of engagement with the detent arms on the prepositioned shadow mask, and operative advanced positions wherein they engage the detent arms and move them to their inoperative out-of-the-way positions to allow the face plate to be telescoped over the shadow mask during the assembly operation, means for moving said detent actuators between their retracted and their advanced positions, and means for moving said combined guide posts

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and pin supports simultaneously between their retracted and their operative pin-supporting and guiding positions.

16. An assembly jig as set forth in claim 15 and wherein said means for moving the combined guide posts and pin supports comprises interengaging means on the detent actuators and the combined guide posts and pin supports for translating movement of the former to the latter.

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