Sept. 30, 1969 G. C. MEETZE, JR 3,469,354

SERVO-SYSTEM AND MULTIPLE-USE BUILDING INCLUDING THE SAME

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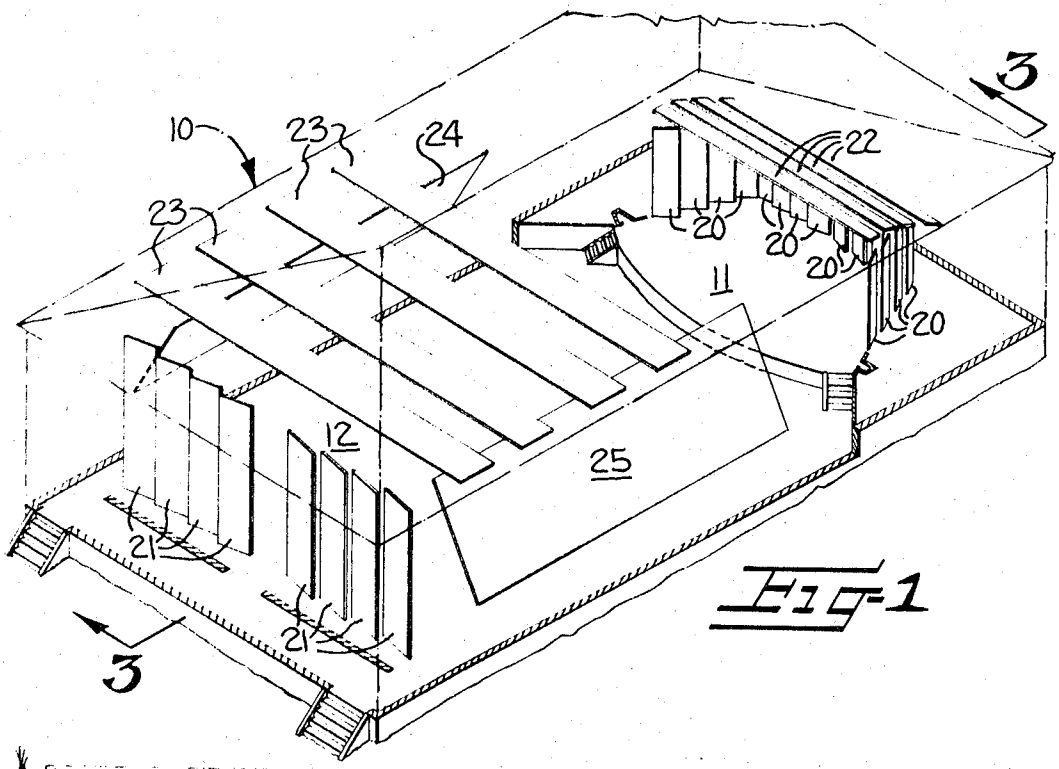


Fig-1

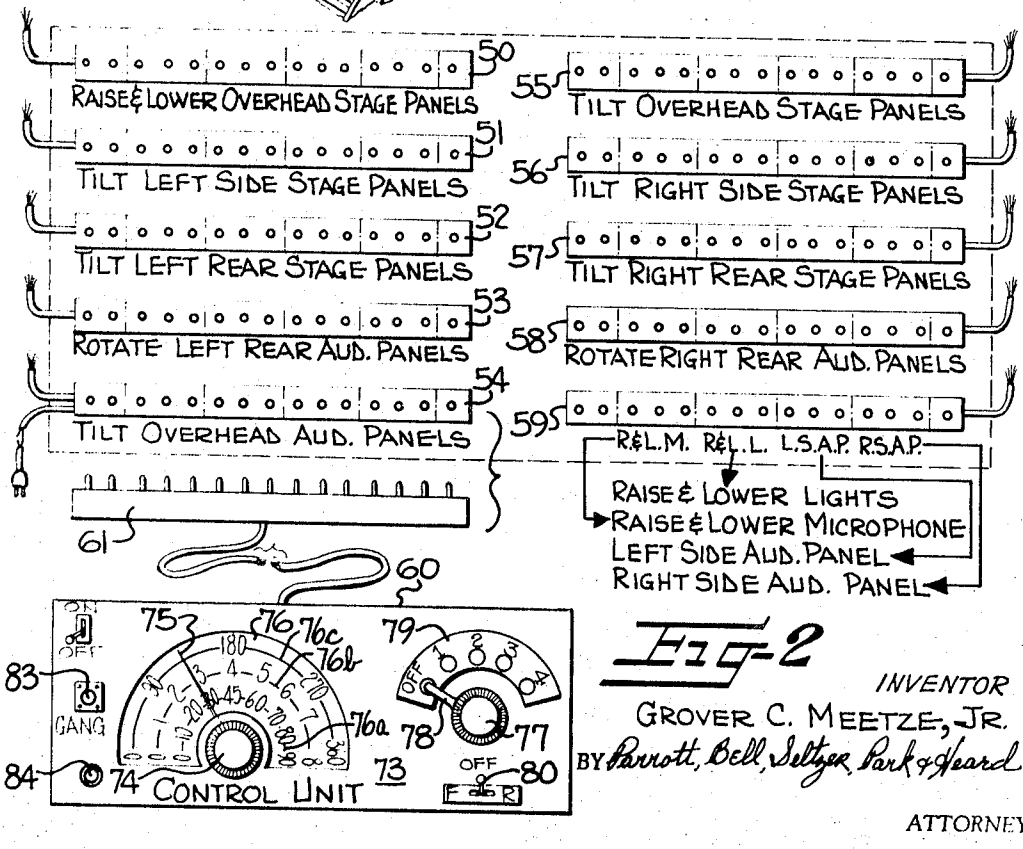


Fig-2

INVENTOR
GROVER C. MEETZE, JR.
BY Parrott, Bell, Seltzer, Park & Heard
ATTORNEYS

Sept. 30, 1969 G. C. MEETZE, JR 3,469,354

SERVO-SYSTEM AND MULTIPLE-USE BUILDING INCLUDING THE SAME

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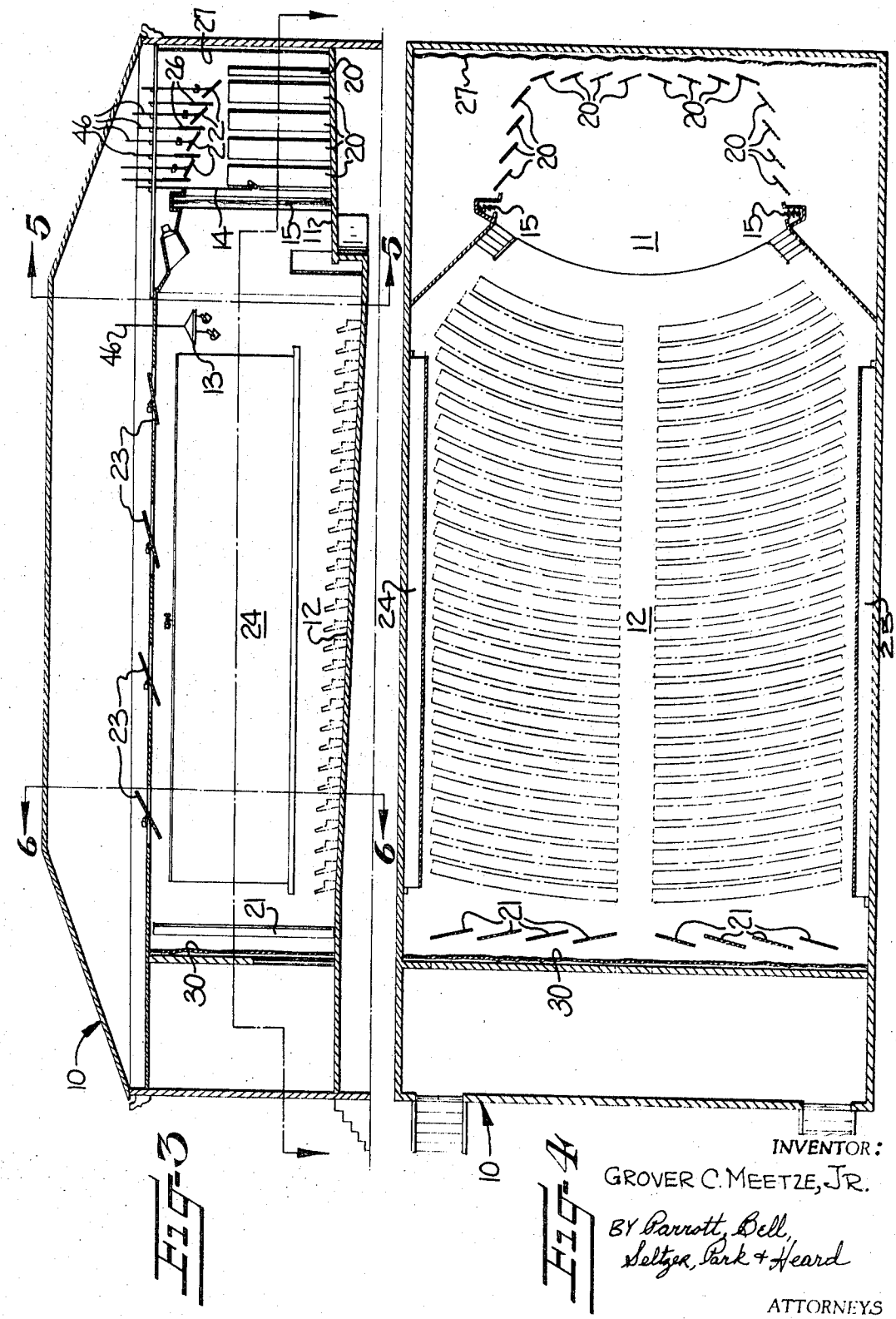


FIG-3

FIG-4

INVENTOR:
GROVER C. MEETZE, JR.
BY Barrett, Bell, Seltzer, Park + Heard
ATTORNEYS

Sept. 30, 1969 G. C. MEETZE, JR 3,469,354

SERVO-SYSTEM AND MULTIPLE-USE BUILDING INCLUDING THE SAME

Filed Nov. 18, 1966 8 Sheets-Sheet 3

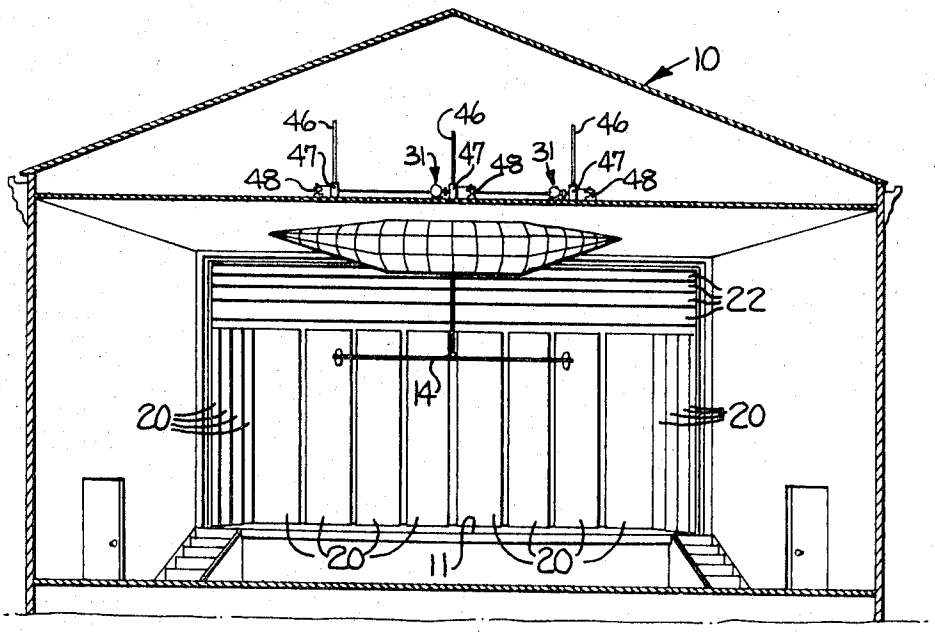


Fig-5

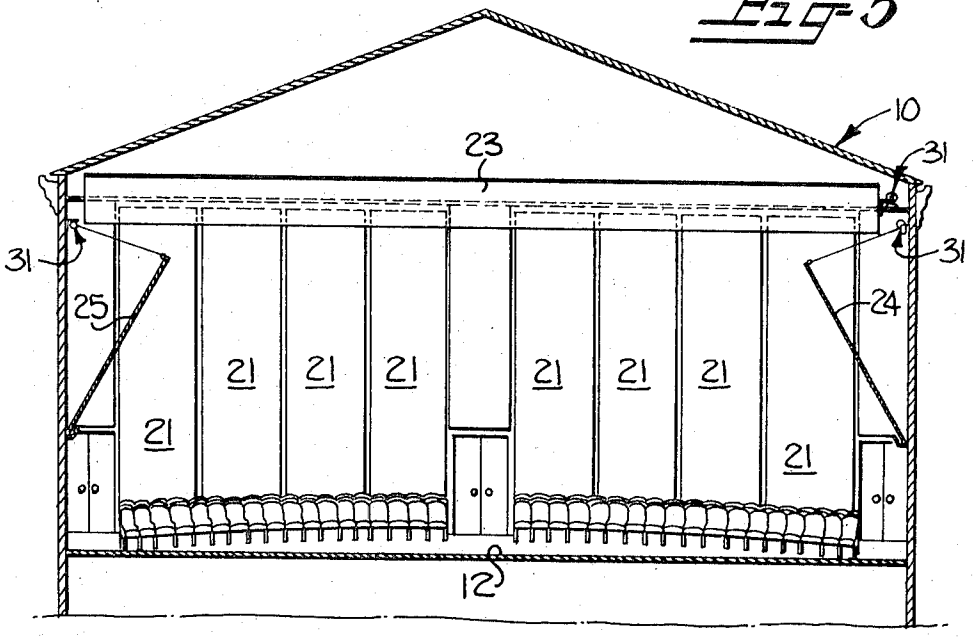


Fig-6

INVENTOR:
GROVER C. MEETZE, JR.

BY Parrott, Bell, Seltzer, Park & Heard

ATTORNEYS

Sept. 30, 1969 G. C. MEETZE, JR 3,469,354

SERVO-SYSTEM AND MULTIPLE-USE BUILDING INCLUDING THE SAME

Filed Nov. 18, 1966 8 Sheets-Sheet 4

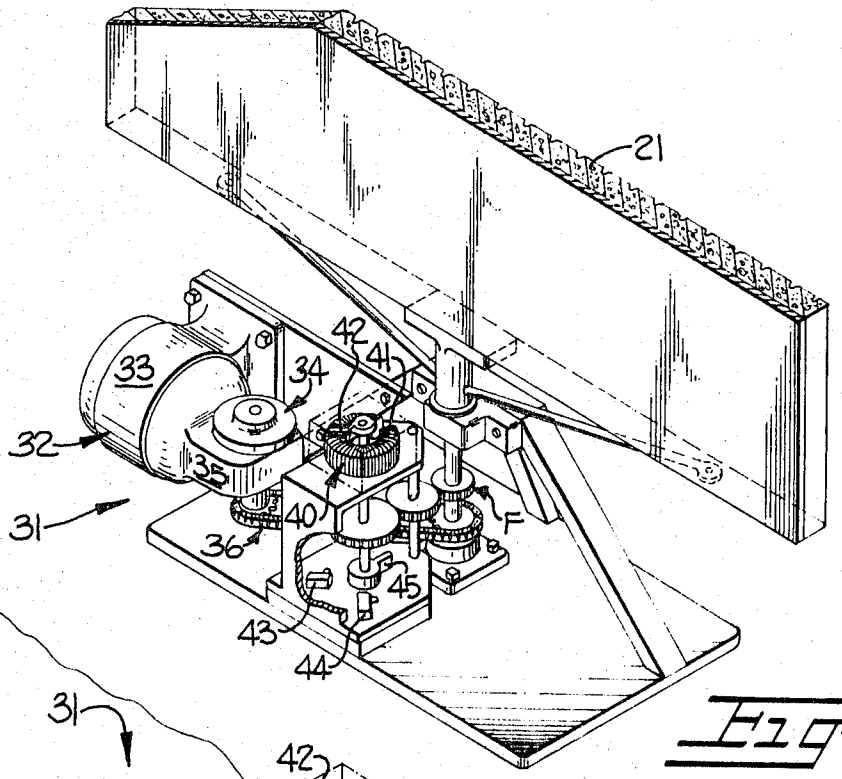


Fig-7

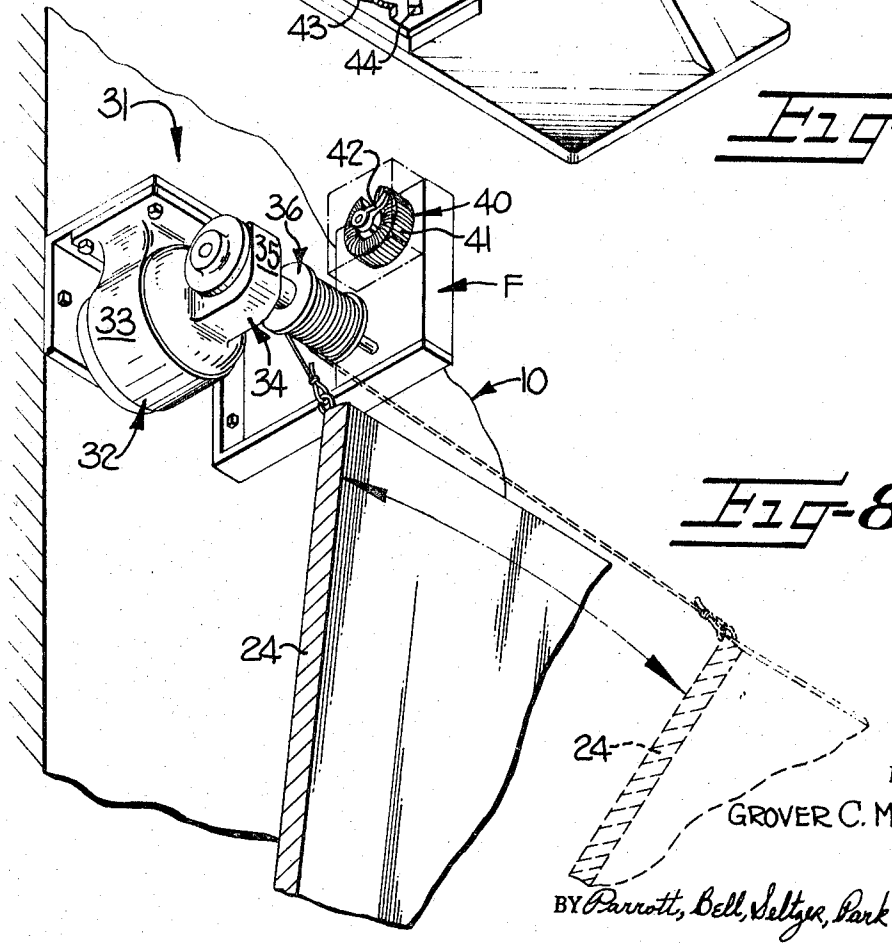


Fig-8

INVENTOR:
GROVER C. MEETZE, JR.

BY Parrott, Bell, Seltzer, Park & Heard

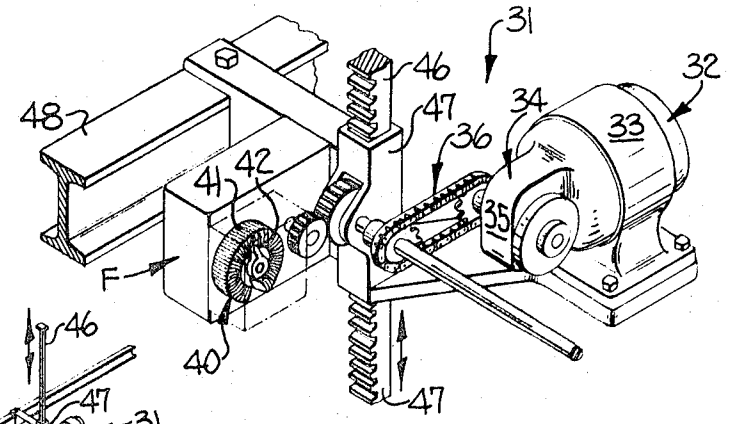
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Sept. 30, 1969 G. C. MEETZE, JR 3,469,354

SERVO-SYSTEM AND MULTIPLE-USE BUILDING INCLUDING THE SAME

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Fig-10



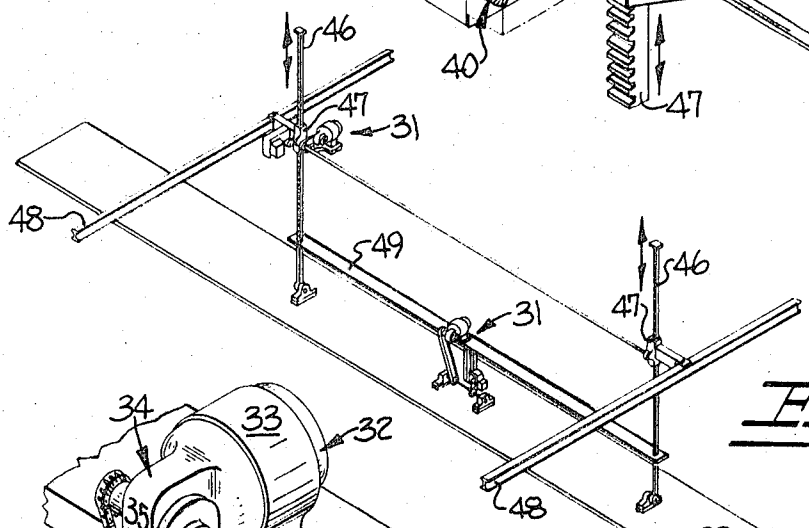
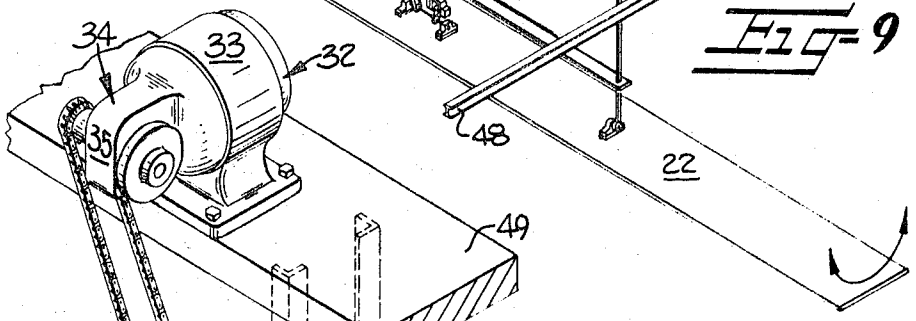


Fig-9



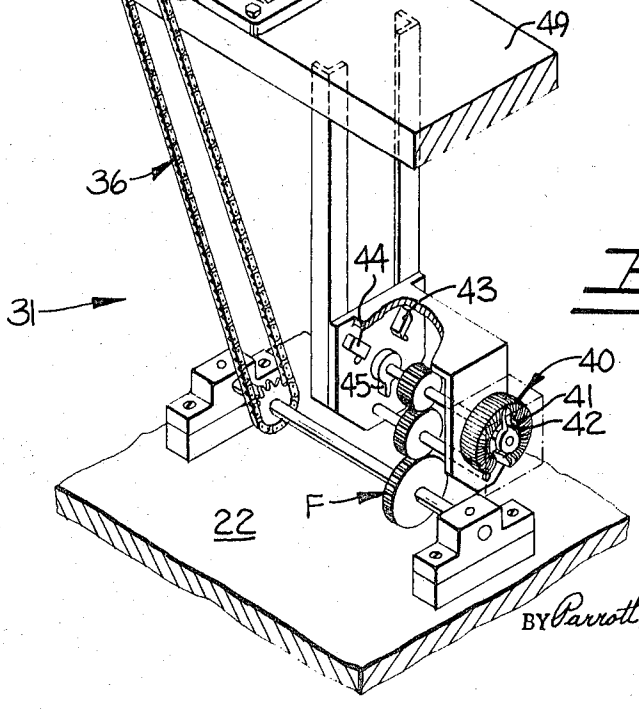


Fig-11

INVENTOR:
GROVER C. MEETZE, JR

BY Parrott, Bell, Seltzer, Park & Heard

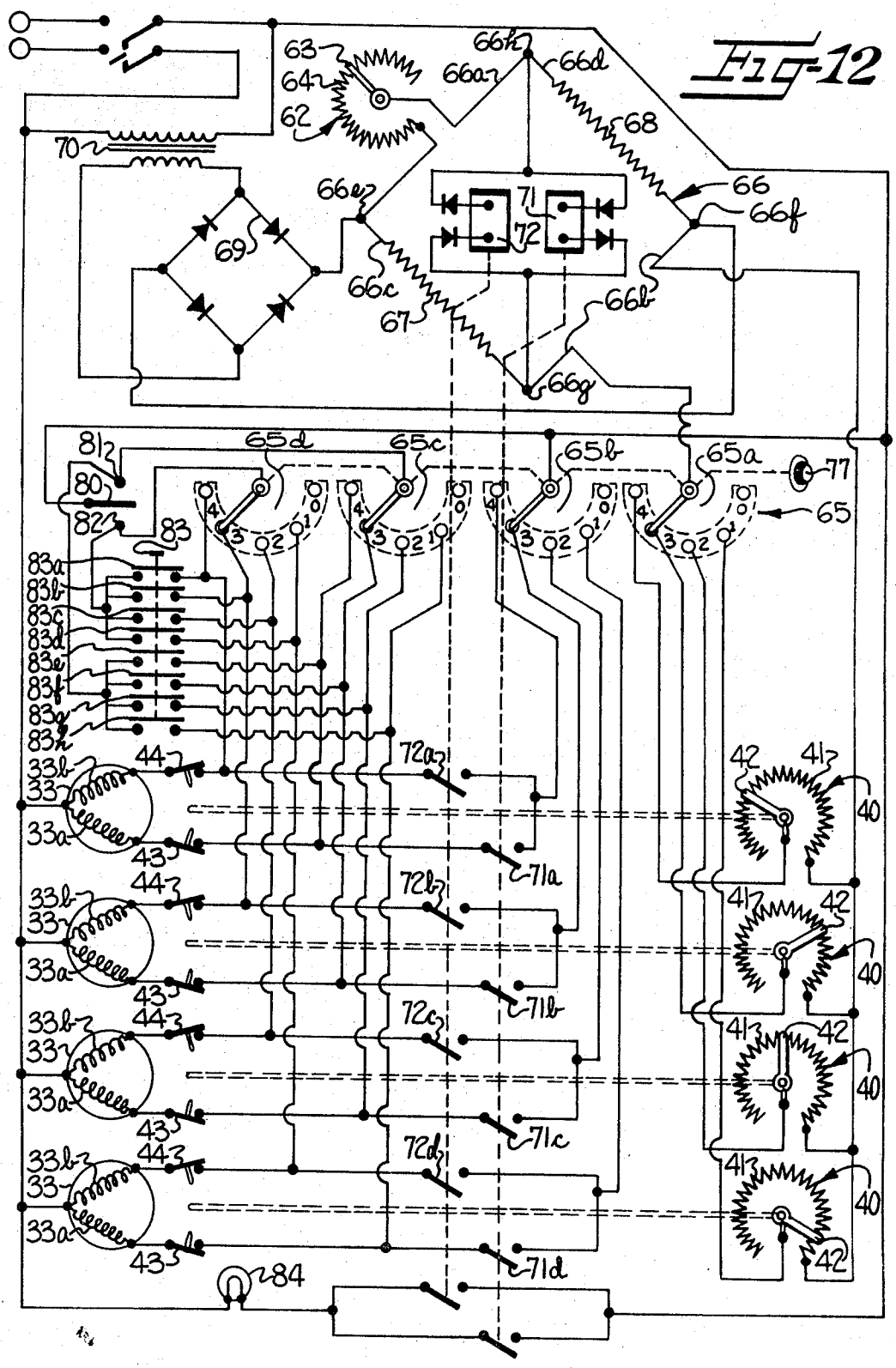
ATTORNEYS

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SERVO-SYSTEM AND MULTIPLE-USE BUILDING INCLUDING THE SAME

Filed Nov. 18, 1966 8 Sheets-Sheet 6

Fig-12



Sept. 30, 1969 G. C. MEETZE, JR 3,469,354

SERVO-SYSTEM AND MULTIPLE-USE BUILDING INCLUDING THE SAME

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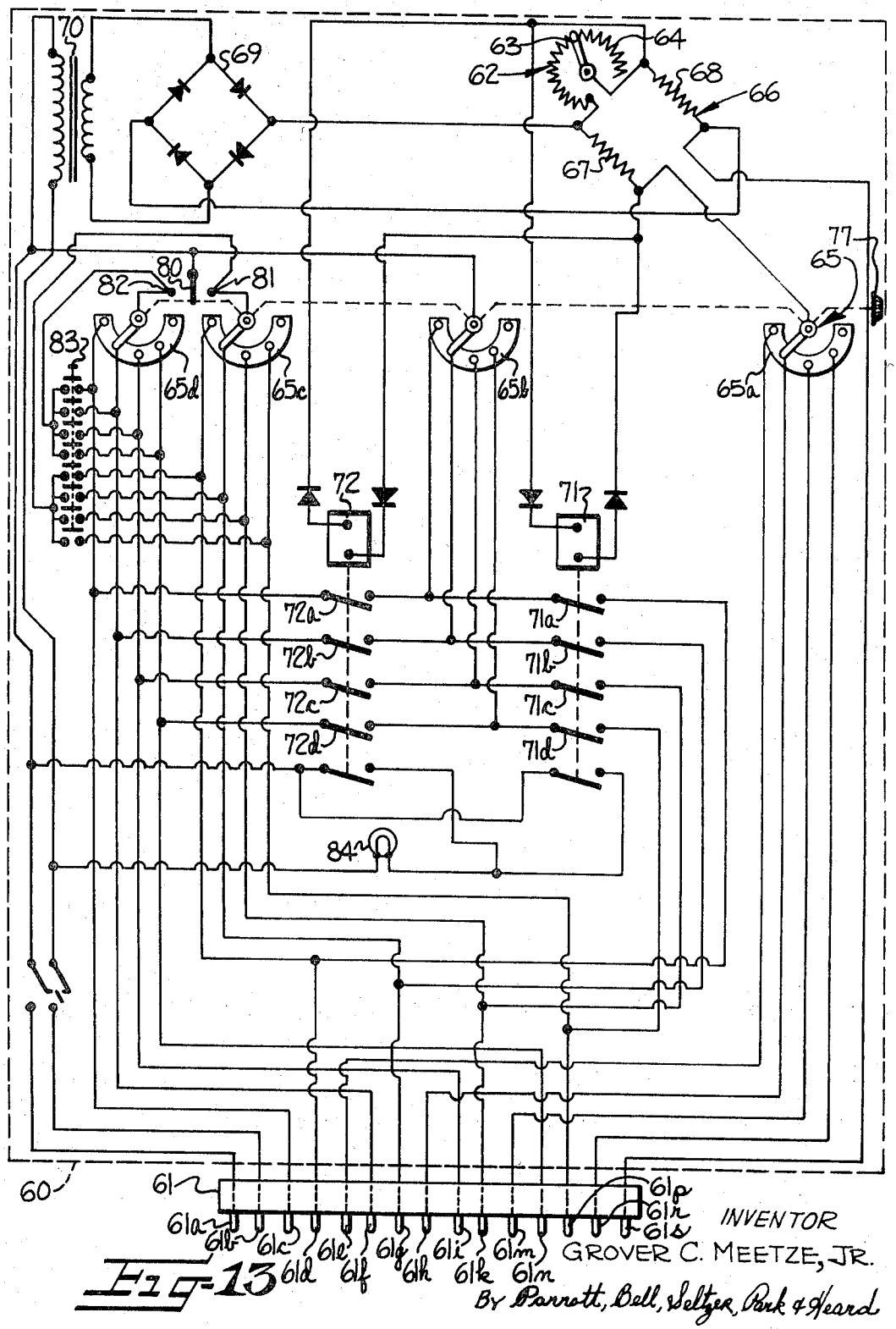


Fig-13

INVENTOR
GROVER C. MEETZE, JR.
By Parrott, Bell, Seltzer, Park & Heard
ATTORNEYS

SERVO-SYSTEM AND MULTIPLE-USE BUILDING INCLUDING THE SAME

Filed Nov. 18, 1966 8 Sheets-Sheet 8

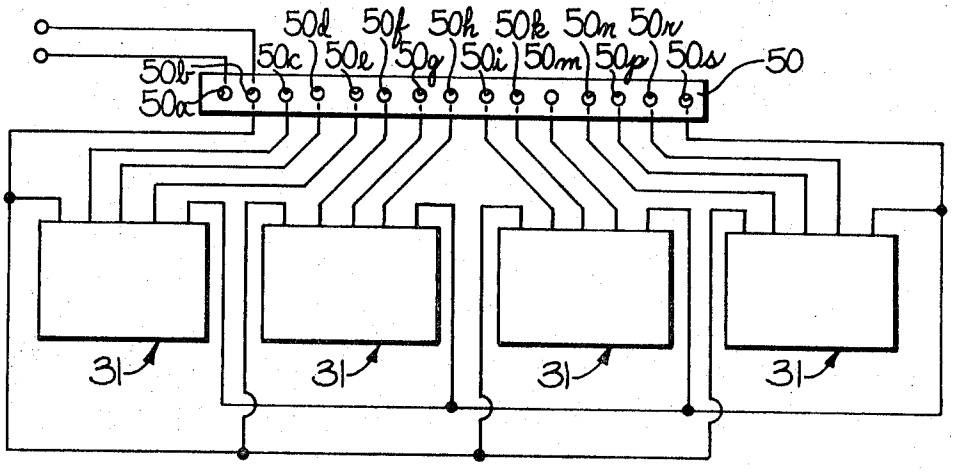


Fig-14

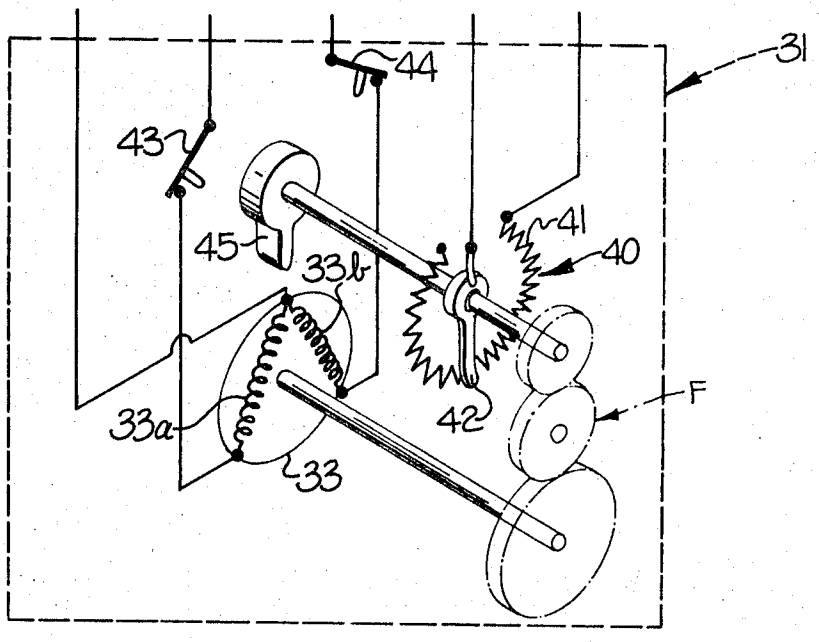


Fig-15

INVENTOR:
GROVER C. MEETZE, JR.

BY Parrott, Bell, Seltzer, Park & Heard
ATTORNEYS

United States Patent Office 3,469,354 Patented Sept. 30, 1969

3,469,354

SERVO-SYSTEM AND MULTIPLE-USE BUILDING INCLUDING THE SAME

Grover C. Meetze, Jr., 104 Hillside Drive, Davidson, N.C. 28036

Filed Nov. 18, 1966, Ser. No. 595,399
Int. Cl. E04h 3/24; E04b 1/99; F21p 5/02
U.S. Cl. 52—1 11 Claims

This invention relates to a servo-system for selectively moving and positioning a plurality of devices or accessories one at a time and independently of each other and more particularly to a multiple-use building or space therewithin, such as an auditorium, having movable accessories and the aforementioned servo-system for selectively moving and positioning these accessories to vary the acoustical, lighting and/or other characteristics of the building.

Ideally, each type of activity involving the attendance of an audience should take place in a building or space within a building, such as an auditorium, especially designed as to the acoustical, lighting and other characteristics thereof for that specific type of activity for optimum performance of the activity and enjoyment of the audience. In this respect, the building characteristics, such as reverberation time, flutter, echo, sound absorbency and other acoustical characteristics, as well as the placement of microphones, lights, curtains and other accessories, should vary in accordance with the type of activity to be presented.

For economical and other equally cogent reasons, most buildings must be designed to accommodate, at various times, a large variety of types of activities, and such buildings are referred to herein as "multiple-use building." Accordingly, the characteristics of the building may not be designed specifically for one particular type of activity, but must be designed for the large variety of types of activities for which the building may be used. Historically, such buildings have been constructed with "average" characteristics which permit use of the building for a large variety of activities, but, unfortunately, are not optimum for any of the activities.

More recently, it has been proposed that the characteristics of such buildings or auditoriums be varied by providing movable accessories at strategic points about the building. For example, multiple and diverse lights, including movable flood and spot lights, are commonly used. Also, movable acoustical members, such as panels, curtains and the like, and movable mirophones are frequently utilized to vary the acoustical characteristics of such buildings.

While these movable accessories have materially increased the quality of the characteristics of such buildings for the various types of activities taking place therein, the same have many serious deficiencies, particularly in the proper positioning thereof for optimum utilization thereof for the various activities. In this respect, certain buildings have heretofore relied solely upon the manual positioning of these accessories to approximate positions thought to provide the desired characteristics. Such manual positioning is inefficient and most often inaccurate, and thereby results in less than optimum settings of the accessories. Moreover, it is not feasible that any substantial manual adjustment of these accessories be made during performance of the featured activity, as is most desirable for certain performances such as an orchestra rendition, wherein certain passages or movements of the rendition are tonally enhanced through adjustment of the acoustical accessory panels to obtain complementary acoustical responses of the building.

Other buildings have heretofore mechanized some of these movable accessories such as acoustical panels, and two general types of controls have been provided therefor, the most common of which is a gang type of control wherein a group of the panels are interconnected and move as a uint, and the second of which is an individual control for each panel. In each instance, the controls are located at a central control point remote from the panels.

While such mechanization provides decided advantages over the aforementioned manual positioning of the panel accessories, such controls have serious limitations which have limited their acceptance and use. For example, with the gang control, it is not possible to adjustably control the positional relationship between panels in a group and hence considerable flexibility in the variance of the characteristics of the building is lost. The individual controls, while permitting each panel to be positioned independently, still relies upon the skill and knowledge of the operator, and is subject to his errors in judgement and manipulation of the accessories and therefore does not permit the variance of the characteristics of the building to be fully exploited. Further, it requires a large control unit, and therefore a large amount of space at the control point, which is very expensive.

It is therefore an object of the present invention to provide a servo-system for independently controlling the positioning of each of a plurality of movable devices, such as acoustical, lighting and other accessories of a multiple-use building, and wherein the desired position for each devices may be preselected or predetermined and the device is accurately positioned in accordance therewith.

It is a more specific object of the present invention to provide a multiple-use building or auditorium in which the performance characteristics of the building may be varied to be optimum for each of the variety of activities which are to take place therein and in which the aforementioned problems and deficiencies encountered with previous buildings of this type are obviated.

A further more specific object of the present invention is to provide a building of the character described wherein the acoustical, lighting, and other characteristics of the building may be varied to be optimum for each of a variety of activities and wherein these variable characteristics are achieved by use of a plurality of movable accessories under the control of a servo-system by which the positioning of each accessory may be predetermined for optimum utilization thereof.

Some of the objects of the invention having been stated, other objects will appear as the description proceeds when taken in connection with the accompanying drawings, in which:

FIGURE 1 is a diagrammatic perspective view of a building provided with a plurality of movable accessories for varying the characteristics of the building;

FIGURE 2 is a functional schematic view of a portion of a servo-system for controllably varying the position of the movable accessories,

FIGURE 3 is a longitudinal vertical sectional view through the building taken substantially along line 3—3 in FIGURE 1;

FIGURE 4 is a sectional plan view of the building, taken substantially along line 4—4 in FIGURE 3;

FIGURE 5 is a transverse vertical sectional view through one end of the building taken substantially along line 5—5 of FIGURE 3;

FIGURE 6 is a transverse vertical sectional view through the other end of the building taken substantially along line 6—6 of FIGURE 3;

FIGURE 7 is a fragmentary perspective view, showing details of a drive for moving an accessory or panel about a substantially vertical axis;

FIGURE 8 is a view similar to FIGURE 7, showing details of a drive for moving an accessory or panel about a substantially horizontal axis;

FIGURE 9 is a fragmentary perspective view of a panel horizontally mounted overhead of the stage of the building, showing drive means for effecting its movement;

FIGURE 10 is an enlarged fragmentary perspective view showing details of the drive in the left-hand portion of FIGURE 9 for attaining vertical adjustment of the panel;

FIGURE 11 is an enlarged perspective view showing details of the drive in the lower central portion of FIGURE 9 for attaining angular adjustment of the panel about a substantially horizontal axis;

FIGURE 12 is a schematic electrical diagram, showing a preferred electrical relationship of all the elements of a servo-system according to the invention;

FIGURE 13 is an electrical wiring diagram showing those components within the control unit in the lower left-hand portion of FIGURE 2;

FIGURE 14 is an electrical wiring diagram of one of the control stations for a plurality of slave units shown in FIGURE 2; and

FIGURE 15 is a schematic view of the internal wiring of one of the slave units in the control station of FIGURE 14.

Referring more specifically to the drawings, a multiple-use building, generally designated at **10**, is shown in FIGURES 1 and 3–6 as having a performance area or stage **11** adapted for the performance of a variety of activities and an audience area or auditorium **12** adapted to contain or seat an audience for the presentation of the featured activity. Building **10** is provided with a plurality of accessories mounted for movement relative to building **10** to vary the characteristics of the building for optimum performance and enjoyment of each type of activity performed.

It should be understood that the various characteristics of the building, such as acoustical, lighting, etc., desired to be varied will determine, in large part, the type and location of the various accessories. For convenience of discussion and illustration, representative groups of movable acoustical and lighting accessories are shown and described herein, but the present invention should not be considered as being restricted to these particular accessories or to the particular type of building illustrated since the type of building and the type and location of accessories therein can be varied without departing from the scope of this invention.

In the illustrated embodiment, the movable accessories include (FIGURE 3) lighting means **13**, microphone means **14** and stage draw curtains **15**. Lighting means **13** and microprone means **14** are mounted for vertical movement, and draw curtains **15** are mounted for generally horizontal movement, relative to stage **11** in conventional manner, and, while only single units of the lighting means **13** and microphone means **14** are illustrated, it should be understood that these are exemplary only and in most instances multiple units would probably be utilized.

The movable accessories in building **10** also include a variable acoustical system for varying the acoustical characteristics of building **10** and this system is formed of a plurality of movable acoustical members disposed throughout the performance and audience areas **11** and **12** of building **10** and constructed and arranged to provide the desired acoustical characteristics therefor. In the illustrated embodiment, these movable acoustical members include a plurality of generally vertically disposed elongate acoustical panels **20, 21** (FIGURES 1 and 4) respectively arranged around the rear and sides of stage **11** and along the rear of auditorium **12** and each of which is mounted for tilting movement about generally vertical axes. A plurality of horizontally disposed elongate acoustical panels **22, 23** (FIGURES 1 and 4) are respectively arranged above stage **11** and auditorium **12** and extend generally thereacross, and are mounted for tilting movement about generally horizontal axes. Panels **22** above stage **11** are also mounted for independent vertical movement in addition to their tilting movement. Also, generally vertically disposed, elongate acoustical panels **24, 25** are mounted on opposite sides of auditorium **12** for tilting movement about generally horizontal axes.

Each of the panels **20, 21, 22, 23, 24** and **25** may be substantially rectangular, and has at least one surface thereof formed of a material, such as fiber glass or plywood, finished to give the panel a relatively hard and smooth surface which is highly reflective of sound waves. All of the panels, except panels **21** at the rear of auditorium **12**, may have both surfaces formed in this manner, but each of the panels **21** at the rear of auditorium **12** preferably has the other surface thereof constructed of relatively soft and porous sound absorbent material, such as perforated asbestos. Therefore, each of the panels **21** may be rotated about its vertical axis to alternatively present, at selected angles, surfaces of substantially different acoustical characteristics.

The movable acoustical members may also include generally vertically disposed acoustical drop curtains **26** (FIGURE 3) mounted above stage **11** for vertical movement and each being positioned in front of one of the overhead stage panels **22**. Therefore, with the exception of the front drop curtain **26**, each of these curtains is disposed between an adjacent pair of the overhead stage panels **22** for aiding in controlling and varying the acoustical characteristics of building **10**. Also, if desired, stationary acoustical curtains **27, 30** may be respectively positioned at the rear of stage **11** and auditorium **12** behind the vertical acoustical panels **20, 21**. Preferably, the drop curtains **26** and stationary curtains **27, 30** are constructed of a highly sound absorptive material, such as heavy cotton muslin or asbestos cloth.

The present invention provides a servo-system for controllably moving each of the aforementioned movable accesories into any respective desired positioned relationship with the building **10** to vary the characteristics of the building to be optimum for the performance of each particular activity. While this servo-system is shown and will be described in connection with the above-described accessories, it should be understood that the same is not restricted thereto, but may be used to selectively controllably move or position any plurality of movable devices or members one at a time and independently of each other.

This servo-system includes an individual slave unit **31** (FIGURES 7–11 and 15) for controlling the movement of each individual accessory and additionally, individual slave units **31** are provided for controlling each type of movement of an accessory having more than one type of movement. Each slave unit **31** includes a motive means **32** (FIGURES 7–11) for moving the corresponding movable accessory to its various positions and which preferably is in the form of an electric motor **33** and speed reduction means **34** connecting the output of electric motor **33** to the corresponding movable accessory.

Preferably, electric motor **33** is of the reversible type having a forward direction circuit or winding **33*a*** and a reverse direction circuit or winding **33*b*** (FIGURE 15) for moving the corresponding accessory in either of two directions as determined by the particular winding energized. Also, while speed reduction means **34** may be of any desired character, the same is illustrated as being a gear reduction transmission **35** mounted on the output side of electric motor **33** and drive train means **36** connecting the gear reduction transmission **35** to the accessory. For imparting rotary or tilting movement to each of the panels **20, 21, 22** and **23**, drive train means **36** comprises a sprocket and chain drive to a shaft connected to the panel and corresponding to the axis of rotation thereof (FIGURES 7 and 11). In the case of each of the panels **24** and **25** at opposite sides of auditorium **12**, means **36** is illustrated as a winch and cable device

(FIGURE 8). Additionally, for imparting vertical movement to the panels 22 and to the light means 13, microphone means 14 and acoustical drop curtains 26, means 36 is in the form of a gear and sprocket mechanism connecting the gear reduction transmission 35 with an intermediate shaft and a rack and pinion device connecting the intermediate shaft to the accessory (FIGURE 10).

Preferably, some means is provided for maintaining each of the accessories in the position to which it is moved by the corresponding slave unit 31. While this means may be of any desired character, its function is preferably provided by gear reduction transmission 35, which is preferably a worm gear reduction transmission.

Each slave unit 31 also includes a slave reference device 40 which preferably is in the form of a slave variable resistor 41 (FIGURE 15) having a positionally movable member 42 for varying the resistance thereof. The positionally movable member 42 of slave variable resistor 41 has a predetermined range of movement, and a feedback means F connects this positionally movable member 42 to the corresponding accessory for correlated movement of the positionally movable member therewith. Therefore, the positionally movable member 42, by its position, will indicate the corresponding position of the accessory to which it is connected. Preferably, feedback means F comprises a gear train which connects the positionally movably member 42 to the corresponding accessory in such a manner that the positionally movable member 42 moves throughout its full range of movement upon movement of the accessory throughout its full range of movement. In this respect, limit switches 43, 44 (FIGURES 11 and 15) are provided and are associated with an actuator means 45 which is connected to and moves with the positionally movable member 42. These limit switches 43, 44 are connected to the electric motor 33 by suitable wiring and are located at positions corresponding to the limits of the range of movement of the positionally movable member 42 to stop motor 33 when positionally movable member 42 reaches the limits of its range of movement. Therefore, limit switches 43, 44 define the limits of the range of movement of the accessory being moved by the motor 33.

Referring to FIGURE 9, it is noted that the slave unit 31 for controlling the tilting movement of each of the acoustical panels 22 over the stage 11 is mounted so as to be movable vertically with the panel. In this respect, each of the panels 22 is mounted for vertical movement by spaced supporting rods 46 slidably mounted in suitable brackets 47 supported from ceiling structure 48 of the building 10. Motor 33 and slave reference device 40 are suitably mounted on a supporting board 49 mounted at opposite ends on the supporting rods 46.

Conveniently, slave units 31 for a plurality of functionally similar accessories may be interconnected into a slave station broadly designated for control of that function. For example, as seen in FIGURE 2, all of the slave units 31 for raising and lowering the overhead stage panels 22 are interconnected into a slave section 50, while all of the slave units 31 for tilting the left side stage panels 20 are interconnected into a slave station 51. Similar slave stations 52, 53, 54, 55, 56, 57, 58 and 59 are provided for other groups of slave units for controlling various groups of accessories as indicated by the legends in FIGURE 2.

This interconnection of a plurality of slave units 31 into a slave station is illustrated schematically in FIGURE 14 and for convenience of illustration only, each such slave station has been shown as including four (4) slave units 31 but it is apparent that the same could include more or less slave units as desired. Each slave station, as for example slave station 50, is shown as being a female contact board having contacts 50*a* and 50*b* connected to a source of A.C. electrical power. Contact 50*b* is connected by suitable wiring to the winding circuits of the electric motor 33 of each slave unit 31. Contacts 50*c*, 50*d*, 50*e*; 50*f*, 50*g*, 50*h*; 50*i*, 50*k*, 50*m*; and 50*n*, 50*p*, 50*r* are respectively connected to the winding circuits of motor 33 and positionally movable member 42 of the slave units 31. Contact 50*s* is connected to the slave variable resistor 41 of each slave unit 31.

For individually and independently controlling the movement and positioning of each of the movable accessories, the servo-system of the present invention further includes a master control unit 60 (FIGURES 2 and 13) which may be selectively electrically connected to any one of the slave stations 50 through 59. While a cannon plug type connection 61 having contacts 61*a*, 61*b*, 61*c*, 61*d*, 61*e*, 61*f*, 61*g*, 61*h*, 61*i*, 61*k*, 61*m*, 61*n*, 61*p*, 61*r* and 61*s* corresponding to the contacts of the slave stations is shown, it should be understood that any other type of selective interconnection between the master control unit 60 and a selected slave station may be utilized, such as a multi-pole, multi-throw selector shift (not shown).

Master control unit 60 includes a master control device 62 having a positionally adjustable member 63 movable through a predetermined range of movement and having the various positions to which the same may be adjusted correlated to the various positions to which the accessories are movable. Preferably, master control device 62 comprises a master variable resistor 64 having the positionally adjustable member 63 as the wiper arm thereon for varying the resistance thereof.

Master control unit 60 also includes selector means for selectively electrically interconnecting each of the slave reference devices 40 of the slave units 31 connected into a selected slave station to the master control device 62, one at a time and independently of each other. This means preferably is in the form of a multi-pole, multi-position selector switch 65 which is illustrated in the drawing as having four poles or sections 65*a*, 65*b*, 65*c* and 65*d* with each section having five positions numbered 0, 1, 2, 3 and 4. The positions 1, 2, 3 and 4 of switch section 65*a* are electrically connected by suitable wiring to the positionally movable members 42 of the various slave reference devices 40 connected in the selected slave stations. Of course, if more or less slave units were connected in the slave station, the number of positions of the sections of selector switch 65 will be varied accordingly.

The selector switch section 65*b* has the positions 1, 2, 3 and 4 thereof respectively connected by suitable wiring to the forward and reverse direction windings of the electric motors 33 of the slave units 31. The other selector switch sections 65*c* and 65*d* are for control of the slave units separate and apart from the master control device 62 and will be described hereinafter.

Master control unit 60 also includes means for generating an electrical signal in response to a deviation of the positionally movable member 42 of a selected slave reference device 40 connected to the master control device 62 from a predetermined correlated positional relationship with the positionally adjustable member 63 of master control device 62. Preferably, this signal generating means is an electrical comparison circuit for comparing the resistances of the master variable resistor 65 and the slave variable resistor 41 of the selected slave reference device 40. This comparison circuit preferably is a wheatstone bridge circuit 66 which has the master variable resistor 64 connected in a side 66*a* and the selector switch 65 and selected slave variable resistor 41 connected in the electrically opposite side 66*b* thereof. The remaining sides 66*c* and 66*d* have standard matched resistors 67, 68 connected therein.

The wheatstone bridge circuit 66 is preferably D.C. energized across a first pair of opposite corners 66*e* and 66*f* and therefore, these corners are connected by suitable wiring to a standard source of A.C. power through a bridge rectifier 69 and a suitable transformer 70. Accordingly, upon an imbalance between the resistance of

the master variable resistor 64 and that of the selected slave variable resistor 41 due to a deviation from the predetermined positional relationship of the positionally adjustable wiper member 63 of the master variable resistor 64 with the positionally movable member 42 of the slave variable resistor 41, an electrical signal will be generated across the other two opposite corners 66*g* and 66*h* of the wheatstone bridge circuit 66.

In accordance with the present invention, means is connected to the wheatstone bridge circuit 66 and to the electric motors 33 of the slave units 31 for energizing the electric motor 33 of the selected slave unit 31 in response to the generated electrical signal. Preferably, this means is polarized so as to energize the appropriate winding of the electric motor 33 to cause the same to move the accessory connected thereto in a direction, corresponding to the polarity of the generated signal, to move the accessory and the positionally movable member 42 of the selected slave reference device 40 into the predetermined positional relationship with the wiper member 63 of the master slave resistor 64 by the shortest available path.

As illustrated in the drawings, this means comprises a pair of relays 71, 72 connected in parallel across the opposite corners 66*g* and 66*h* and polarized by the appropriate use of diodes. Relay 71 has its contacts 71*a*, 71*b*, 71*c* and 71*d* connected in series in the forward direction windings 33*a* of the electric motors 33, and relay 72 has its contacts 72*a*, 72*b*, 72*c* and 72*d* connected in the reverse direction windings 33*b* of the electric motors 33.

Master control unit 60 includes a control panel 73 having a control knob 74 connected to the positionally adjustable member 63 of master control device 62 for manual movement and positioning thereof. To aid in this positioning, a pointer 75 is connected to and moves with knob 74 and cooperates with a dial 76 having three calibrated scales 76*a*, 76*b* and 76*c* thereon. Scales 76*a* and 76*c* are calibrated in degrees and correspond to the range of tiltable movement of the panels 20, 21, 22, 23, 24 and 25, and scale 76*b* is calibrated in feet and corresponds to the vertical range of movement of the overhead stage panels 22 and the light means 13, microphone means 14 and drop curtains 26.

Control panel 73 also includes a control knob 77 connected to the poles of selector switch 65 for manual movement thereof to select the particular slave unit to be connected to the master control device 62. To aid in this selection, a pointer 78 is carried by knob 77 and moves therewith and cooperates with a dial 79 having five positions corresponding to the five positions of selector switch 65.

Preferably, suitable override means is provided in control unit 60 for permitting manual overriding control of the slave units 31 separate from the master control device 62. In this respect, the positions 1 through 4 of selector switch section 65*c* are respectively connected by suitable wiring to the forward direction windings 33*a* of the electric motors 33 and the corresponding positions of selector switch section 65*d* are connected to the reverse direction windings of the electric motors 33. A double-throw manual selector switch 80 has one contact 81 thereof connected to the selector switch section 65*c* and the other contact 82 thereof connected to the selector switch section 65*d*. By appropriate movement of the switch 80 to its two active positions, forward or rearward rotation of the motors 33 may be provided in overriding relation to the master control device 62. It is noted that if the selector switch 65 is dialed to a selected slave unit and the manual override switch 80 is actuated to cause the motor 33 of that slave unit to move the accessory to a particular desired position, that when the manual override switch 80 is released the master control device 62 will attempt to cause the accessory to move into the predetermined positional relationship therewith; therefore the selector switch 65 must be moved to the "zero" or off position if the accessory is to be retained in the position to which it was moved by the override control.

A gang control mechanism is preferably included in the master control unit 60 to permit optional gang movement of all accessories connected to a slave station. In this respect, a gang switch 83 (FIGURES 2 and 12) has a first series of contacts 83*a*–83*d* thereof connected to the reverse direction windings 33*b* of each of the motors 33, and another series of contacts 83*e*–83*h* thereof connected to the forward direction windings 33*a* thereof. Gang switch 83 has each series of contacts thereof connected in series with the forward and reverse contacts 81 and 82 of the manual override switch 80, and can only be used in conjunction therewith. Additionally, to achieve gang control of all of the motors, the selector switch 65 should be moved to the "zero" or off position before gang switch 83 is actuated.

Preferably, control unit 60 includes an indicator light 84 (FIGURES 2 and 12) which is connected in the polarized relay circuit so as to be lighted upon the generation of an electrical signal of either polarity, and to be unlighted when no signal is generated, as when the positionally adjustable member 63 of the master variable resistor 64 is in the predetermined positional relationship with the positionally movable member 42 of the slave variable resistor 41.

The operation of the servo-system of the present invention in the positioning of the movable accessories will now be described. When the position of any one or more of the accessories corresponding to one of the slave stations 50–59 is to be adjusted, the master control unit 60 is connected to the appropriate slave station. The desired position of the accessory is then preset or predetermined by manually rotating control knob 74 until pointer 75 is in a position relative to the appropriate scale corresponding to the desired position of the accessory. This moves the positionally adjustable member 63 of the master variable resistor 64 into a corresponding position and causes master variable resistor 64 to have a correlated resistance. Then, the slave unit 31 corresponding to the accessory to be positioned is connected to master control device 62 by moving the selector switch 65 to the appropriate position by means of control knob 77. Thereby, the slave variable resistor 41 of the selected slave unit 31 is placed in resistance-comparison relationship with the master variable resistor 64 across the Wheatstone bridge circuit 66.

Due to the manual adjustment of the positionally adjustable wiper member 63 to the desired position of the accessory, there will probably be a resistance imbalance across the Wheatstone bridge, and an electrical signal of a polarity corresponding to a direction opposite to the direction of the deviation will be generated. The appropriate one of the polarized relays 71 or 72 will be energized by the electrical signal and will in turn energize the appropriate winding of the electric motor 33 of the selected slave unit 31 to move the accessory in a direction to bring it to its desired position by the shortest available path of travel. As the accessory is moved, the positionally movable member 42 of the selected slave variable resistor 41 will be moved with the accessory, due to the feedback means F interconnecting the same, until the positionally movable member 42 of the slave variable resistor 41 is brought into predetermined correlated positional relationship with the positionally adjustable member 63 of the master variable resistor 64 and until the slave variable resistor 41 is brought into resistance balance with the master variable resistor 64 across the bridge. When this occurs, the generated electrical signal will terminate and the relay will open. The electric motor 33 of the selected slave unit 31 will be deenergized and will terminate movement of the accessory and maintain the same in the position to which it has been moved.

It is noted that during movement of the accessory the light 84 will be lighted, and that immediately upon its becoming unlighted when the circuit to the motor 33 is open, the operator will know that he may select another accessory through the selector switch 65 for positional adjustment. As stated earlier, the operation of the master control device may be overridden by the manual override switch 80 alone or in combination with the gang control switch 83.

The control unit 60 may be suitably disconnected from the particular slave station when each of the accessories corresponding to that slave station has been moved to the desired position, and may be connected to any one or successively to all of the remaining slave stations for appropriate positioning of other accessories. It should be noted that, due to the construction of the control unit 60 and the slave units 31, the adjustment of the accessories may occur at any time including during the performance of a particular activity without distracting the audience or performers. Additionally, because the particular position of any accessory may be preset or predetermined by the position of the positionally adjustable member 63 of the master control device 62, the optimum positions of such accessories for each type of activity may be very accurately predetermined prior to the performance of the activity, as for example during a rehearsal, and the accessories moved to their optimum positions for the particular activity in a minimum time and with minimum expense and great accuracy. Additionally, the positions of the accessories may be adjusted for variance in building characteristic requirements occurring during the performance of the particular activity, unnoticeably and with great precision.

It is therefore believed apparent that the present invention provides a novel servo-system for controlling the movement and positioning of a plurality of accessories, one at a time and independently of each other, and with great accuracy and precision, and, more particularly, provides a multiple-use building including a plurality of movable accessories for varying the characteristics of the building under control of this servo-system.

In the drawings and specification there has been set forth a preferred embodiment of the invention and, although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention being defined in the claims.

I claim:

1. In a building having multiple uses and having a plurality of accessories each movable to a plurality of predetermined positions to vary the characteristics of said building to adapt the same to its multiple uses and a plurality of motive means each connected to a corresponding one of said accessories for moving the same to its various positions; the combination therewith of an electrical servo-system including

a master variable resistor having a positionally adjustable member effective to vary the resistance of said master variable resistor upon positional adjustment thereof and having the various positions thereof correlated to the positions to which said accessories may be moved,

a plurality of slave variable resistors each having a positionally movable member operatively connected to a corresponding one of said accessories for correlated movement therewith and being effective to vary the resistance of said slave variable resistor upon positional movement thereof,

selector means electrically connected to said master variable resistor and to each of said slave variable resistors for selectively electrically interconnecting said master variable resistor with each of said slave variable resistors one at a time and independently of each other,

means operatively associated with said master variable resistor and said slave variable resistors for generating an electrical signal in response to a deviation from a predetermined correlated positional relationship between the positionally adjustable member of said master variable resistor and the positionally movable member of a selected one of said slave variable resistors, and

means responsive to said generated electrical signal for energizing the motive means connected to the accessory corresponding to said selected slave variable resistor to move the accessory and the positionally movable member of said selected slave variable resistor connected thereto into said predetermined correlated positional relationship with said positionally adjustable member of said master variable resistor.

2. A building according to claim 1, wherein said plurality of accessories includes microphone means mounted for movement and being movable by said motive means under control of said master variable resistor.

3. A building according to claim 1, wherein said plurality of accessories includes lighting means mounted for movement and being movable by said motive means under control of said master variable resistor to vary the lighting characteristics of said building.

4. A building according to claim 1, wherein said motive means connected to each accessory for moving the same comprises an electric motor and speed reduction means.

5. In a building having a plurality of acoustical members each mounted for independent movement between a plurality of positions to vary the acoustical characteristics of said building and a plurality of motive means each connected to a corresponding one of said acoustical members for moving the same to its various positions, the combination therewith of an electrical servo-system including

a master control device having a positionally adjustable member having the various positions thereof correlated to the positions to which said acoustical members may be moved,

a plurality of slave reference devices each having a positionally movable member operatively connected to a corresponding one of said acoustical members for correlated movement therewith,

selector means electrically connected to said master control device and to each of said slave reference devices for selectively electrically interconnecting said master control device with each of said slave reference devices one at a time and independently of each other,

means operatively associated with said master control device and said slave reference devices for generating an electrical signal in response to a deviation from a predetermined correlated positional relationship between the positionally adjustable member of said master control device and the positionally movable member of a selected one of said slave reference devices, and

means responsive to said generated electrical signal for energizing the motive means connected to the acoustical member corresponding to said selected slave reference device to move the acoustical member and the positionally movable member of said selected slave reference device connected thereto into said predetermined correlated positional relationship with said positionally adjustable member of said master control device.

6. A building according to claim 5, wherein said plurality of acoustical members includes a plurality of tiltable acoustical panels.

7. A building according to claim 6, wherein said plurality of tiltable acoustical panels includes panels disposed generally horizontally relative to said building and panels disposed generally vertically relative to said building, and all said panels being independently movable relative to

each other for varying the acoustical characteristics of the building.

8. A building according to claim 7, wherein some of said horizontally disposed acoustical panels are each mounted for tiltable movement about a horizontal axis and also mounted for vertical movement to further vary the acoustical characteristics of said building.

9. A building according to claim 5, wherein said plurality of acoustical members includes at least one acoustical curtain.

10. A building according to claim 5, wherein said plurality of acoustical members includes a plurality of generally horizontally disposed, tiltable acoustical panels and a plurality of generally vertically disposed acoustical curtains each curtain being disposed between an adjacent pair of said acoustical panels and being independently movable relative thereto to further vary the acoustical characteristics of said building.

11. In a multiple-use building having a performance area adapted for the performance of a variety of activities and an audience area adapted to contain an audience to the performance of these activities, the combination therewith of a variable acoustical system for said building including

a plurality of movable acoustical members comprising,

a plurality of generally horizontally disposed acoustical panels mounted for independent tilting movement about generally horizontal axes above said performance and audience areas of said building, said acoustical panels above said performance area also being mounted for independent vertical movement,

a plurality of generally vertically disposed acoustical panels mounted for independent tiltable movement about generally vertical axes behind said performance and audience areas of said building and along opposite sides of said performance area, and

a plurality of generally vertically disposed acoustical drop curtains each disposed between certain adjacent pairs of said acoustical panels above said performance area and being mounted for independent vertical movement relative to said acoustical panels, and

an electrical servo-system operatively related to said movable acoustical members for controlling the same comprising,

a master control device having a positionally adjustable member with the various positions thereof correlated to the positions to which said acoustical members may be moved,

a plurality of slave reference devices each having a positionally movable member operatively connected to a corresponding one of said acoustical members for correlated movement therewith,

selector means electrically connected to said master control device and to each of said slave reference devices for selectively electrically interconnecting said master control device with each of said slave reference devices one at a time and independently of each other,

means operatively associated with said master control device and said slave reference devices for generating an electrical signal in response to a deviation from a predetermined correlated positional relationship between the positionally adjustable member of said master control device and the positionally movable member of a selected one of said slave reference devices,

a plurality of motive means each connected to a corresponding one of said movable acoustical members for imparting tilting movement to all of said panels about their respective axes and for imparting vertical movement to said curtains and to said horizontally disposed panels above said performance area, and

means responsive to said generated electrical signal for energizing the motive means connected to the movable acoustical member corresponding to said selected slave reference device to move the acoustical member and the positionally movable member of said selected slave reference device connected thereto into said predetermined correlated positional relationship with said positionally adjustable member of said master control device.

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JOHN E. MURTAGH, Primary Examiner

U.S. Cl. X.R.

52—6, 28, 29, 64; 181—30; 240—9