



SINGLE LEVER CONTROL FOR MULTIPLE ACTIONS



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## 3,091,130 <br> SINGLE LEVER CONTROL FOR MULTTPIE ACTIONS

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The present invention relates to single lever control mechanisms.
More particularly, the present invention relates to a single lever control mechanism whereby the movement of a single lever can selectively control multiple actions or movements.
Specifically, the present invention relates to a single lever control mechanism whereby the movement of a single lever can selectively control two remote servient mechanisms either singularly, simultaneously or in a multiplicity of combinations involving varying degrees of control or sequential control.
A variety of known control devices provide control for dual servient mechanisms by the operation of a single lever through intermittent gearing arrangements or linear displacement of the control lever as it is oscillatably moved in a fixed plane. Complete selective control of the servient mechanisms with respect to direction and magnitude is impossible with such control devices, because the interaction of the two servient mechanisms so controlled is restricted by the planar of the individual control device.

The known single lever control devices in which the control lever is not limited to planar movement have been limited to arrangements whereby the control cables are attached directly to the conrol lever. The displacement of the control lever is relied upon directly to effect the required movement of the control cables. In such devices the lateral displacement of the cables ioherently causes binding or frictional resistance thereon, and, therefore, limits the application of said devices. Moreover, complete selective control of the cables is inefficient, because movement of the control lever in any direction inherently results in movement of all the cables to some extent.

It is therefore the principal object of the present invention to provide an improved single lever control mechanism for providing multiple actions.

It is a further object of the present invention to provide an improved single lever control mechanism in which selective movement of the control lever effects efficient individual control of the servient mechanisms both as to direction and magnitude.

It is a still further object of the present invention to provide an improved single lever control mechanism which is simple, strong and compact in construction.

It is a still further object of the present invention to provide an improved single lever control mechanism which is substantially universal in application without causing binding or frictional resistance.
These and other objects of the present invention, as well as the advantages thereof over the prior art, will be apparent in view of the following description and the attached drawings. A preferred embodiment is shown by way of example in the accompanying drawings and described in detail herein. Various modifications and changes in details of construction are comprehended within the scope of the present invention as defined by the appended claims.

The invention comprises two parallel pairs of shafts at right angles to each other, having sprockets at both ends driving chains and journaled in a rectangular frame, opposite chains being connected by control rods at right
angles to each other passing slidably through a single lever control element, and one of each pair of opposite chain drive mechanisms being operatively connected to motion transmitting means.

Referring to the drawings:
FIG. 1 is a schematic perspective view of a preferred embodiment of the present invention showing the control lever in neutral position;

FIG. 2 is a side elevation thereof;
FIG. 3 is a plan view partially cut away taken substantially on line 3-3 as shown in FIG. 2;

FIG. 4 is a cross sectional view taken substantially on line 4-4 in FIG. 3;

FIG. 5 is a schematic perspective similar to that shown in FIG. 1 with the control lever moved along one control axis;

FIG. 6 is a schematic perspective similar to that shown in FIG. 1 with the control lever moved along the control axis normal to that shown in FIG. 5;
FIG. 7 is a schematic perspective similar to that shown in FIG. 1 with the control lever moved to a position diagonally of the frame along both control axes;

FIG. 8 is a schematic perspective similar to that shown in FIG. 1 with the control lever moved to another of the countless positions possible by movement along both control axes.
In the preferred embodiment of the invention, a closed chain is mounted around the two sprockets at one end of each pair of shafts, and an open chain engages the two sprockets at the other end of each pair of shafts. The free ends of each open chain are connected to the control cables of the servient mechanisms.
The control rods, which are always perpendicular to each other, are slidably interconnected through a slide socket which is operated by the swivel pivoted control lever. That is, the cross over point of the two control rods always lies within the slide-socket, although the position of the slide-socket itself may be changed. The ends of each control rod drivingly engage the chains on the opposite ends of one pair of parallel shafts.

Because of this configuration, movement of the control lever so as to slide the slide-socket along the axis of one control rod causes the other control rod to be carried laterally with the slide-socket. The lateral movement of the control rod advances or retracts the chains to which it is attached over the sprockets, correspondingly displacing the control cables to one of the servient mechanisms.

Reverse movement of the control lever reverses the displacement of the control cables, causing the servient mechanism to return to its neutral position or beyond, if desired. Lateral movement of the control lever along the axis of the other control rod will cause similar directional displacement of the control cables to the second servient mechanism.
It is apparent that the displacement of the control cables is a direct linear function of the displacement of the control lever and that the direction of the displacement corresponds to the direction of the displacement of the control lever. Therefore, diagonal movement of the control lever will cause co-ordinate movement of the control cables leading to the two servient mechanisms, correspondingly moving the slide-socket to a position diagonally from its neutral position. The magnitude and direction of the translation of the cross-over point of the control rods from the neutral position to its new position is determinative of the magnitude and direction of the displacement of the control cables.
Accomplishing the translation of the cross-over by sliding the control rods through the slide-socket as it is positioned enables the control rods always to remain perpendicular to the shafts and be connected to the shafts through the chains at the ends thereof. This provides
an inherently stable mechanism which can be sturdily constructed to operate without binding of the control shafts or the driving mechanisms.
The stability of such a control mechanism permits its ready adaptation as a unified control, as, for example, is required for the operation of dual hydraulic winches; for selective remote control of the dual functional movements of such heavy equipment as cranes, hoists and tracked vehicles; or, for such cooperative control as is required in the coordination of the engine and steering of boats.
Referring now to FIG. 1, the single lever control mechanism, designated generally by the numeral $\mathbf{1 0}$, consists of a preferably square or rectangular frame 11 fixedly mounted in operative position by means not shown. Parallel shafts 12 and 13 are journaled in frame 11, as by ball bearings 14 shown in FIG. 3. Parallel shafts 15 and 16 are similarly journaled in frame 11, as by similar bearings 18, and are perpendicularly disposed to shafts 12 and 13. Interference between the perpendicularly disposed pairs of parallel shafts is prevented by placing shafts 15 and 16 beneath shafts 12 and 13 , as shown in FIG. 4.
Secured to each of the shafts $12,13,15$ and 16 , preferably outwardly of frame 11, as by Allen screws 17, are sprocket wheels 19 and 20. The pair of sprockets 19 attached to one end of each shaft 12 and 13 and the pair of sprockets 19 attached to one end of each shaft 15 and 16 engage closed chains 21 and 22 , respectively. The pair of sprockets 20 attached to the other end of each shaft 12 and 13 and the pair of sprockets 20 attached to the other end of each shaft 15 and 16 engage open chains 23 and 24, respectively.
The ends of open chain 23 are attached, as by cable clamp 25, to the respective ends of the control cable 26 of a servient mechanism, the control unit of which is schematically represented by sheave 28 with rotational indicator arm 29. Similarly, the ends of open chain 24 are attached, as by cable clamp 30 (FIG. 2), to the respective ends of the control cable 31 of another servient mechanism, the control unit of which is schematically represented by sheave 32 with rotational indicator arm 33.

Sheave assemblies 34, 35, 36 and 37 schematically represent a remote transfer mechanism, as, for example, of the type disclosed in U.S. Patent No. 2,737,822, which could include an elbow 39, as shown in FIG. 2 and disclosed in U.S. Patent No. 2,762,606.
However, it should be understood that while the preferred embodiment is disclosed as being applied by cables to a remote transfer system, the invention is equally adaptable to a linkage system or to an integral application with any of the shafts $12,13,15$ and 16 , or any combination thereof, being directly connected to the servient mechanism.
Control rod 40 extends through elongated bearing slots 41 and 42 in frame 11 to connect to closed chain 21 on one end and open chain 23 on the other end, as by keying through a bored bar link 43 in chains 21 and 23. Control rod 44 is perpendicularly disposed to control rod 40 and similarly extends through elongated bearing slots 45 and 46 in frame 11 to connect to closed chain 22 on one end and open chain 24 on the other end, as by bored bar links 47.

Control rods 40 and 44 are slidably positioned through bores $45^{\prime}$ and $46^{\prime}$, respectively, perpendicular to each other in slide-socket 48 which thereby establishes the cross-over point 49 of control rods 40 and 44 . Helical springs 50 may be placed over control rods 40 and 44 to engage the frame 11 and slide-socket 48 so as to yieldably urge slide-socket 48 to neutral position medially of the sides of frame 11. By centrally locating the neutral cross-over point 49, the optimum directional control is realized from the control device 10 . However, the neutral cross-over point 49 may be displaced from the central location in installations where some directional con-
trol may be relinquished for an increase in displacement. Selection of the neutral cross-over point for various requirements will be within the purview of one skilled in the art in view of the operational description hereinafter included.

Furthermore, it may be desirable to mechanically locate the neutral cross-over point 49 by supplying a spring loaded detent 52 in slide-socket 48 to engage a depression 53 on the surface of control rod 44 when the slide-socket 48 is in the neutral position. A detent $\mathbf{5 2}^{\prime}$ would similarly engage depression $53^{\prime}$ on control rod 40.

A vertical bore 54 perpendicular to bores 45 and 46 defines an elongated socket in slide-socket 48 to accommodate ball 55 on the lower end of control lever 56. Control lever 56 is preferably secured in a swivel pivot 58 which is shown mounted above frame 11 as by a plurality of support members $\mathbf{5 9}$ extending therefrom.

## Operation

Establishing the central positioning of the cross-over point 49 as the neutral position of the control device, as in FIGS. 1-4, the indicator arms 29 and 33 on schematic sheaves 28 and 32, respectively, are shown positioned vertically.

Referring now to FIG. 5, the control lever $\mathbf{5 6}$ is moved in the axial plane of control rod 40 so that the slidesocket 48 is slid axially along control rod 40 . Since control lever 56 is secured in swivel pivot 58 , ball 55 will travel along an arcuate path while moving slide-socket 48 axially along control rod 40 . The bore 54 in slidesocket 48 permits ball 55 to slide upwardly in its thus defined elongated socket and thereby accommodate the vertical component of the motion of ball 55 while fully utilizing the horizontal component.

When slide-socket 48 is moved axially of control rod A0, perpendicularly disposed control rod 44 is moved laterally from its neutral location, thus simultaneously driving chains 22 and 24 which engage sprockets 19 and 20, respectively. The movement of open chain 24 displaces control cable 31 to rotate sheave 32 clockwise from its neutral position as indicated by the rotational displacement of arm 33. Had the slide-socket 48 been moved in a reverse direction along control rod 80 , the direction of the displacement of cable 31 would also have been reversed and arm 33 would have been moved to the position 33', shown in phantom. Furthermore, the magnitude of the displacement at the servient mechanism is directly proportionate to the magnitude of the movement of the control lever 56 .

It should now be readily apparent that by engaging the one end of the control rod with a closed chain the control rod is stabilized and the force required to displace the control cables to which the open chain is connected will not effect an unbalanced movement or binding action between the connection of the control rod to the open chain and the slide-socket.

Referring now to FIG. 6, this control lever 56 is rotated in the axial plane of control rod 44 so that slidesocket 48 is slid axially along control rod 44. This causes control rod 40 to be laterally displaced from its neutral position, thus simultaneously driving chains 21 and 23. This movement of open chain 23 displaces control cable 26 to rotate sheave 28 clockwise from its neutral position as indicated by the rotational displacement of arm 29. Had the slide-socket been moved in a reverse direction along control rod 44, the direction of the displacement of cable 26 would also have been reversed and arm 29 would have been rotated to the position 29', shown in phantom.

Referring now to FIG. 7, the control lever $\mathbf{5 6}$ is moved so that the slide-socket 48 is moved diagonally of the frame 11 to a position toward the observer. That is, the cross-over point has been displaced along the axes of both control rods rather than along the axis of one control rod while remaining fixed with respect to the other,
as shown in FIGS. 5 and 6 , so that in this position the cross-over point has in effect been translated into one of four quadrants defined by the neutral positions of the control rods. The sliding connection between slide-socket 48 and control rods 40 and 44 allows them both to be laterally displaced. The lateral displacement of each control rod is equal in magnitude to its perpendicular coordinate definition of the translation of the cross-over point.

When the slide-socket is moved from its centrally located neutral position directly to the position shown in FIG. 7, control rods 40 and 44 are simultaneously displaced from their neutral position to the FIG. 7 position and thereby simultaneously drive their respectively connected chains 21 and 23 and 22 and 24.

The driving of open chain 23 as control rod 49 is laterally slid in this direction displaces cable 26 to rotate sheave 28 clockwise as indicated by the rotational displacement of arm 29. Also, the driving of open chain 24 as control rod 44 is laterally slid in this direction displaces cable 31 to rotate sheave $\mathbf{3 2}$ clockwise as indicated by the rotational displacement of arm 33 .

Of course, the two sheaves 28 and 32 need not have been moved concurrently to this position, but may have been moved consecutively or by steps by having moved slide-socket 48 along the axis of one control rod and then the other to arrive at the translated position shown in FIG. 7. Nor need the magnitude of the rotation of the two sheaves 28 and 32 be equal, but may be varied by the operation of the control lever $\mathbf{5 6}$ to selectively displace the proper control rod an amount equal to the magnitude of rotation desired. Had the control lever 56 been moved in a reverse direction to place the slide-socket 48 in the quadrant furthest away from the observer-i.e., the opposite quadrant-the direction of the displacement of cables 26 and 31 would also have been reversed and arms 29 and 33 would have been rotated to the positions $29^{\prime}$ and $\mathbf{3 3}^{\prime}$, shown in phantom.

Referring now to FIG. 8, the control lever 56 has been moved so that slide-socket 48 is in the adjacent quadrant to that of FIG. 7. In this position the control rod 44 has been laterally displaced in the same direction as in FIG. 7 so that sheave 32 is again found to have been rotated in a clockwise direction, as indicated by the rotational displacement of arm 33. However, the lateral displacement of control rod 40 has been reversed from that shown in FIG. 7 so that the sheave 28 has been rotated counterclockwise, as indicated by the rotational displacement of arm 29. Similarly, had the control lever been moved in a reverse direction to place the slide-socket 48 in the opopsite quadrant, the rotation of the sheaves 28 and 32 would also have been reversed, as shown by the rotational displacement of arms 29 and 33 to positions $29^{\prime}$ and $3^{\prime}$, shown in phantom.
The versatility of the control and its adaptability to a variety of control applications should now be readily apparent.

It must be noted that while a preferred embodiment of the control was shown to cause rotation in the schematic depiction of the servient mechanism, this function was chosen because it permitted presentation of the flexibility of the control with extreme visual clarity. It should also be apparent that the control may be adapted to swing, push or pull remote mechanisms either directly or by suitable linkage arrangements known to the art.

## What is claimed is:

1. A single lever control mechanism for multiple actions, comprising, a frame, parallel pairs of shafts rotatably mounted in said frame perpendicularly to each other, control rods perpendicular to each other laterally movable in said frame, means interconnecting each control rod to a pair of said parallel shafts, said means adapted to rotate said pairs of shafts and maintain each said control rod parallel to its interconnected shafts, single lever
means selectively to displace said control rods, and servient control means operatively connected with said shafts.
2. A single lever control mechanism for multiple actions, comprising, a frame, parallel pairs of shafts rotatably mounted in said frame perpendicularly to each other, control rods perpendicular to each other laterally movable in said frame, means interconnecting each control rod to a pair of said parallel shafts, said means adapted to rotate said pairs of shafts and maintain each said control rod parallel to its interconnected shafts, single lever means selectively to displace said control rods either singularly, concurrently or consecutively, and servient control means operatively connected with said shafts.
3. A single lever control mechanism for multiple actions, comprising, a frame, parallel pairs of shafts rotatably mounted in said frame perpendicularly to each other, control rods perpendicular to each other laterally movable in said frame, means interconnecting each control rod to a pair of said parallel shafts, said means adapted to rotate said pairs of shafts and maintain each said control rod parallel to its interconnected shafts, single lever socket means slidably engaging said control rods adapted to laterally displace said control rods either singularly or concurrently, and servient control means associated with said shafts.
4. A single lever control mechanism for multiple actions, comprising, a rectangular frame, parallel pairs of shafts rotatably mounted in said frame, said pairs of shafts perpendiculariy mounted with respect to each other, the shafts in each pair rotatably connected, control rods laterally slidable in said frame, said control rods perpendicularly disposed to each other and each adapted to rotate one pair of shafts by its lateral displacement, a slide-socket engaging said control rods, said slide-socket adapted to slide axially along said control rods singularly or concurrently, means selectively to slide said slidesocket, and servient control means associated with said shafts.
5. A single lever control mechanism for multiple actions, comprising, a rectangular frame, parallel pairs of shafts rotatably mounted in said frame, said pairs of shafts perpendicularly mounted with respect to each other, the shafts in each pair rotatably connected, control rods laterally slidable in said frame, said control rods perpendicularly disposed to each other and each adapted to rotate one pair of shafts by its lateral displacement, a slidesocket engaging said control rods, said slide-socket adapted to slide axially along said control rods singularly or concurrently, means selectively to slide said slide-socket, means yieldingly to urge said slide-socket to a predetermined position, and servient control means associated with said shafts.
6. A single lever control mechanism for multiple actions, comprising, a rectangular frame, parallel pairs of shafts rotatably mounted in said frame, said pairs of shafts perpendicularly mounted with respect to each other, the shafts in each pair rotatably connected, control rods laterally slidable in said frame, said control rods perpendicularly disposed to each other and each adapted to rotate one pair of shafts by its lateral displacement, a slide-socket engaging said control rods, said slide-socket adapted to slide axially along said control rods singularly or concurrently, a swingingly pivoted control lever adapted selectively to slide said slide-socket, and servient control means asscoiated with said shafts.
7. A single lever control mechanism for multiple actions, comprising, a rectangular frame, parallel pairs of shafts rotatably mounted in said frame, said pairs of shafts perpendicularly mounted with respect to each other, the shafts in each pair rotatably connected, control rods laterally slidable in said frame, said control rods perpendicularly disposed to each other and each adapted to rotate one pair of shafts by its lateral displacement, a slidesocket, perpendicular crossed bores in said slide-socket, each of said bores slidingly receiving one of said control
rods, means selectively to slide said slide-socket along said control rods singularly or concurrently, and servient control means associated with said shafts.
8. A single lever control mechanism for multiple actions, comprising, a rectangular frame, parallel pairs of shafts rotatably mounted in said frame, said pairs of shafts perpendicularly mounted with respect to each other, the shafts in each pair rotatably connected, control rods laterally slidable in said frame, said control rods perpendicularly disposed to each other and each adapted to rotate one pair of shafts by its lateral displacement, a slidesocket, perpendicular crossed bores in said slide-socket, each of said bores slidingly receiving one of said control rods, a swingingly pivoted control lever adapted selectively to slide said slide-socket along said control rods singularly or concurrently, and servient control means associated with said shafts.
9. A single lever control mechanism for multiple actions, comprising, a rectangular frame, parallel pairs of shafts rotatably mounted in said frame, said pairs of shafts perpendicularly mounted with respect to each other, the shafts in each pair rotatably connected, control rods laterally slidable in said frame, said control rods perpendicularly disposed to each other and each adapted to rotate one pair of shafts by its lateral displacement, a slide-socket, perpendicular bores in said slide-socket, each of said bores slidingly receiving one of said control rods, a swingingly pivoted control lever adapted selectively to slide said slide-socket along said control rods singularly or concurrently, means yieldingly to urge said slide-socket to a predetermined position, and servient control means associated with said shafts.
10. A single lever control mechanism for multiple actions, comprising, a rectangular frame, parallel pairs of shafts rotatably mounted in said frame, said pairs of shafts perpendicular to each other, dual means for rotatably connecting each pair of shafts, said means displaced from each other axially of said shafts, control rods laterally slidable in said frame, each of said control rods parallel to one pair of shafts, each of said control rods engaging the rotatable connecting means of said pair of shafts which it parallels, a slide-socket, perpendicular crossed bores in said slide-socket, each of said bores slidingly receiving one of said control rods medially of said shaft connecting means, means selectively to slide said slide-socket along said control rods singularly or concurrently, and servient control means associated with said shafts.
11. A single lever control mechanism for multiple actions, comprising, a rectangular frame, parallel pairs of shaifts rotatably mounted in said frame, said pairs of shafts perpendicular to each other, dual means for rotatably connecting each pair of shafts, said means displaced from each other axially of said shafts, control rods laterally slidable in said frame, each of said control rods parallel to one pair of shafts, each of said control rods engaging the rotatable connecting means of said pair of shafts which it parallels; a slide-socket, perpendicular crossed bores in said slide-socket, each of said bores slidingly receiving one of said control rods medially of said shaft connecting means, a swingingly pivoted control lever adapted selectively to slide said slide-socket along said control rods singularly or concurrently, and servient control means associated with said shafts.
12. A single lever control mechanism for multiple actions, comprising, a rectangular frame, parallel pairs of shafts rotatably mounted in said frame, said pairs of shafts perpendicular to each other, dual means for rotatably connecting each pair of shafts, said means displaced from each other axially of said shafts, control rods laterally slidable in said frame, each of said control rods parallel to one pair of shafts, each of said control rods engaging the rotatable connecting means of said pair of shafts which it parallels, a slide-socket, perpendicularly crossed bores in said slide-socket, each of said bores slidingly receiving one of said control rods medially of said shaft connecting
means, a swingingly pivoted control lever adapted selectively to slide said slide-socket along said control rods singularly or concurrently, means yieldingly to urge said slide-socket to a predetermined position, and servient control means associated with said shafts.
13. A single lever control mechanism for multiple actions, comprising, a rectangular frame, parallel pairs of shafts rotatably mounted through said frame, said pairs of shafts perpendicular to each other, means for rotatably connecting each pair of shafts attached to both ends of each shaft exterioriy of said frame, control rods laterally slidable in said frame, each of said control rods parallel to one pair of shafts, each of said control rods engaging the rotatable connecting means of said pair of shafts which it parallels, a slide-socket, perpendicular crossed bores in said slide-socket, each of said bores slidingly receiving one of said control rods medially of said frame, a swingingly pivoted control lever adapied selectively to slide said slide-socket along said control rods singularly or concurrently, means yieldingly to urge said slide-socket to a predetermined position, and servient control means associated with said shafts.
14. A single lever control mechanism for multiple actions, comprising, a rectangular frame, parallel pairs of shafts rotatably mounted through said frame, said pairs of shafts perpendicular to each other, sprockets attached to both ends of each shaft exteriorly of said frame, chains drivingly engaging the sprockets on each end of the pairs of parallel shaits, control rods laterally slidable in said frame, each of said control rods parallel to one pair of shafts, each control rod engaging the chains drivingly associated with that pair of shafts parallel to said control rod, a slide-socket, perpendicular crossed bores in said slide-socket, each of said bores slidingly receiving one of said control rods medially the engagement of the control rod to its driving chains, a swingingly pivoted control lever adapted selectively to slide said slide-socket along said control rods singularly or concurrently, and servient control means associated with said shafts.
15. A single lever control mechanism for multiple actions, comprising, a rectangular frame, parallel pairs of shafts rotatably mounted in said frame, said pairs of shafts perpendicular to each other, sprockets attached to both ends of each shaft exteriorly of said frame, closed chains drivingly engaging the sprockets on one end of each pair of shafts, open chains drivingly engaging the sprockets on the other end of each pair of shafts, control rods laterally slidable in said frame, each of said control rods parallel to one pair of shafts, each control rod engaging the chains drivingly associated with that pair of shafts parallel to said control rod, a slide-socket, perpendicular crossed bores in said slide-socket, each of said bores slidingly receiving one of said control rods medially of said frame, an elongated socket in said slide-socket, a swingingly pivoted control lever, a ball on the end of said lever received in said elongated socket so that selective rotation of said control lever slides said slide-socket along said control rods singularly or concurrently, and servient control means attached to the ends of said open chains.
16. A control of the character described in claim 15 with spring means yieldingly to urge said slide-socket to a predetermined position.

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