

Dec. 25, 1951

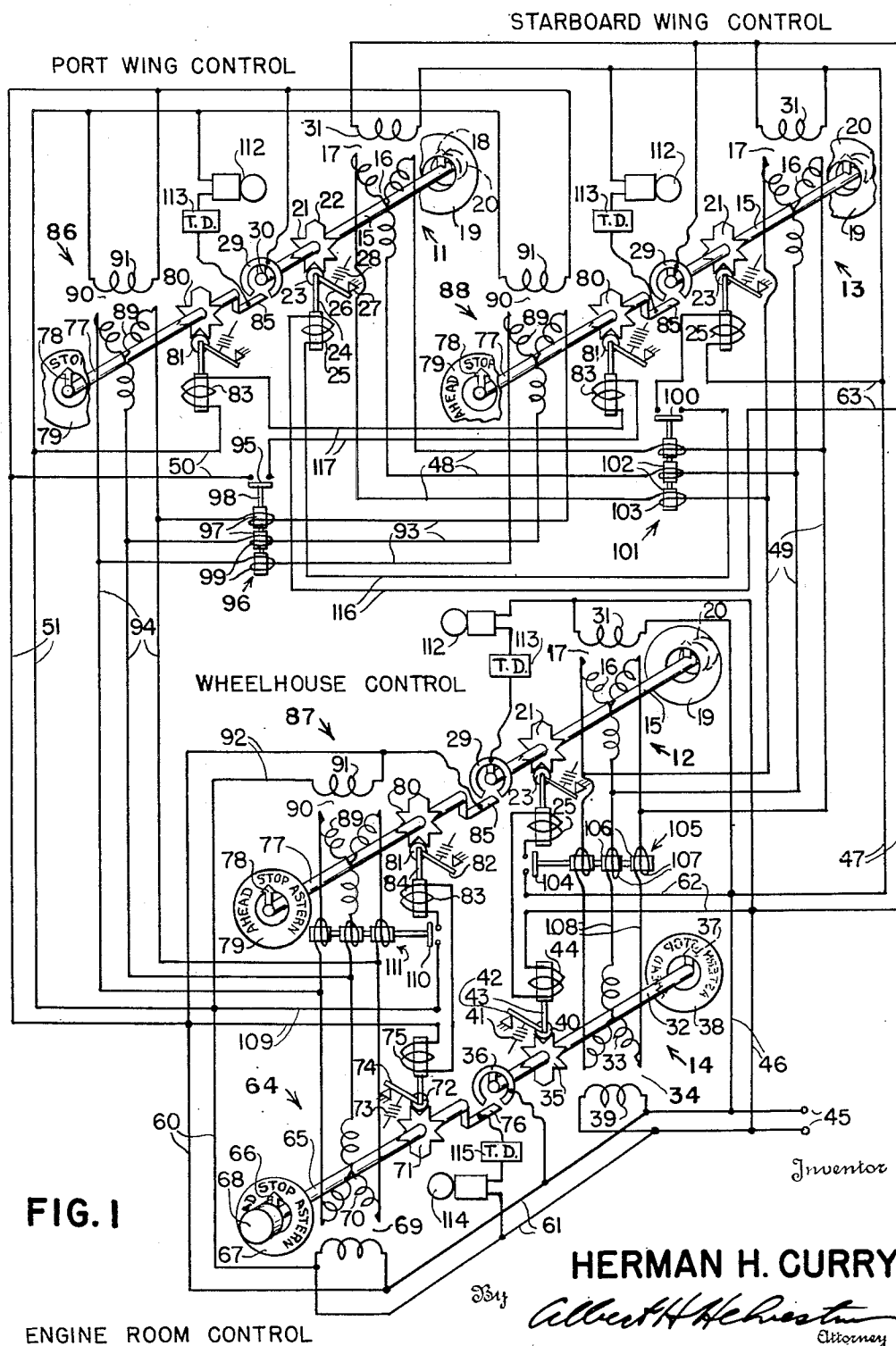
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2,579,476

ENGINE ROOM TELEGRAPH

Filed March 14, 1946

3 Sheets-Sheet 1



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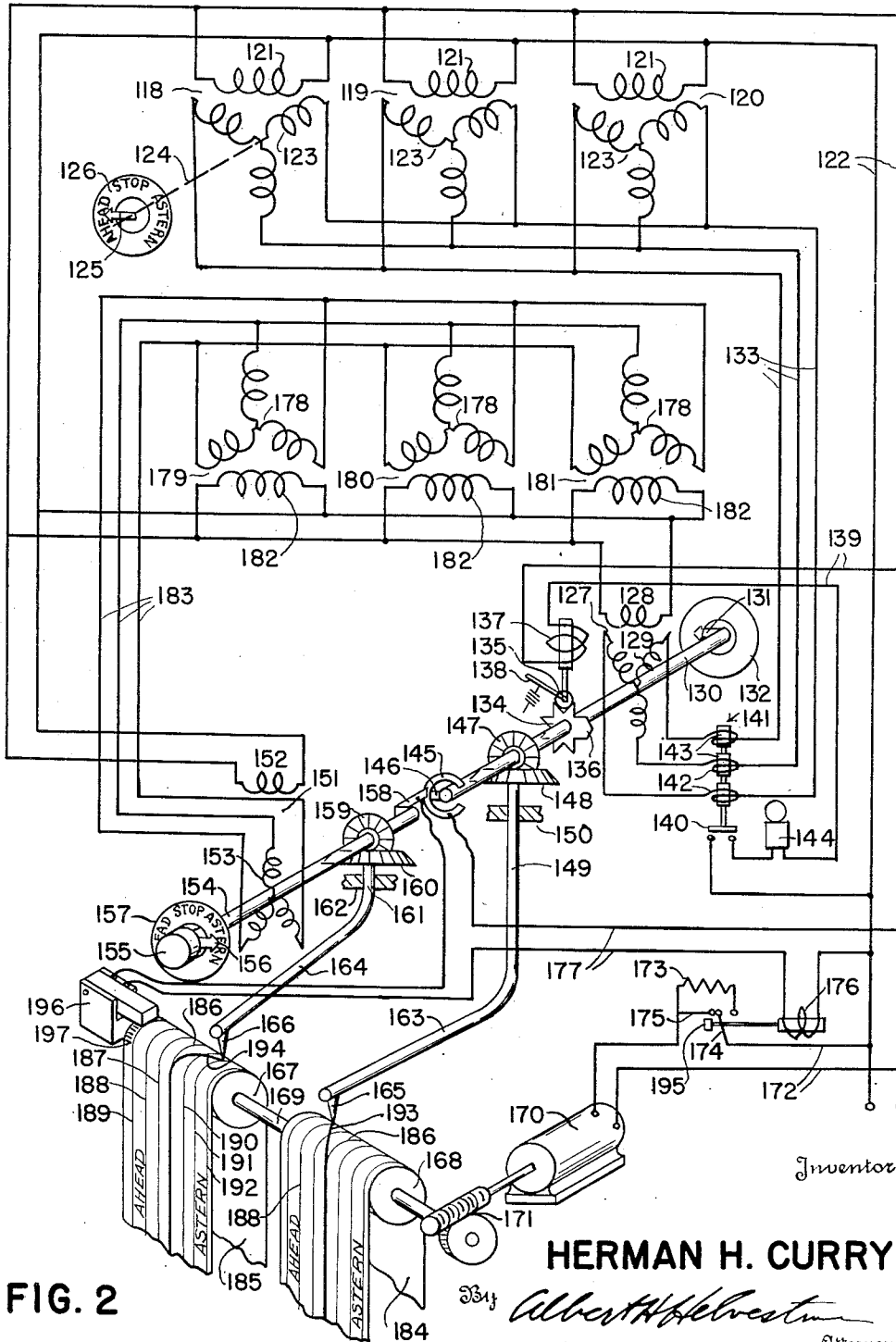
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ENGINE ROOM TELEGRAPH

3 Sheets-Sheet 3

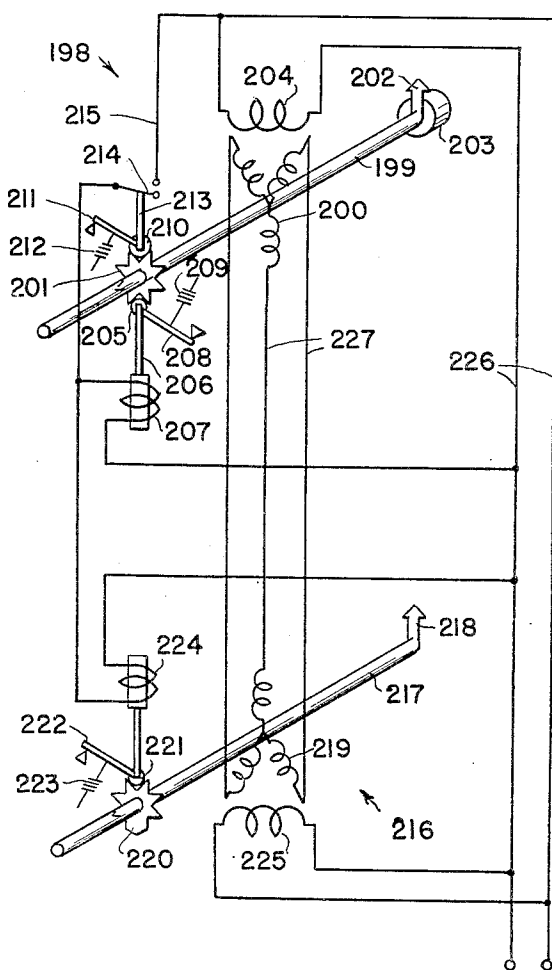


FIG. 3

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ENGINE ROOM TELEGRAPH

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1

This invention relates to systems for transmitting motion between two or more remote stations and particularly to an improved electrically controlled engine room telegraph.

Heretofore, complicated and costly electrical and mechanical telemetric devices have been proposed for transmitting signals between remote stations, such as the bridge and the engine room of a vessel. This is especially true in those cases where more than one transmitting device was used on the bridge for sending signals to the engine room receiver. Usually, it is desired to have signals sent to the engine room from at least three positions on the bridge of a vessel, for example, the wheelhouse, and the starboard and port wings of the bridge. In the past when such plurality of bridge transmitting units were employed, either complicated mechanical linkage connected all the transmitting units to a single transmitting device self-synchronizing with a receiving device in the engine room, or if the transmitting stations were electrically interconnected, a complicated panel of transfer relays were employed for connecting the last operated transmitter unit to the engine room receiver. The mechanical linkage installation was subject to freezing, added friction to the system and was difficult to install and maintain in satisfactory operating condition. The electrical installation utilizing transfer relays was costly to install, was subject to electrical failure and objectionable because the last transmitter to be operated showed the true indication while the remaining transmitters were unaffected thereby and the different control positions indicated thereon led to confusion.

An important object of this invention is to provide an improved motion transmission system especially adapted for signaling control movements between a plurality of transmitting stations and one or more receiving stations such that all stations show the last signal transmitted. Another object of the invention is to provide an electrical transmission system operatively incorporating all the transmitters and receivers into a self-synchronizing electrical system which is automatically locked in any one of the control positions and only released from this condition upon movement of one of the transmitters toward another control position. Another object of this invention is to provide in such a self-synchronizing system an improved sense of touch or "feel" for facilitating the control thereof. A further object of this invention is to provide novel warning and recording devices for indicating de-

2

lays or errors in transmission and reception of signals.

More specifically, this invention as applied to engine room telegraph provides a novel controlling mechanism which releasably holds all the transmitting and receiving devices in any control position selected and which is operable to release the system for operation when any one transmitting device is moved toward another control position. This is accomplished in the illustrated embodiment of the invention herein by the provision of one or more novel holding devices in the form of a toothed or star wheel having a roller detent yieldingly pressed into engagement therewith and an electrical device responsive to current flow in the self-synchronizing circuit for retracting the detent from engagement with the star wheel. A novel feature of the invention is the corresponding relation of the star wheel holding means to the various control positions of the system such that when all the operating parts of the system have followed up the transmitting device, the re-engagement of the roller detent with the star wheel automatically centers all the transmitting and receiving devices to the midpoint of the control position selected. The requirement that a transmitting device be first moved toward another position before the detent holding means releases the system provides a resistance in the system which the operator must overcome. This requires little manual effort but the resistance encountered improves the "feel" of the system to the operator's control. Furthermore, upon synchronization of all the transmitting and receiving devices the operator can feel the system seeking the center of the nearest scale position.

The engine room telegraph of this invention incorporates a repeat-back self-synchronizing system whereby the engine room answers the signal from the bridge and indicates to the bridge the control movement exercised over the engine. Preferably the repeat-back system is similar to the transmission system from the bridge and includes all the stations on the bridge. Each station, whether on the bridge or in the engine room, has a motion transmitting device and a motion receiving device preferably arranged side by side in one unit. Each station unit has a pointer and scale for indicating the control positions of the bridge control system and a pointer and scale for indicating the control positions of the repeat-back system. The motion transmitting device of each station unit is provided with a control handle for moving the system in which it is asso-

ciated. Since both systems are self-synchronizing, the movement of any control handle, whether in the control system from the bridge units to the engine room or in the repeat-back system from the engine room unit to the bridge units, is followed by movement of all transmitting and receiving devices in the system. The novel detent holding means elastically restrains both systems in their respective control positions except when an operator intentionally makes a change in the control position.

In order to warn personnel of any delay or error in acknowledging the transmission and receipt of signals, novel alarm devices are provided. An important object of this invention is to provide warning devices electrically associated with the bridge and repeat-back systems which sound an alarm or otherwise indicate a failure of either system to synchronize after a short delay, and which further sounds an alarm or otherwise indicates a warning when the acknowledgement or answer of the repeat-back system does not agree with the bridge control system.

A further object of the invention is to provide a novel recording device for graphically indicating the control movements transmitted from the bridge and acknowledged by the engine room. It is intended that this recording device be in operation at all times. Of special significance is the provision of special means for varying the speed of the graphic recorder. In normal operation, the speed is relatively slow, but a novel provision automatically increases the speed of the recorder when errors in transmission and acknowledgement occur resulting in a graphic amplification which serves as a clearly understandable record of the event. A further novel feature is the provision of a manual control for increasing the speed of the recorder for use at times when it is expected that many signals will be transmitted to the engine, such as when docking or undocking a vessel.

In the drawings, Fig. 1 is a diagrammatic view of a preferred form of the invention in which the several parts thereof are shown in a position registering "Stop." Fig. 2 is a diagrammatic view of a modified form of the invention wherein recording means are applied to the engine room telegraph system, such means shown registering an error on the part of the engine room operator in operating the repeat-back signal device. Fig. 3 shows a modification.

Referring more particularly to Fig. 1, the system comprises a plurality of transmitting stations which may be located on the bridge or deck of a ship, the operation of any one of which will produce a corresponding operation of the receiving station which may be located in a remote place, such as a ship's engine room. The deck indicator or transmitter 11 is adapted to be mounted on the port wing of the bridge, the deck transmitter 12 in the wheelhouse and the deck transmitter 13 on the starboard wing. The engine room receiver 14 is operated by these deck transmitters.

The transmitters 11, 12 and 13 are identical and each thereof comprises a shaft 15, suitably journaled for rotation, upon which are affixed the three phase rotor windings 16 of a self-synchronous machine or motor 17. A pointer 18 is carried at one end of the shaft and operates around the face of the dial 19 which bears suitable indicia thereon. A controller or handwheel 20 is affixed to the end of the shaft to permit rotation thereof to any desired position. To

releasably and yieldingly retain the shaft in adjusted position a star wheel 21 is affixed to the shaft. This star wheel has seven notches which correspond to the seven positions usually used in a ship's engine room telegraph and correspond to the signal "Stop" and three speeds ahead and three astern. The wheel is essentially an eight pointed star and the portion thereof which is unused is bridged as at 22 so that the detent, subsequently described, will automatically force the wheel into the positions adjacent this particular bridged section should the shaft be rotated too far. A roller detent 23 is mounted adjacent this star wheel and rides over the edge thereof. This detent is carried by an arm 24 connected to the core of a solenoid 25 which when energized serves to withdraw the detent from engagement with the star wheel. A lever 26 has one end engaging the axle of the star wheel and the other end thereof resting on a fixed pivot 27. A spring 28 attached to the lever serves to hold the detent into engagement with the star wheel. It will be seen that the detent will force the star wheel into a definite angular position and will serve to positively position the pointer 18 on the dial. This is particularly important as the synchronizing torque in systems of the kind here used decreases with the decrease in the angle of displacement so that at small angles the torque is insufficient to produce exact synchronism of the transmitter and receiver. This may lead to a variation in the receiver pointer which would cause confusion in the engine room. With the star wheel, however, the detent serves positively to position the transmitter and receiver in the same angular position once movement of the wheel permits the detent to appear over the appropriate notch. The shaft may be turned by hand against the restraining influence of the detent, but the electrical machine affixed to the shaft may not necessarily provide enough torque to rotate the shaft against the detent. The end of the shaft 15 opposite to that carrying the hand wheel 20 carries an annular commutator 29 lying in a plane normal to the shaft and supported concentrically about the axis of the shaft by a radial member 30. The commutator 29 has a section thereof removed for a purpose subsequently described. Operatively associated with the rotor winding 16 of the machine 17 is a single phase stator winding 31.

Deck transmitters 12 and 13 are identical in structure with deck transmitter 11 and no further description thereof is deemed necessary. Like parts bear similar reference numerals.

The engine room receiver 14 is similar to the transmitters described above and comprises a shaft 32 journaled for rotation, to which is affixed a rotor winding 33 of a self-synchronous machine 34, a star wheel 35 of the same configuration as star wheel 21, and a commutator 36 positioned in the same manner as commutator 29. A pointer 37 is provided, but no hand wheel, for operation over a dial 38 bearing suitable indicia which is shown dotted as it appears on the reverse of the dial. This same indicia appears in the dials 19 of transmitters 11, 12 and 13. A single phase stator winding 39 is provided for the machine 34. A roller detent 40 is positioned to ride over the teeth of the star wheel 35 to releasably hold the shaft in adjusted position. A spring 41 biasing the pivoted lever 42, attached to the detent, holds the detent into engagement with the wheel. The detent 40 is carried by the arm 43 which is connected to the

core of solenoid 44 for movement into and out of engagement with the wheel against the spring bias when energized.

The stator windings 31 of the transmitters 11, 12 and 13 are all connected in parallel and are supplied with power from terminals 45 adapted to be coupled to a suitable source of electrical energy, say 110 volt, 60 cycle, alternating current. This energizing circuit may be traced through conductors 46 and 47. The stator winding 39 of the receiver is similarly energized. The rotor windings 16 of the transmitters are connected in parallel by means of conductors 48 and 49.

The solenoids 25 of the transmitters 11 and 13 are series connected for operation in unison and are connected to the line by conductors 116, 63, 47 and 46. The energization of this solenoid circuit is controlled by switch 100 operated by relay 101. This relay comprises cores 102 operating in coils 103 in the conductors 48 of the circuit connecting the rotor windings 16 of the deck transmitters 11, 12 and 13 with the rotor winding 33 of the engine room receiver 14.

Solenoid 25 of the transmitter 12 and solenoid 44 of the receiver are also connected in series for joint operation and are coupled to the line by conductors 62 and 46. A switch 104 in this solenoid circuit is operated by relay 105 comprising cores 106 operating in coils 107 in the conductors connecting rotor windings 16 and 33. It will be seen that the three solenoids 25 and solenoid 44 operate in unison and simultaneously lock or unlock the detents into or out of engagement with the star wheels.

When the windings of a self-synchronous system such as that here used are properly phased out, the rotors will remain stationary in the same angular relation to their respective stators. The voltages in the connecting windings are then equal and opposite and no current flows therebetween. However, if the rotor of one transmitter is displaced in space phase, a resultant voltage becomes available for circulating a current through the connecting windings which will produce a torque in the receiver tending to turn the rotor thereof to a position corresponding to the new position of the generator rotor, the two rotors tending to move in synchronism. The magnitude of the current flowing between the transmitter rotor and the receiver rotor is a function of the angular displacement therebetween. It is this current that is utilized in controlling the operation of the solenoids 25 and 44 which operate the detents 23 and 43, respectively.

The above description relates to the transmitting system from bridge to engine room. The repeat-back system which will now be described is merely the reverse of this transmitting system and comprises an engine room indicator or transmitter and a plurality of deck indicators or receivers by which the engine room operator may repeat the signal received from the bridge back thereto.

The engine room repeat-back transmitter 64 comprises a shaft 65, axially aligned with shaft 32 and spaced a small distance, which carries a pointer 66 adapted to operate over the fixed dial 67 and may be turned by means of the controller or hand wheel 68. The self synchronous machine 69 has its rotor 70 affixed to the shaft 65. A star wheel 71 of the same configuration as those previously described is fastened to the shaft and is engaged by a roller detent 72 engaging the teeth thereof and held thereagainst by a spring 73 act-

ing through the pivoted lever 74 bearing upon the detent. The detent 72 is connected to the moveable core of solenoid 75 for movement into and out of engagement with the wheel 71. A single phase primary of the machine 69 is operatively associated with the rotor winding 70. The end of the shaft opposite that carrying the wheel 71 has a brush 75 extending therefrom and spaced radially thereof. The axial spacing of shafts 32 and 65 of the engine room receiver 14 and transmitter 64 is such that brush 76 wipes commutator 36 except when the brush is opposite the gap in the commutator.

The repeat-back receiving stations 86, 87 and 88 which are shown in association with the deck transmitting stations, are identical in construction and each thereof comprises a repeat-back receiver having a shaft 77 journaled for rotation one end of which carries a pointer 78 adapted to operate over the face of the fixed dial 79. No hand wheel is, of course, provided for any of these receivers. The shaft 77 carries the three phase rotor 89 of the self-synchronous motor 90 and a star wheel 89 whose teeth engage the roller detent 81 held into engagement therewith by a spring biased lever 82. The detent 81 is coupled to the core of a solenoid 83 by an arm 84 for movement into and out of engagement with the star wheel 89 when the solenoid is energized. The shaft 77 is axially aligned with shaft 15 of transmitter 12 and spaced a short distance therefrom. The end of shaft 77 carries an offset brush 85 adapted to wipe the commutator 29 of transmitter 12 except when the brush is opposite the gap in the commutator. Each motor 90 has a single phase stator winding 91.

The stator windings 91 of the deck receiving stations 86 and 88 are connected to a source of power by conductors 51, 60 and 61 while that of receiver 87 is connected via conductors 92, 60 and 61. The rotor windings 89 of the deck receivers are connected in parallel by conductors 93 and 94 and are connected to the rotor windings 70 of the engine room repeat-back transmitter 64.

Solenoids 83 of the deck receivers 86 and 88 are series connected and coupled to the line by conductors 117, 53, 51, 60 and 61. A switch 95 in the solenoid circuit is operated by relay 96 comprising cores 97 operating in coils 99 in the conductors 93 connecting the windings 89 of the deck receiver self-synchronous motors 90 to the windings 70 of the engine room transmitter machine 69.

Solenoid 83 of the deck receiver 87 is connected in series with the solenoid 75 of the engine room transmitters 64 and are supplied with power by conductors 109, 60 and 61. A switch 110 in this solenoid circuit is controlled by relay 111 comprising cores operating in coils in the conductors connecting the rotor windings 70 and 89. It will be seen that the three solenoids 83 and solenoid 75 operate in unison, as the same current energizes the relays 93 and 111 for joint operation, so that the shafts of the deck receivers and engine room transmitter may rotate without the restraining effect of the detents operating on the star wheels.

Each of the deck stations has an electric bell 112 connected in series to a time delay device 113 of conventional type. This device may be set for any selected period of time, six seconds for example. The bell and time delay device are connected to the line through the brush 85 and commutator 29 by suitable lead wires. These wires have been shown connected directly to the

brush and commutator to simplify the drawing, but any suitable connection such as slip rings and contacts may be used. It will be seen that when the shafts 77 and 15 are angularly positioned so that the brush 85 is opposite the gap in the commutator the alarm will not be energized. But if the shafts are angularly displaced the brush 85 will contact the commutator to complete the alarm circuit and cause the bell to ring after a predetermined time interval.

The engine room receiver and repeat-back transmitter are similarly provided with an electric bell 114 and a time delay device 115 connected thereto. These two devices are connected to the line across the brush 76 and commutator 36 so that as long as the shafts 65 and 32 are angularly disposed in a position to place the brush 76 in the gap in the commutator 36, the alarm will not be sounded. However, any angular displacement of one shaft with respect to the other will energize the alarm circuit.

The operation of the device is as follows: In its initial setting, assumed to correspond to "stop" on the dial, all of the equipment is disposed as indicated in Fig. 1. That is to say, all indicators point to "stop" on the dials, the roller detents all bear on the star wheel to hold the pointers in position and the brushes are positioned adjacent the gap in the commutators. When it is desired to transmit a signal to the engine room, any deck transmitter may be operated. For example, assume that the wheelhouse wing control is used to transmit the "ahead" signal to the engine room. The controller or hand wheel 20 is turned to rotate the shaft 15 in a counter-clockwise direction against the restraining effect of the detent 23 operating on star wheel 21. The operator thus has a very definite feel that the system is properly locked in position. This turning also causes commutator 29 to contact the brush 85, completing the alarm circuit, and also displaces the rotor 16 of the self-synchronous motor 17 with respect to the rotor 33 of the receiver 14. This angular displacement causes a current to flow in the conductors 108 connecting the rotor windings which energizes relay 195 to close switch 194 thus energizing the solenoids 25 and 44 of the wheelhouse control to withdraw the detents 23 and 40 from their respective starwheels, making the shafts free to rotate. If the engine room receiver fails to rotate to a position corresponding to that of the wheelhouse transmitter, the alarm 112 will sound after a six second delay. If the shaft 32 assumes the same angular position in which shaft 15 of the wheelhouse transmitter was placed, the pointer 37 will turn to "ahead" on the dial 38. It should be noted that movement of the shaft 32 has placed commutator 36 in contact with brush 76 to complete the circuit for the alarm 114. If the engineer does not respond within one second, this alarm will sound. The engineer, observing this message, then grasps controller 68 of the engine room transmitter 64 and turns the pointer 66 to "ahead." The rotation of shaft 65 will cause the brush 76 to disengage the commutator 36, assuming a position adjacent the gap therein, thus breaking the alarm circuit. This angular movement of the transmitter 64 is made against the restraining influence of the detent 72 engaging the star wheel 71. It also produces an angular displacement with respect to the deck receiver 87 and the current in the conductors connecting the rotors 89 and 70 actuates the relay 111 to close switch 110 to energize the

solenoids 83 and 75, withdrawing the detents 81 and 72 from their respective star wheels, thus permitting the motor 90 to rotate shaft 77 to move the brush 85 to the gap in the commutator 29 to deenergize the wheel-house alarm circuit. If the engineer does not perform the repeat-back operation within six seconds the deck alarm 112 will sound.

When the relay 111 is energized to permit unlocking of the shafts 77 of receiver 87 and shaft 65, the relay 96 is also energized to close the solenoid circuit of deck receivers 86 and 88 thus unlocking their respective shafts to permit the pointers 78 to register the same reading as that of receiver 87.

The operation of the system from either of the wing control stations is identical with that set forth above in connection with the wheelhouse control.

Referring more particularly to Figure 2, I have shown a recording system combined with the transmitting system of the general type shown in Fig. 1, but somewhat simplified for a reader comprehension thereof.

Deck transmitters 118, 119 and 120 comprise self-synchronous electrical machines, each having primary windings 121 connected to a source of alternating current by conductors 122. The three phase rotor windings 123 are connected in parallel. Deck transmitter 121 has a shaft 124 to which is affixed a pointer 125 which operates over dial 126 bearing suitable indicia. The several ahead and astern speeds, corresponding to slow, one-half and full speed, have not been indicated in the interest of clarity. The pointer, however, is turned to indicate half speed ahead. The shafts, dials and pointers have not been illustrated for the other transmitters.

The engine room receiver 127 comprises a self-synchronous alternating current machine having a single phase stator winding 128 and a three phase rotor winding 129 affixed to the shaft 130. A pointer 131 is carried by one end of the shaft and operates over dial 132 upon which suitable indicia (not shown) is inscribed. The rotor windings 129 of the receiver are connected to the rotor windings 123 by conductors 133 to permit synchronous operations of the transmitters and receiver in a manner well known in the art.

The shaft 130 has a star wheel 134 affixed thereto which is engaged by a roller detent 135 held into engagement therewith by a spring biased lever 138. The star wheel is fundamentally an eight point star having two points bridged as at 136 to provide seven recesses which correspond to the seven speeds, viz., stop, three speeds astern and three ahead. When the detent 135 rests between the teeth the wheel is positively positioned and holds the pointer 131 in a definite position on the dial 132. A solenoid 137 is operatively connected to the detent for removing the detent from engagement with the star wheel. The solenoid is connected to the source of power by conductors 139, one of which contain a switch 140 in series therewith. A relay 141 comprising coils 142 in the conductors 139 and cores 143 serves to operate switch 140 to complete the circuit to solenoid 137 to unlock the shaft 130 of the receiver for rotation to permit it to assume an angular position corresponding to that of the transmitter whereupon switch 140 opens and the detent again engages the star wheel. An alarm 144 is inserted in the solenoid circuit for sounding in the engine room when a signal is transmitted.

The other end of the shaft 130 carries a commutator 145 supported thereon by a radial arm 146. The commutator is annular in form and mounted in a plane concentric with and normal to the axis of the shaft. The shaft also carries a bevel gear 147 meshing with a second bevel gear 148 attached to one end of shaft 149 rotatably journaled in bracket 150.

The repeat-back system comprises an engine-room transmitter 151 having a single phase stator winding 152 and a three phase rotor winding 153 affixed to shaft 154 journaled for rotation and axially aligned with and spaced from shaft 130. One end of the shaft carries a controller or hand wheel 155 and a pointer 156 operating over a fixed dial 157 carrying suitable indicia. The other end of the shaft carries a brush 158 axially displaced from the shaft and wiping the commutator 145, except when the brush is opposite the gap therein, to complete a control circuit described below. The shaft 154 also has a bevel gear 159 affixed thereto which engages a bevel gear 160 affixed to the end of a shaft 161 rotatably journaled in bracket 162. The rotor winding 153 is connected to the parallel connected three phase rotor windings 178 of deck receivers 179, 180 and 181 by conductors 183. The single phase primary windings 182 are connected to a source of single phase power. These receivers may be supplied with pointers and dials as shown in Fig. 1.

The shafts 149 and 161 have radial arms 163 and 164, respectively, the ends of which carry styluses 165 and 166. The recording device upon which the stylus operates comprises a pair of drums 167 and 168 mounted on a shaft 169 driven by an electric motor 170 through a worm and wheel drive 171. The motor is connected to the line by conductor 172. A resistance 173 in this line may be cut into or out of the motor circuit to change the speed thereof by switch 174 which may be moved to contact one end of the resistance or one end of a conductor 175 paralleling said resistance. The switch 174 is operated by a solenoid 176. This solenoid circuit includes the brush 158 and commutator 145, conductors 177 connecting the said elements to the line in series with the solenoid 176. When the brush 158 engages the commutator 145 the solenoid 176 is energized to operate the switch 174 to bypass the resistance 173 and thereby increase the speed of the motor 170 to rotate the drums 168 and 169 at a greater speed. The switch 174 may also be manually operated by means of a knob 195 attached thereto.

Paper tapes 184 and 185 pass over drums 168 and 169, respectively and receive the marks made by the stylus. The paper may be calibrated as shown, having a centrally disposed line 186 indicating "stop" and lines 187, 188 and 189 corresponding to slow, one half and full speed ahead, respectively, and line 190, 191 and 192 indicating slow, one half and full speed astern.

Arms 163 and 164 move the stylus 165 and 166 over these tapes in a direction and to a degree corresponding to the movement of the receiver shaft 130 and transmitter shaft 154 by reason of the beveled gears coupling the shafts to their respective stylus arms. The trace 193 on tape 184 is made by stylus 165 and the trace 194 on tape 185 by stylus 166.

While a variable speed motor has been shown, it is obvious that any suitable speed varying means may be used in lieu thereof, such as a variable speed transmission in which case the

solenoid 176 would operate the gear shifting means.

The operation of the device is as follows. With the deck transmitter set for stop the shaft 130 of the receiver 127 will be in a corresponding position. If the transmitter 151 is also set for stop, the brush 158 will be adjacent the gap in the commutator 145 thus opening the circuit to solenoid 176. This will keep the switch in a position to cut in the resistance 173 and the motor will operate at slow speed to avoid excessive use of tape. The bevel gears will turn their respective stylus to the lines 186 on the tapes indicating that both receiver 127 and transmitter 151 are in agreement.

However, if the deck transmitter 118 is turned to half-speed ahead as shown in Fig. 2, the current flowing in conductors 133 will operate relay 141 to close switch 140, energizing solenoid 137 to remove detent 135 from the star wheel whereupon the receiver assumes the same position as the deck transmitter as shown by pointer 131 of the receiver. Relay 141 will then open switch 140 to permit the detent to hold the shaft 130 in position. Turning of the shaft 130 also rotated commutator 145 counterclockwise into engagement with the brush 158 thus completing the circuit to the motor control solenoid 176 to speed up the motor 170 by cutting out resistance 173. Rotation of the shaft 130 also rotated shaft 149 through bevel gears 147 and 148 a corresponding amount so that the stylus 165 moved from the line 186 on tape 184 to line 188 registering a deck signal of one half speed ahead.

For purposes of illustration, Fig. 2 has been drawn to illustrate the application of an erroneous repeat-back signal. The operator has turned the transmitter pointer 156 to half speed astern. This movement of shaft 154 does not disengage the brush 158 from the commutator 145, the motor 170 continuing to run at high speed. Rotation of the shaft 154 has also rotated shaft 161 through bevel gears 159 and 160 to turn the arm 164 to position the stylus 166 on the tape 185 to register thereon one half speed astern as shown by the trace 194. A record has thus been made showing the signal received as well as the one repeated back.

The operator may turn the pointer 156 of transmitter 151 through 180° to one half speed ahead whereupon brush 158 will be opposite the gap in the commutator, thus breaking the circuit to the motor control solenoid 176 and slowing down the motor 170. This movement of shaft 154 will also cause stylus 166 to be moved to register a corresponding impression on the tape 185.

Having provided means for recording the signals between the bridge and engine room, it is desirable also to indicate on the tape other factors relating thereto, such as time, propeller speed, propeller revolutions, position of the prime mover throttle or control lever, etc. In Fig. 2 I have shown a printing clock 196 for recording the time on the tape 185 when the engine room receiver and transmitter are not in agreement. The printing clock is of a type well known in the art and no further description thereof is deemed necessary other than to state that it has a printing arm carrying hour and minute hands and the date whose imprint is made on the tape at predetermined intervals when its operating solenoid (not shown) is connected to a suitable source of power. The printing arm of the clock 196 overhangs the edge of the tape 185 adjacent the end of drum 167. The means for forcing the print-

ing arm into engagement with the tape is connected in series with the brush 158, commutator 145 and the solenoid 176 so that printing of the time is only effected when the engine room receiver 127 is angularly displaced with respect to the engine room transmitter 151. The marks made by the printing clock has been shown at 197 in Fig. 2. From this record, the time the signals were recorded on the tapes may be found. While only one printing clock has been shown it is of course obvious that another similar clock could be used in connection with tape 184 for the same purpose. It is also obvious that the clock could be made to print the time whenever a certain amount of tape had passed over the drum. This could be effected by having projections on the tape at fixed distances which would operate a switch to energize the clock to record the time. It is also obvious that other recording instruments could be substituted for, or used with the printing clock shown in Fig. 2 and the same energizing circuit could be used for operating such instruments in the same manner in which the clock is energized.

In Figs. 1 and 2, the solenoids which retract the detents from the star wheels are connected to the line by switches operated by relays controlled by current flowing in the conductors connecting the secondary windings. In Fig. 3 I have illustrated a system which uses a switch operated by movement of the transmitter detent for controlling the solenoid circuit.

The transmitter 198 comprises a shaft 199 upon which is affixed a three phase rotor winding 200, a star wheel 201 similar to those previously described, an indicator 202 and a controller in the form of a hand wheel 203. The bridged portion between one pair of teeth shown on the star wheels in Figs. 1 and 2 has been omitted in star wheel 201 to permit the ready disclosure of the roller 210. It is of course obvious that this roller could be mounted next to the roller detent 205, in which case the star wheels previously described could be used. A single phase primary winding 204 is associated with the rotor winding. A roller detent 205 is mounted on the end of a rod 206 carried by the core of a solenoid 207. The detent is yieldingly held into engagement with the teeth of the star wheel by a pivoted lever 208 one end of which engages the axle of the detent. A spring 209 holds the detent against the star wheel, positively positioning the transmitter in a predetermined position. A second roller 210 is mounted to ride upon the teeth of the star wheel 201 and is yieldingly held into engagement therewith by a pivoted lever 211 and a spring 212. A rod 213 affixed to the roller 210 has its free end attached to the movable member of switch 214, in the line 215.

The receiver 216 comprises a shaft 217 carrying an indicator 218, a rotor winding 219 and a star wheel 220. A roller detent 221 is yieldingly held into engagement with the star wheel by a pivoted lever 222 biased by a spring 223. The detent is fastened to the core of a solenoid 224 for retraction from engagement with the star wheel when the solenoid is energized. Stator winding 225 is operatively associated with the rotor winding 219. Other features of the transmitter and receiver have not been illustrated in the interest of simplification.

The transmitter and receiver stator windings are connected to a source of single phase alternating current by conductors 226 and the rotor windings of the two machines are connected by

conductors 227. The conductor 215 puts the switch in series with the parallel connected solenoids 207 and 224 across the line.

The operation of the system is as follows. Rotation of transmitter shaft 199 by means of hand wheel 203 will force the roller detent 205 from between the teeth of the star wheel 201 against the tension of spring 209. At the same time roller 210 is similarly forced to ride upon the adjacent tooth moving the rod 213 in a vertical direction against the tension of spring 212 to close switch 214. This serves to energize solenoids 207 and 224 to retract roller detents 205 and 221 from the star wheels 201 and 220 leaving the receiver shaft free to align itself angularly with the transmitter shaft under the influence of the synchronizing torque generated by current flowing in conductors 227. The switch 214 is designed to close before the roller 210 rides over the point of the tooth, preferably when the shaft 199 has been rotated about 10° in either direction. When the roller 210 rides over the point of the adjacent tooth it will assume a position between that and the next tooth and will open the switch 214 to deenergize the solenoids 207 and 224 whereupon the springs 209 and 223 will force the detents 205 and 221 into engagement with their respective star wheels to yieldingly hold said shafts against rotation.

While but one receiver and one transmitter have been shown in Fig. 3 it is to be understood that the control system for the solenoids could be substituted for that shown in Figs. 1 and 2. Where there is a plurality of transmitters, it would only be necessary to connect the switches for each transmitter, corresponding to switch 214 in Fig. 3, in parallel and these in series with the parallel connected solenoids as shown in Fig. 3 so that the closing of any switch by movement of a transmitter shaft would close the circuit for all the solenoids to permit all of the devices to synchronize simultaneously.

While I have described the preferred form of my invention I do not wish to limit myself to the precise details as shown but wish to avail myself of such variations and modifications as may come within the scope of the appended claims.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

I claim:

1. In an electric motion transmitting system, a transmitting station and a receiving station remote from each other, a self-synchronous motor in each station electrically linked together by a self-synchronizing circuit for self-synchronous operation, a controller for moving the motor in said transmitting station, means movable with said controller for indicating a plurality of control positions, means releasably holding both of said motors in any one of said plurality of positions, and means responsive to increase in current in said self-synchronizing circuit connecting said motors as a result of moving the transmitting motor by said controller for releasing said holding means.

2. In an electric motion transmission system, a transmitting station and a remote receiving station each having a self-synchronous motor therein, a circuit electrically linking the motors in said transmitting and receiving stations together for self-synchronous operation, means

releasably holding one of said motors in any one of a plurality of positions, said means being in the form of a star wheel having a roller detent yieldingly pressed into engagement therewith, the teeth of said star wheel terminating in relatively sharp points, and a solenoid electrically connected into said self-synchronizing circuit and operable upon increase in current therein to withdraw said roller detent from engagement with the star wheel sufficiently to allow operation of the system.

3. In an electrical motion transmitting system, a transmitting station and a remote receiving station each having a self-synchronizing motor therein, a circuit electrically linking the motors in said transmitting and receiving stations for self-synchronous operation, a controller for moving the motor in said transmitting station, means movable with said controller for indicating a plurality of control positions, means releasably holding one of said motors in any one of said plurality of control positions, said last means comprising a star wheel operatively connected to one of said motors having each tooth thereof corresponding with one of said control positions and a roller yieldingly pressed into engagement with the teeth of the star wheel, a solenoid adapted upon energization to retract said roller detent from the teeth of the star wheel sufficient to free the system for operation, and a circuit operatively connecting said solenoid into the self-synchronizing circuit between said motors.

4. In an electrical motion transmission system, a transmitting station having a self-synchronizing motor, a controller for moving said motor, and a pointer movable with said controller relative to a dial divided into sectors indicating a plurality of control positions to which said motor may be moved, a receiving station having a self-synchronizing motor therein electrically connected to the motor in said transmitting station for self-synchronizing operation therewith, a star wheel fixed to one of said motors and movable therewith, the teeth on said star wheel corresponding in number to the number of said control positions and arranged so that the roots of the teeth assume the mid-points of the control positions to which they correspond, a detent carrying a roller adapted to enter the teeth of the star wheel to releasably hold the synchronized motors at the mid-point of any one of said control positions, means yieldingly urging said detent roller into engagement with the teeth of said star wheel, a solenoid for retracting said roller detent sufficient to free the star wheel and the system for synchronized operation, and a circuit for the solenoid operatively connected into the synchronizing circuit between said motors and responsive to the increase in current therein as a result of moving said transmitting motor to retract said roller detent.

5. An engine room telegraph system comprising in combination, a deck indicator unit and an engine room indicator unit each having a motion transmitting self-synchronous motor and a motion receiving self-synchronous motor and means for indicating the respective positions of the motors, electric circuit means connecting the motion transmitting motor of each unit with the motion receiving motor of the other unit for self-synchronous operation, an alarm device, an electric circuit for operating said alarm device normally open but adapted to be closed when the motors in one or both of said units are

not in positional agreement, and means for interposing a time delay in said alarm circuit preventing operation of said alarm device until after a predetermined interval of time.

6. In an engine room telegraph system, a self-synchronous transmitter and receiver, means electrically connecting said transmitter and receiver for self-synchronous operation, means releasably holding each of said transmitter and receiver in any one of a plurality of positions, said holding means comprising a star wheel having teeth thereon and a detent normally biased yieldingly against said teeth, said teeth terminating in relatively sharp points, a knob connected to the star wheel of the transmitter for manually turning the transmitter star wheel, means operable upon manually turning any one of said star wheels and forcing its associated detent from between said teeth for retracting all of said detents from engagement with said star wheels to permit said transmitter and receiver to assume the same angular position, said last means being operable upon approximate realignment of said star wheel to allow said detent to return against and exactly realign said wheels in one of said plurality of positions.

7. An engine room telegraph comprising a plurality of self-synchronous transmitters connected in parallel and a self-synchronous receiver, means connecting said transmitters and said receiver for self-synchronous operation, means releasably holding each of said transmitters and receiver in any one of a plurality of positions, said holding means comprising a star wheel having relatively sharp teeth thereon and a roller detent yieldingly engaging said teeth, electrical means for simultaneously retracting all of said detents from engagement with said star wheels, a circuit for energizing said electrical means, a knob connected to the star wheel of the transmitter for manually turning the transmitter star wheel, and means operable upon manually turning any one of said star wheels and forcing its said detent from between said teeth for energizing said circuit to retract said detents, permitting said transmitters and receivers to assume the same angular position.

8. In an electrical motion transmitting system, a transmitting station and a receiving station remote from each other, a self-synchronous motor in each station electrically linked together by a self-synchronous circuit for self-synchronous operation, a controller for moving the motor in said transmitting station, means movable with said controller for indicating a plurality of control positions, a cam fixed to rotate with the self-synchronous motor at the receiving station, said cam having a plurality of closely spaced depressions, each depression corresponding to one of said control positions, a follower means yieldingly pressed against said cam, said cam and said follower being so constructed that said follower will cause said cam when yieldingly pressed thereagainst to move to the nearest control position, and means responsive to a change in position of said motor at said transmitting station to withdraw said follower at least during the initiation of said change.

9. The combination of claim 8, in which a similar cam and follower are provided at the transmitting station, said last mentioned cam being fixed to rotate with the self-synchronous motor at said transmitting station and means responsive to said change in position of said

15

motor at said transmitting station to also withdraw the follower at said transmitting station simultaneously with the withdrawal of the follower at said receiving station.

10. The combination of claim 8, in which the means responsive to a change in position includes an electrical retracting means energized by an increase in current in the self-synchronous circuit.

11. In an engine room telegraph system, a deck indicator and an engine room indicator, each comprising a motion transmitting device having a dial and a pointer and a motion receiving device having a dial and a pointer, means interconnecting the transmitting device of each indicator with the receiving device of the other indicator for synchronous operation, an alarm bell at the deck indicator and an alarm bell at the engine room indicator, means including a time delay means for ringing said alarm bell at said deck indicator when the transmitter and receiver at said deck indicator are in misalignment, and means including a time delay means for ringing said alarm bell at said engine room indicator when the transmitter and receiver at

16

said engine room indicator are in misalignment, the time delays inserted by said two time delay means being different.

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