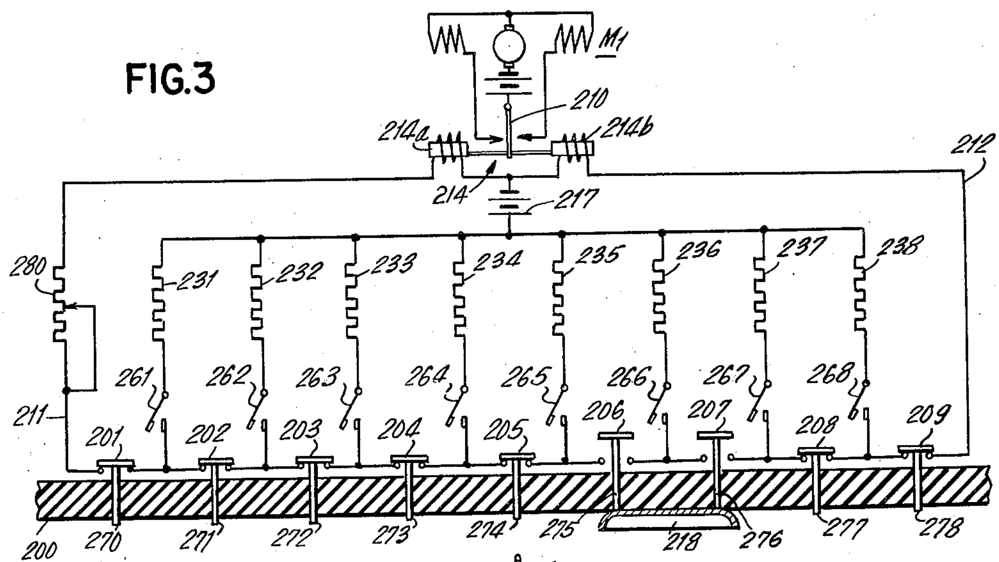
Dec. 25, 1962 W. REINERS ET AL 3,070,320

METHOD AND APPARATUS FOR SERVICING MULTI-STATION FABRICATING MACHINES, PARTICULARLY YARN WINDING MACHINES

Filed Oct. 8, 1959 3 Sheets-Sheet 1

FIG.3



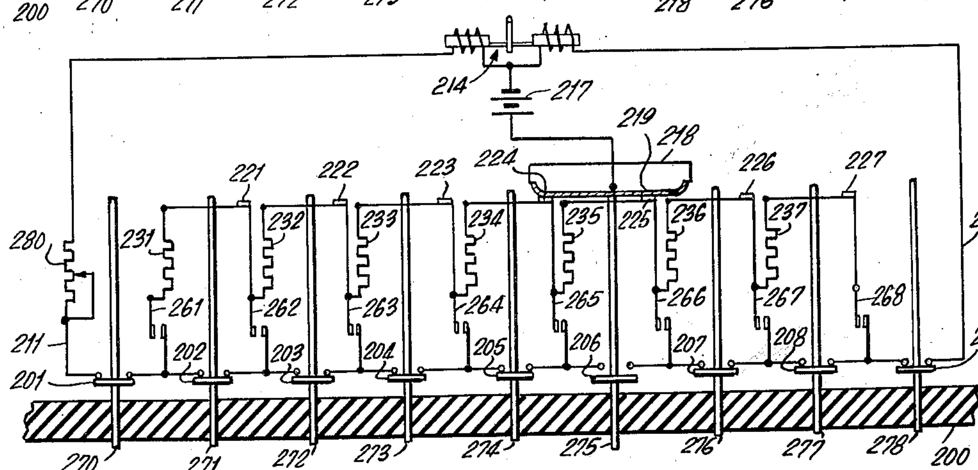


FIG.4

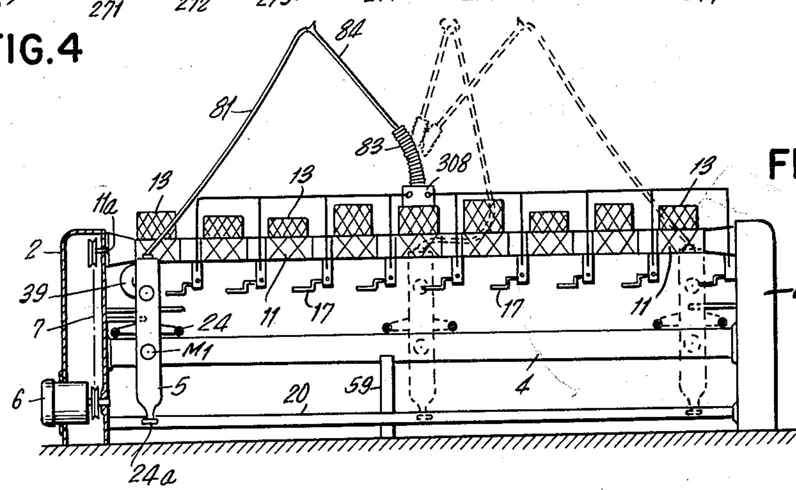
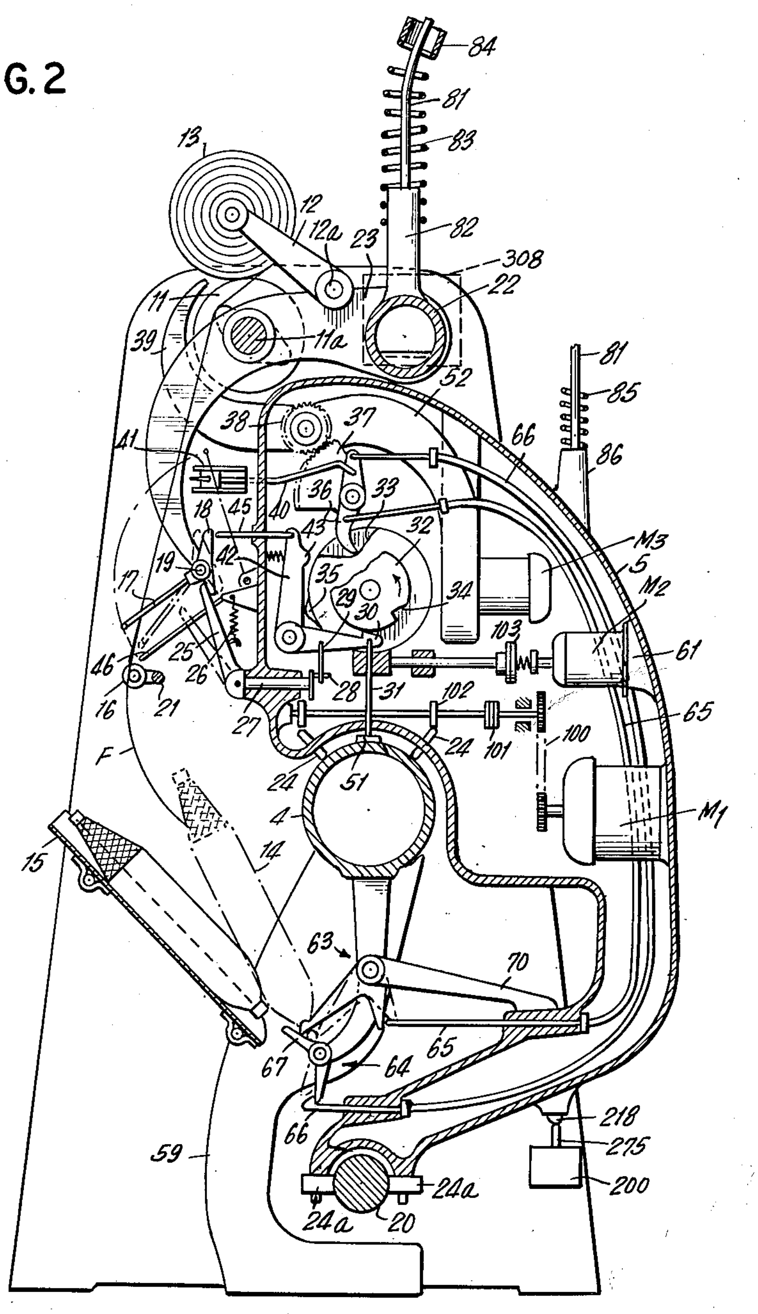


FIG.1

FIG. 2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12a
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86
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36
33
18
45
40
43
32
M3
42
5
19
35
M2
17
29
34
30
103
61
25
46
26
28
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102
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16
21
27
24
101
100
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24a
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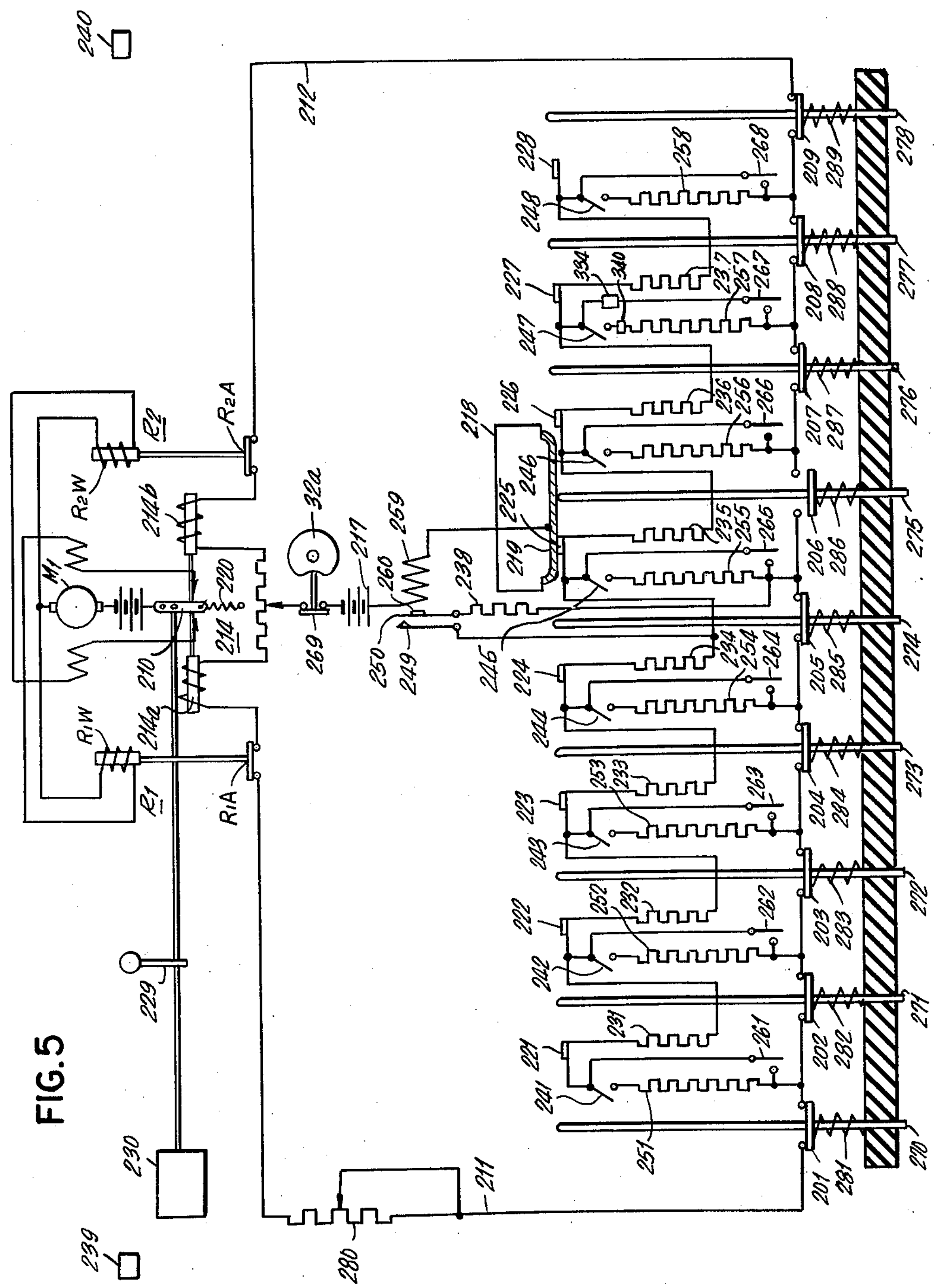

FIG. 5

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METHOD AND APPARATUS FOR SERVICING MULTI-STATION FABRICATING MACHINES, PARTICULARLY YARN WINDING MACHINES

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24 Claims. (Cl. 242—35.5)

Our invention relates to method and means for the elimination of fault and stoppage in machines equipped with a multiplicity of fabricating stations of the same design and performance. In a more particular aspect the invention is preferably applicable to textile fabricating machines, such as yarn-coil winding machines in which relatively small yarn packages, for example the spinning cops as they come from the spinning machine, are re-wound into larger yarn packages of a particular size and shape desired for further fabrication of the yarn. A machine of this type may comprise a large number of individually operating winding stations, for example 80 such stations.

In a further aspect, our invention relates to the sequential servicing of the fabricating stations by means of a mobile servicing unit or "tender" whenever it becomes necessary to eliminate stoppage conditions in a station as may be caused in a winding machine by yarn breakage or depletion of the yarn supply coil.

Such multi-station machines with a servicing unit or tender common to a number of stations have previously been disclosed in the copending application Serial No. 728,139, filed April 14, 1958, of Stefan Fürst, assigned to the assignee of the present invention; and our invention also relates to improvements in machines of the type disclosed and claimed in that application.

The traveling tender, for cooperating with the individual winding stations, is provided with servicing mechanisms which, in the event of yarn breakage or depletion of a supply coil, locate the respective yarn ends of the takeup spool and yarn-supply coil, then pass both yarn ends to a knotter which ties them together, whereafter the winding station is again placed into operation. Stoppages of the type just mentioned may happen at any unforeseeable moment; and since the servicing tender is rather expensive, it is important to keep its idling periods, namely the periods of travel along a row of winding stations, at a minimum compatible with the irregularity of the occurring stoppages.

In the multi-station machines with a traveling servicing unit or tender as heretofore proposed, the tender is caused to travel along the row of winding stations in a regular sequence, for example in such a manner that the tender passes along the row from the left to the right and thereafter from the right to the left. During each forward and return travel the tender is automatically stopped at any individual winding station requiring a servicing operation at that time. The knotting or coil-exchanging mechanisms, of the tender then become active to eliminate the fault, whereafter the winding station continues its winding operation and the tender continues traveling along the machine in accordance with its fixed travel sequence. With such a regular program of travel, the tender often requires a relatively long traveling time, and an individual winding station in which a fault may occur just after the tender has passed by will remain stopped and inactive for the correspondingly long interval of time.

It is an object of our invention to reduce the idle traveling time of the tend to the best feasible minimum and to thereby improve the efficiency of the automatic servicing operations or to make a single servicing tender

economically applicable for a greater number of individual winding stations.

According to our invention we provide the tender with a reversible propulsion drive and equip the individual fabricating stations with a fault-responsive sensing means which is connected with the drive control system of the tender so that each fabricating station, in response to occurrence of fault, issues a call signal which positionally identifies that particular station and controls the tender to travel from the position previously occupied to the location of the troubled fabricating station where the servicing mechanisms of the tender become active to eliminate the fault or stoppage condition. With particular reference to multi-station winding machines, the call signal in each station is preferably issued by the response of the yarn guard or other feeler member to breakage or absence of yarn.

With such a travel control system for the servicing tender, the tender is normally at standstill as long as no fault or stoppage occurs in any one of the fabricating or winding stations to be serviced. Upon occurrence of a fault-responsive call, the drive control system of the tender becomes active to cause traveling of the tender in the one direction and over the particular distance required to place the servicing mechanisms of the tender into active engagement with the troubled station.

As mentioned, the call signals may be issued by fault-responsive sensing means located at the individual fabricating or winding stations of the multi-station machine. and it will be understood that the checking or sensing of the working conditions by the sensing means may be continuously or intermittently as may be desired.

However, according to another feature of our invention, a model preferably an electric model, of the stations may be provided and the model unit may then be located remote from the fabricating machine proper, for example in a convenient central location or in a control cabinet. With such an imitation of the actual machine by means of a model, the station-position identifying means of the model are sensed by the control device and the servicing tender of the actual machine is set in motion in accordance with the operation condition of the model.

A reversible and position-responsive travel control of the servicing tender in response to fault-dependent call signals makes it possible to maintain an optimum number of fabricating or winding stations in operation and to reduce the idling travel period of the servicing tender, thus greatly improving the economy of the machine plant.

According to another, more specific feature of our invention the directional control of the tender travel is effected by supplying the drive control system with controlling energy through the fabricating stations or their model images in such a manner that the flow of energy, for example electric current, passes either through one path which includes all stations or station models on the right side of the tender or, alternatively, through another path which includes all stations or station models on the left side of the position just occupied by the tender. The control apparatus of the tender then measures the strength of the controlling energy, or the difference in energy if both paths are simultaneously activated. The occurrence of power flow in one of the two paths, or of a power difference between the two paths is then indicative of the location or distance of the troubled station to be next serviced, whereas, in the event of simultaneous power flow in both paths, the result of the comparison or the differential effect is indicative of the urgency and the preferred traveling direction.

It may happen in a system as just briefly described, that two stations become troubled that are located at opposite sides of the position then occupied by the servicing tender but at equal distances therefrom. In order to prevent in such a case the two power supply paths to become balanced with respect to their action upon the drive control system of the tender, which would cause the tender to remain at a standstill, one of the two traveling directions is given preference by inserting into only one of the two current supply paths an impedance with respect to the power flow. For example, when operating with an electric control system, one of the two current paths is provided with a resistor whose resistance value is so chosen or adjusted that the current in a preferred one of the two paths will always be greater than that in the other under operating conditions which otherwise would result in current balance.

In control systems of the kind last mentioned, the occurrence of a fault-responsive call signal is preferably used for increasing the flow of power or electric current through the one appertaining path or circuit branch. That is, since two paths or branches are available, only one of them is supplied with power or current in the event only one station at a time calls for a servicing operation by the tender. This one circuit branch then issues the control command which causes the drive of the tender to pass it to the particular station. However, when a call signal is simultaneously received from both sides, the supplied amounts of power or electric current are weighed against each other, and the circuit branch carrying the strongest current will then determine to which side the tender will travel first. If two call signals are active simultaneously on one and the same side of the tender, the combined call signal preferably manifests the simultaneous existence of two individual calls, for example by correspondingly increasing the electric current flow, and this increased current flow is preferably made so strong as to outweigh an individual call signal which comes from the opposite side of the tender and whose distance from the tender is equal to that of the station closest to the tender on the opposite side where two stations have simultaneously responded. It can be achieved in this manner that the occurrence of a second call signal on one and the same side will determine the advancing direction of the servicing tender with the result that the machine side troubled by a greater number of simultaneous call signals will be serviced before the tender travels to the other side. Consequently, those stations are first returned to operative condition for whose servicing a minimum of traveling time is required by the tender.

If disturbances of respectively different urgency can occur in the individual winding stations, the invention affords the possibility of assigning to a particular disturbance a higher degree of urgency than to others, for example by assigning to that particular disturbance a greater flow of power or electric current. In this manner, graduated differences in urgency of the fault elimination can be introduced. For example, in a multi-station coil winding machine operating with yarn susceptible to a relatively great number of breakages, it may be preferable, in the event the supply coil in a station becomes depleted, to service that station with preference rather than performing the more frequent knotting operation required by yarn breakage in another station. In this case the signal denoting a higher degree of urgency may be issued in each station by a yarn feeler which rests against the body of yarn on the supply coil and which closes a contact when the yarn of the supply coil is used up.

It may happen during operation of the multi-station machine, that the servicing tender remains inactive because all stations are operating without trouble. In this case, and in accordance with another feature of our invention, it is preferable to assign to the mobile tender a predetermined stopping or waiting place, for example in the middle of the machine, from which the distance to most of the individual winding stations is the shortest. It is also of advantage if the operating condition or position of the servicing tender is made visible at the tender and/or at some other location of the machine, for example by the provision of pilot lights or other signals which readily show when a call is issued to the tender, when the tender is traveling to the calling station, when the tender is active to eliminate stoppage condition, or when the tender is temporarily inactive. Provision may further be made to pass the servicing tender to a predetermined stoppage position, either in the middle of the machine or at one end where it is put out of operation. This is desirable, for example, when the individual stations are being set up for operation as may be necessary, for example, when changing from one to a different type of yarn.

As mentioned, the drive control system of the servicing tender is provided with a measuring or comparing device for determining the distance of a calling station from the tender or the preference of a servicing operation to be performed. According to a further feature of our invention, we serve this purpose preferably by providing a differential relay which receives power from the two power supply paths described above. Particularly suitable is an electric differential relay whose respective two windings are connected in two circuit branches. The differential relay is preferably given an inactive midposition in which the drive of the tender is deenergized to keep the tender at standstill. When using an electric differential relay, the proper centering of its armature or contact assembly can readily be effected by providing a calibrating potentiometer rheostat.

In order to directionally control the travel of the servicing tender in dependence upon the location of the respective calling station as well as in dependence upon the instantaneous position of the tender, it is preferable to represent the winding stations in the control system by corresponding substitute devices, such as electric resistors when operating with an electric control system. These station-representing resistors or other devices are then connected with each other in accordance with the type of power (electric, or hydraulic, for example) being used. The substitute devices for resistors may be connected in series or parallel relation to each other or in a combined series and parallel arrangement. When using an electric parallel connection of the station-representing resistors, as shown in FIG. 1 of the drawing, the servicing tender is controlled to first travel with preference to the one side of the machine from which a greater number of faults or stoppages is being signalled. However, this arrangement makes difficult or prevents a response in dependence upon the distance of the troubled stations. However, when the station representing devices or resistors are connected in series, as in FIG. 4, then the proper gauging of the distance of a troubled station is afforded, but it is difficult, in the event of several simultaneous calling signals, to let the tender preferentially travel to the machine side from which more faults are being signalled. Most favorable is a combination of series and parallel connections which affords utilizing the advantages of both types of circuits. It is further preferable to insert into one of the two circuit branches an electric impedance or resistance which reduces the flow of power or current through that particular branch in order to let the drive control system of the servicing tender give preference to the other circuit branch whenever the conditions are such that otherwise the effects of both branches would cancel each other. This prevents the possibility that the servicing tender may remain idle at standstill, although a number of call signals are being issued from both sides of the machine.

The above-mentioned objects, advantages and features of our invention, said features being set forth with particularity in the claims annexed hereto, will be apparent from, and will be mentioned in, the following in conjunction with the drawings, in which:

FIG. 1 is a schematic and simplified front view of a multi-station coil winding machine, in which, for explanatory purposes, a number of parts shown in the other illustrations are omitted and in which only nine winding stations are shown although such a machine may comprise a much larger number of stations to be serviced by a single mobile tender.

FIG. 2 shows one of the winding stations of the same machine in cross section.

FIGS. 3, 4 and 5 illustrate schematically three different circuit diagrams of control systems applicable with a machine as exemplified by FIGS. 1 and 2.

Before dealing with the invention proper, as embodied in the control systems shown in FIGS. 3 to 5, it will be helpful to describe, by way of example, the design and operation of a winding machine and of a servicing tender common to a multiplicity of individually operable stations. The machine chosen for exemplification and described presently with reference to FIGS. 1 and 2, is largely similar to that more fully illustrated and described in the above-mentioned copending application Serial No. 728,139. As will be explained below, in the machine here exemplified, the servicing tender is driven by an electric motor mounted on the tender itself. It should be understood, however, that for the purposes of the invention the drive motor for the tender may also be stationarily mounted and may drive the tender through a transmission, such as an endless chain, as shown and described in the application Serial No. 728,139. Furthermore, instead of directly controlling the electric propulsion motor of the tender, the travel-reversing control may also be applied to electromagnetic or other clutches that transmit traveling motion to the tender in a selected direction from a continuously operating drive.

In the machine illustrated in FIGS. 1 and 2, two lateral standards **1** and **2** of the machine frame or carrier structure are connected with each other by a tubular horizontal carrier **4**. Mounted on the carrier **4** are a number of individual coil winding stations along which a servicing tender **5** may travel. The tender **5** carries the servicing devices required for eliminating faults and stoppages of the coil winding operation in the respective winding stations. A motor **6** drives, by means of a gear transmission **7**, a shaft **11***a* common to a number of yarn guiding drums **11**.

Each individual winding station is provided with a take-up spool **13** which rests against the yarn guiding drum **11**. The spool **13** is journalled in a frame **12** pivoted at **12***a* so that sufficient entraining friction obtains between spool **13** and guiding drum **11** under the weight of the spool and the frame. The yarn guiding drum **11** passes the yarn F onto the spool **13** while reciprocating the yarn in the axial direction of the spool for the purpose of producing a cross-wound yarn package. The yarn F comes from a supply coil **14** and passes through a yarn tensioner **16** to the yarn guiding drum **11**.

In FIG. 2, the supply coil **14** is shown by dot-and-dash lines in the position occupied when the coil is being unwound. The supply coil **14** is carried by a pivotally mounted thorn **67** which can be turned about its pivot so as to be located in the end portion of a trough **15**. In this position of thorn **67**, a supply coil **14** arriving from above in the trough **15** is automatically speared up on the thorn. Thereafter, the thorn **67** returns to the unwinding position. Located between the yarn tensioner **16** and the yarn guiding drum **11** is a yarn guard **17** which continuously tests the operation for presence of the yarn F and which turns clockwise in the event of yarn failure. A double-armed lever **18** is fastened to the yarn guard **17** in the vicinity of its pivot **19**. The fault-responsive pivoting motion of guard **17** in the clockwise direction causes the winding station to be stopped in known manner by lifting the take-up spool **13** off the guiding drum **11**. Since the mechanism required for such stopping operation is known as such it is not illustrated in order not to obscure the other components. Lever **18** forms a switching segment, and also serves for resetting the yarn guard **17**.

Each yarn guard **17** is connected or provided with an electric signal contact. These contacts, not shown in FIGS. 1 and 2, are denoted by **241** through **248** or **261** through **268** in the circuit diagrams illustrated in FIGS. 3 to 5. They serve to control the travel of the tender along the winding stations as will be explained below.

The lateral standards **1** and **2** of the machine frame structure are connected with each other not only by the tubular carrier **4** but also by a bottom rail **20** (FIGS. 1, 2), a horizontal carrier **21** for the tensioners **16**, and an upper tubular rail **22** (FIG. 2). Mounted on the upper rail **22** in each winding station is an arm **23** extending downward in a vertical plane. A supporting member **59** serves for bracing the tubular carrier **4**. The tender **5** has running wheels **24** which roll along the carrier **4**. Rollers **24***a* journalled on the tender **5** serve to guide the tender along the bottom rail **20**.

Mounted on tender **5**, at the servicing side thereof, is a switch arm **25** which is kept in approximately vertical position by a pull spring **26**. Switch arm **25** is fastened to a shaft **27** which carries a crank **28**. Rotating motion of switch arm **25** thus causes the crank **28** to entrain a linking rod **29** and a stop pawl **30** in the upward or downward direction. The motion of stop pawl **30** is also imparted to a latch **31**. When latch **31** is thus moved downwardly, it can slide into a center recess of a boss **51** on carrier **4**, thus arresting the tender and latching it to the tubular carrier **4**. The pawl **30** and the latch **31** cooperate with a cam assembly **32** which has a cam notch **34** into which the pawl **30** can enter, whereby the pawl arrests the cam disc. Cam assembly **32** also has a cam groove **33** and a dog **35**. In a given rotational position of groove **33**, a control lever **36** carrying a spur-gear segment **37** can enter into the groove. Segment **37** meshes with a pinion **38** which is connected with a suction tube **39** for conveying the yarn end to be found and seized.

Linked to the control lever **36** is a driving link **40** for controlling a knotting device **41**. The dog **35** of cam disc **32** cooperates with a projection **43** of a control lever **42** so that, during passage of dog **35**, the lever **42** is shifted counterclockwise about its pivot and then pushes a reset tappet **45** in opposition to a pressure spring against the lever **18**. When dog **35** passes beyond the projection **43**, the control lever **42** returns to its illustrated position.

Schematically shown at **46** (FIG. 2) is a conveying arm which is pivoted on the tender **5**. At the start of the yarn-end finding operation, the arm **46** turns from the uppermost position, shown by a dot-and-dash line, downward toward the yarn tensioner **16** in order to thereafter convey the yarn end, then located in the tensioner **16**, upwardly to the knotter **41**. Such devices are known as such, and for that reason are not shown and described herein in further detail.

The tender **5** has a suction conduit **52** which communicates with suction tube **39** and whose lower end communicates with the suction side of a blower driven by an electric motor M3. The suction conduit **52** provides vacuum pressure for the suction tube **39** of the yarn-end finding device.

Another motor M1 on the tender serves to drive the running wheels **24** through a transmission **100**, a slip clutch **101**, and two friction gears **102** engaging the respective wheels **24**. The cam assembly **32** is driven through another slip clutch **103** from a motor M2 also mounted on the tender. Motor M1 is reversible, whereas motors M2 and M3 are unidirectional. Motors M2, M3 may be kept running continuously as long as the machine is in operative condition. The motors M1, M2, M3 of the tender are energized through a flexible cable. The cable **81** connects the control unit **308** on the machine frame structure **1** with the motor M1 of the tender and is kept taut by means of a tubular part **82** on which is mounted a helical spring **83** carrying a tubular rod 84. Another helical spring 85 and tubular part 86 serve as a mounting for the cable 81 on the tender 5. Cable 81 can be made up of several lead wires, each connected to a respective motor M1, M2 or M3. The rod 84 assumes an inclined position toward one or the other side depending upon whether the tender is located toward the left or right of the machine center. When motor M1 is in operation and causes the tender 5 to travel along the winding stations, the switching arm 25 of the tender checks whether the yarn guard 17 in each station has turned into the fault-responsive position shown by full lines in FIG. 2, thus signalling that a knotting or coil-exchanging operation is needed. The fault-responsive movement of yarn guard 17 has the effect of turning its arm 18 into the traveling range of the switch arm 25 on the tender so that when the tender arrives, either from the left or the right, the arm 18 turns the switch arm 25 in one or the other direction. Such turning movement of arm 25 is transmitted through shaft 27 to crank 28 which, irrespective of the direction of rotation, turns the pawl 30 and the latch 31 downward. Now, latch 31 can enter into the centering recess of boss 51 and thus arrest the tender 5 in front of the winding station. The control lever 36 drops into cam groove 33 and entrains the spur gear segment 37 counterclockwise, thus rotating the pinion 38 clockwise. The suction tube 39 fastened to pinion 38 now turns from its lowermost (not illustrated) position upwardly. Since at this time the suction blower is being driven by motor M3, a current of air enters into the nozzle end of suction tube 39 and sucks the free yarn end from take-up spool 13 into the tube 39. For this purpose, the take-up spool 13 is preferably turned slowly in the reverse direction by known means (not illustrated).

During further rotation of cam 32, the control lever 36 again turns back in the clockwise direction, and the suction tube 39 of the yarn-end finder device again turns downwardly, thus entraining the seized yarn end from the take-up spool 13 into the immediate vicinity of the knotter 41. At the same time the conveying arm 46 has passed from its uppermost (dot-and-dash) position to the lowermost (full-line) position 46 where it seizes the yarn end coming from the supply coil 14. During the next following return travel in the upward direction of arm 46, the latter yarn end is also placed against the knotter 41 which now ties both yarn ends together.

In the meantime, the cam 32 has turned to the position where its dog 35 presses against the projection 43 of control lever 42 and thus pushes the return tappet 45 toward the left for a short interval of time. The tappet movement acts upon the lever arm 18 of the yarn guard 17 and resets the guard so that the winding station is ready for further operation. When the knotting operation is satisfactorily performed, the winding station now continues the winding-up of the take-up spool 13. If the knotting operation failed, the yarn guard 17 does not remain in its lowermost position and thus initiates a repetition of the above-described servicing operation.

Immediately after the dog 35 has passed beyond projection 43, the stop pawl 30 enters into notch 34 of cam 32. This releases the latch 31 from the boss 51, and the tender 5 can then travel to another winding station where, if needed, the servicing operation is initiated and performed in the same manner as described above.

As mentioned, the tender, in response to certain conditions, must discharge an empty supply coil from a winding station being serviced and must substitute a full supply coil. The servicing mechanism for performing such exchanging operations in the above-described embodiment comprises two Bowden wires 66 and 65. The Bowden wire 65 controls the spearing-up device for thorn 67 generally designated by 64. The Bowden wire 66 controls a doffer generally designated by 63 for lifting an empty supply coil off the supporting thorn. Since these devices are not essential for explaining and understanding the present invention, they are not further described herein. If desired, however, an illustration and description of further details is available in the above-mentioned copending application Serial No. 728,139.

The travel of the tender in the above-described machine may be controlled from the control unit 308 (FIG. 1) in accordance with the invention by any one of the control systems exemplified in FIGS. 3, 4 and 5. Dealing first with the one shown in FIG. 3, it will be noted that the system includes a traveling slider 218 which is either mounted or mechanically connected with the tender (FIG. 2) to travel together therewith, or which, if the control system constitutes a substitute model of the machine, is driven in proportion to the travel of the tender, for example by a suitable mechanical or electrical connection such as a synchro-tie. During such traveling motion, the slider 218 sequentially actuates a number of control switches 201 to 209 through respective pins 270 to 278 which are displaceable in a mounting bar 200. The switches 201 to 209 are all connected in series between two circuit branches 211 and 212 which can be energized from a suitable current source 217 through the respective windings 214*a* and 214*b* of a differential relay 214 whose armature 210 is normally in an inactive mid-position and, when energized to move in one or the other direction, causes the drive motor M1 to run in one or the other direction for driving the tender to the left or right, depending upon which of the relay windings 214*a* and 214*b* is energized, or more strongly energized than the other, at a time. The supply of current from source 217 to the two circuit branches of relay 214 is controlled by the above-mentioned fault-responsive contacts 261 to 268 which are controlled by the yarn guards 17 in the above-described manner. Only eight winding stations are represented in FIG. 3 by respective signal contacts 261 to 268 and respective resistors 231 to 238, although the same system is analogously applicable for any desired number of winding stations.

Assume that the tender is at rest in a position corresponding to that of the slider 218 in FIG. 3 and that all winding stations of the machine are in proper operation so that all yarn-guard controlled contacts 261 to 268 are open as shown in FIG. 3. Further assume that now a fault occurs, for example in the first station at the left so that its yarn-guard causes closing of contact 261. This energizes the coil 214*a* of the differential relay 214 from source 217 in the circuit: 217—231—261—201—211—280—214*a*—217.

Relay 214 now controls the propulsion motor M1 to move the tender and the slider 218 to the left until slider 218 arrives at the troubled station and opens the limit switch 201, thus interrupting the above-mentioned relay circuit. The control relay 214 is deenergized and motor M1 rapidly coasts to standstill, thus permitting the tender to become latched in proper position and to start its servicing operation at the calling station as described above with reference to FIGS. 1 and 2. When the servicing work is completed, the yarn-guard controlled contact 261 reopens, but this has no effect upon control relay 214 because switches 201 and 202 in the relay control circuit are still open.

When thereafter any other station calls for servicing by closing of its fault-responsive contact, such as contact 263, an energizing circuit for control relay 214 can be completed only through the right-hand circuit branch 212 and relay coil 214*b* so that the motor M1 is controlled to run in the reverse direction. The motor then shifts the tender to the right until slider 218 opens the limit switch, such as switch 204, next adjacent to the right of the closed signal contact.

If two or more signal contacts close simultaneously, both relay coils 214*a* and 214*b* may become energized, but due to the asymmetrical resistance distribution in the control network, one of them will then receive more current than the other so that the motor M1 runs in a preferred direction and first responds to one of the simultaneous calls before taking care of the other.

It will be noted that when more than one fault-responsive contacts are closed simultaneously on one and the same side of the slider 218, for example the contacts 261, 262 and 263, the current flowing through the circuit branch 211 is increased accordingly because a corresponding number of resistors are now connected in parallel. Consequently, the tender is controlled to travel to the side of the greater number of troubled stations in the event one or a smaller number of stations are troubled simultaneously on the opposite side.

The control system shown in FIG. 4 is to a large extent similar to that described above with reference to FIG. 3, except that the station-representing resistors 231 through 237 in FIG. 4 are all connected in series. Furthermore, the control slider 218 traveling together with, or in proportion to, the travel of the tender, is provided with a slide contact 219 which is engageable with a number of stationary contacts 221 through 227.

Assume that, with slider 218 in the illustrated position, a fault-sensing contact, such as contact 263, closes at the left. Then the relay coil 214*a* is energized from source 217 through slide contact 219 and through components 224, 234, 233, 263, 203, 202, 201. As a result, the drive motor M1 is controlled to move the tender toward the left. In other respects the operation need not be further explained because it corresponds to that of the system described above with reference to FIG. 3. It will be noted, however, that in the system of FIG. 4 the control system of the drive will cause the tender to preferentially move in the direction of the closest station from which a call is received.

The tender will move to the closest station in the embodiment of FIG. 4 because the number of serially connected resistors 231–237 between the slide contact 219 and any closed contact will increase as the distance from the slide contact 219 to the closed contact increases. Thus, the relay-energizing current through the appropriate winding of the relay 214 will be less from a more distant station than the current from a closer station.

In the embodiment of the control system shown in FIG. 5, a group of series-connected resistors 231 to 237 is combined with a group of parallel-connected resistors 251 to 258. In this embodiment, the yarn-guard controlled signal switches are denoted by 241 to 248. The parallel resistors 251 to 258 are provided with respective shunt paths which include condition-responsive switches 261 to 268 respectively. Closing of these switches eliminates the respective parallel resistors from the calling circuits. As explained above, the switches 261 to 268 are closed in response to faulty conditions of greater urgency than those responded to by respective contacts 241 and 248. Whenever one of the switches 261 to 268 closes, the circuit branch then completed by that switch is traversed by a stronger current than if the corresponding contact 241 to 248 closes. Consequently, the urgency switches 261 to 268 impose a more intensive control current upon the differential relay 214 than occurs in the event of a normal disturbance. If desired, the leads connected to the signal contacts 241 to 248 and those connected to the switches 251 to 258 may include respective counting devices, such as those shown schematically at the locations 339 and 340, in order to count the number of closing operations for permitting a conclusion as to the economy of system performance.

The slide contact 219 of slider 218, when traveling to a calling station, sequentially engages a series of stationary electric contacts 221 to 228 and also depresses a number of pins 270 to 278 in opposition to respective springs 281 to 288. This causes opening of respective switches 201 to 209. As a result, the line of electric connections for operation of the differential relay 214 is divided in two mutually independent circuit branches extending through leads 211 and 212 respectively for energizing the relay coils 214*a* and 214*b* as explained above.

The lead 211 includes a series connected and preferably adjustable resistor 280 for causing the system to preferentially move the tender toward the right in the event of simultaneous and otherwise equivalent calling signals passing through the two respective circuit branches.

The differential relay 214 is preferably of the type in which the relay armature 210 is normally in inactive mid-position. The proper mid-position can be secured by means of a biasing spring 220. Depending upon whether the armature 210 moves to the left by operation of winding 214*a* or to the right by operation of winding 214*b*, one of the two field windings of motor M1 is energized and causes the motor to drive the servicing tender to the left or right. If desired, a suitable interlock may be provided so that when the motor has commenced running in one direction it cannot be controlled to reverse its direction until after it has completed the travel first called for and has become arrested and operative at the calling station. For example, such an interlock may comprise two lock-out relays as shown at R1 and R2. Relays R1 and R2 respectively include winding R1W, R2W and armatures R1A and R2A. Each of the windings in relays R1, R2 is serially connected with one of the windings of motor M1. When the winding 214a is energized to move armature 210 to the left, in FIG. 5, this energizes the left-hand winding of motor M1 and the relay R2. Consequently, winding 214*b* is disconnected until winding 214*a* is de-energized. Similarly, when winding 214*b* is energized, relay R1 disconnects winding 214*a* until winding 214*b* is de-energized. These relays are preferably of the rapidly-opening and delayed-closing type.

The armature assembly 210 of relay 214 can also be shifted to one or the other position by means of a handle 229 for manual control of the tender. The handle 229 is connected to the relay armature 210. The handle moves with the tender and is capable, when actuated by hand or a limit stop, of moving the armature from its center position to its contact positions and back. If desired, the armature assembly may also be connected with a counter 230 for counting the changes in traveling direction. When the tender travels to the outermost position at the left of the machine, the handle 229 abuts against a stop 239 and is thus placed into its zero position so that the tender is stopped. A similar stop 240 is provided on the right-hand side. Such manually controllable travel of the tender to a limit position beyond the normal operating range is of advantage when all winding stations of the machine are to be newly set up or to be prepared for the winding of a different type of yarn.

A pair of auxiliary contacts 249, 250 is provided in the middle portion of the multi-station machine and connected parallel to the urgency switch 265 and in series with a resistor 238. The contacts 249, 250 form part of a relay 259 which is connected in series between the current source 217 and the slide contact 219 and hence is energized whenever any one of the condition-responsive contacts or switches 241 to 248 and 261 to 268 is closed. In this energized condition of relay 259 the contacts 249, 250 are open as shown in FIG. 5. The relay coil 259, however, is deenergized if and as long as no fault is being signaled. Then relay 259 releases its armature 260 so that contacts 249, 250 close. This causes the differential relay 214 to energize the motor M1 so as to drive the tender to a predetermined waiting position. In the system as shown in FIG. 5, the waiting position is identical with the position occupied by the tender when it is in operative relation to the winding station containing the condition-responsive contact 225. If desired, however, the waiting position selected for the tender need not be occupied by a winding station. In the circuit diagram of FIG. 5 this would mean that at the waiting position the contact 225 and the switch 265 are omitted.

Also provided in the system shown in FIG. 5 is a main switch 269 which can be opened during the servicing operation of the tender and which is closed only after the winding station is put back into proper winding operation. The switch **269** may be controlled, for example, by the above-mentioned cam assembly **32** (FIG. 2) which according to FIG. 5 is provided with a cam *32a* for actuating the switch **269**.

It will be recognized that in the system of FIG. 5 any call, once responded to by initiation of tender travel, will be performed and completed by the tender traveling to the troubled station and eliminating the stoppage condition, before the tender will respond to another call signal. Of course, if the tender, during travel in a given direction, encounters a winding station which has become troubled after the previous call signal from a more remote station at the same side has been fully responded to, the tender will stop and perform its servicing operation at the intermediate location.

The operation of the system will be further understood from the following example.

Assume that the tender was at standstill in a position at the right of the position shown for the slider **218** in FIG. 5, and that all stations are operating satisfactorily so that no yarn-guard contact (**241** to **244** and **246** to **248**), and none of the urgency switches **261** to **268** is closed. Then the relay **259** is inactive and contacts **249**, **250** are closed. As a result, winding **214***a* of the differential relay **214** is energized in the circuit: **217—269—214***a***—280—211—201 — 202 — 203—204—205—238—250—249—225—219—259—217**. Relay **214** switches its armature to the position required to make motor M1 drive the tender and the slider **218** to the left until the slider actuates pin **274** so that switches **206** and **205** are open. The circuit for relay winding **214***a* is now interrupted, and the tender with slider **218** stands still in the predetermined idle mid-position.

If the tender and the slider **18** are located at the left of the mid-position and any of contacts **201** to **204** are open at a time when no servicing action by the tender is being called for, the circuit of relay **259** is closed through circuit branch **212** so that the winding **214***b* is energized to cause shifting of the tender to the right until it reaches the above-mentioned idle mid-position.

The above-described circuit diagrams of FIGS. 3, 4 and 5 can be modified in various ways, thus, the slider **218** can be made to open only one of the switches **202** to **208** at a time, and switch **201** can then be omitted. The tender will nevertheless stop at the calling station as soon as it is latched in position in which, due to the slip coupling **101** (FIG. 2), no traveling motion is transmitted from motor M1 to the running wheels **24** of the tender.

In lieu of controlling the drive by electric power and electric components, other types of controlling energy may be employed in an analogous manner, for example optical components operating with radiating energy such as light rays or heat rays. In this case, the tender may be provided with a source of light which can issue two beams of light toward the right and toward the left upon two photoelectric cells at the respective ends of the machine. Movable gray discs or filter plates are mounted on, or controlled by, the respective yarn guards which, in the even of stoppage conditions, turn out of the beam of light and instead turn a mirror into the beam which passes the light through a parallel path that does not include the gray filters so that the light reaches one of the photoelectric cells without diminution. The photoelectric cells then control the differential relay **214** through electric leads and through any necessary amplifying means.

A control system according to the invention may also operate with pneumatic control circuits and components. In this case the electric resistors are to be substituted by throttle valves or other fluid-flow impeding devices, and the electric switches by corresponding control valves. The control system may further operate with mechanical means, such as with the aid of rotating shafts provided with braking means in lieu of the electric resistors, and with differential gears in lieu of an electric differential relay. Furthermore, instead of providing a central energy source for the control system, two separate energy or power sources for feeding the two branches or paths of the system can be used.

While the invention has been described above with reference to a multi-station winding machine according to the copending application Serial No. 728,139, it is analogously applicable to multi-station winding machines of different design, as well as to other fabricating machinery in which a group of mutually independent fabricating stations simultaneously perform substantially the same fabricating operation and are individually serviced, in response to stoppage or other fault, by a single traveling servicing unit or tender in accordance with the principles explained in the foregoing.

We claim:

1. The method of eliminating fault in automatic fabricating machines having a multiplicity of serially grouped and independently operable fabricating stations with respective working devices of the same fabricating performance and having a servicing tender movable along the group of stations and engageable with any one of them at a time for removing fault therein, which comprises issuing for each station a station-identifying call signal in response to occurrence of fault in said station, maintaining the tender at standstill when no call signal is issued, and selectively driving the tender under control by a call signal in one direction and along the distance required to place the tender into servicing engagement with the calling station.

2. A fabricating machine comprising a multiplicity of individually operable fabricating stations arranged in a serial group and having respective working mechanisms of substantially the same design and fabricating performance and having each a stoppage-responsive sensing means, a mobile tender common to said group of stations and having a given travel path along said group, said tender having servicing mechanisms engageable with one of said respective stations at a time for removing stoppage conditions therein, a reversible propulsion drive connected with said tender for moving it along said path upon call by said stoppage-responsive sensing means, drive control means connected with said reversible drive, and a selective call system connecting said multiplicity of sensing means with said drive control means for controlling said tender to travel in the direction and by the amount required for placing the tender into servicing engagement with a station whose sensing means has responded.

3. A coil winding machine comprising a multiplicity of serially grouped and mutually independently operable winding stations each having coil rewinding means and sensing means responsive to stoppage conditions, a mobile tender common to said group of stations and having a travel path along said group, said tender having servicing mechanisms engageable with one of said respective winding stations at a time for removing stoppage conditions therein, a reversible propulsion drive connected with said tender for moving it along said path upon call by said stoppage-responsive sensing means, drive control means connected with said reversible drive, and a selective call system connecting said multiplictiy of sensing means with said drive control means for controlling said tender to travel in the direction and by the amount required for placing the tender into servicing engagement with a winding station whose sensing means has responded and manually operable means for controlling the tender.

4. A fabricating machine comprising a multiplicity of individually operable fabricating stations arranged in a serial group and having respective working mechanisms of substantially the same design and fabricating performance and having each a stoppage-responsive sensing means, a mobile tender common to said group of stations and having a given travel path along said group, said tender having servicing mechanisms engageable with one of said respective stations at a time for removing stop-

page conditions therein, a reversible propulsion drive connected with said tender for moving it along said path upon call by said stoppage-responsive sensing means, drive control means connected with said reversible drive, a selective call system connecting said multiplicity of sensing means with said drive control means for controlling said tender to travel in the direction toward the calling station, and said call system comprising a number of limit switch means correlated to the respective stations and operable in dependence upon the traveling position of said tender for stopping the travel of said tender when said tender arrives at the calling station.

5. A coil winding machine comprising a multiplicity of serially grouped and independently operable winding stations each having coil rewinding means and having yarn feeler means responsive to stoppage conditions, a mobile tender common to said group of stations and having a travel path along said group, said tender having servicing mechanisms engageable with one of said respective winding stations at a time for removing stoppage conditions therein, a reversible propulsion drive connected with said tender for moving it along said path upon call by said stoppage-responsive sensing means, drive control means connected with said reversible drive, a selective call system comprising a multiplicity of normally inactive signal means connected with said respective yarn feeler means to be activated by occurrence of said stoppage conditions, said signal means being connected with said drive control means for controlling said tender to travel toward a calling station, and said call system comprising a number of limit switch means correlated to the respective stations and operable in dependence upon the traveling position of said tender for stopping the travel of said tender when said tender arrives at the calling station and manually operable means for controlling the tender.

6. A fabricating machine comprising a multiplicity of individually operable fabricating stations arranged in a serial group and having respective working mechanisms of substantially the same design and fabricating performance and having each a stoppage-responsive sensing means, a mobile tender common to said group of stations and having a given travel path along said group, said tender having servicing mechanisms engageable with one of said respective stations at a time for removing stoppage conditions therein, a reversible propulsion drive connected with said tender for moving it along said path upon call by said stoppage-responsive sensing means, drive control means connected with said reversible drive, a power-supply system having two power-flow branches connected with said drive control means for selectively energizing said control means to run said reversible drive in a direction dependent upon which of said two branches supplies preponderant energization at a time, a number of switch means serially interposed between said two branches and normally in condition to permit power supply through each switch means but operable in dependence upon travel of said tender to disconnect one of said two branches from said drive control means when the location of said tender corresponds to that of one of said respective stations, said respective sensing means being controllingly connected with said power-supply system at respective points intermediate said switch means whereby the said tender is controlled to travel in the direction and by the amount required for placing it into servicing engagement with a station whose sensing means has responded.

7. A machine according to claim 6, comprising a flow-impeding device in one of said two branches so as to control said motor to shift said tender in one given direction when a plurality of said sensing means on opposite sides respectively of said tender are in fault-responsive condition simultaneously.

8. In a machine according to claim 6, said multiplicity of sensing means being parallel connected to each other in said system so as to increase the power supply in one of said branches in dependence upon the number of sensing means simultaneously active on one of the respective sides of said tender, whereby said control system will control said tender to run to the side of the greater number of calls in the event several sensing means are simultaneously active on both sides of said tender.

9. A machine according to claim 6, comprising a control device connected with said drive control means and adapted to control said motor to move said tender to a given idle position substantially midway of said path, and means connecting said control device with all of said sensing means for activating said control device only when all of said sensing means are inactive.

10. With a fabricating machine comprising a multiplicity of individually operable fabricating stations arranged in a serial group and having respective working mechanisms of substantially the same design and fabricating performance and having each a stoppage-responsive sensing means, said machine also comprising a tender common to said group of stations and movable on a given travel path along said group, said tender having servicing mechanisms engageable with one of said respective stations at a time for removing stoppage conditions therein, in combination, a travel control system for said tender comprising a reversible propulsion drive connected with said tender for moving it along said path upon call by said stoppage responsive means, electric drive control means connected with said reversible drive and having two control coils for controlling said tender to run in one and the other direction respectively, an electric network having current supply means and two circuit branches, said two control coils being connected between said supply means and said two branches respectively, a number of normally closed switches positionally correlated to said series of respective stations and all electrically connected in series between said two circuit branches, said switches being sequentially controllable to open in dependence upon the travel of said tender so as to electrically separate said two branches from each other at a location corresponding to that of said tender, said multiplicity of sensing means having respective normally open signal contacts connected parallel to each other between said current supply means and respective circuit points intermediate said series of switches, whereby closing of any one of said signal contacts due to stoppage condition in a station causes said drive to move said tender toward said station.

11. In a machine control system according to claim 10, said drive control means comprising a differential relay of which said two coils form part, whereby said relay responds to the preponderantly energized coil when several of said contacts appertaining to stations on opposite sides of said tender are closed simultaneously.

12. In a machine control system according to claim 11, one of said two circuit branches comprising a resistor so as to have greater electric resistance than the other branch, whereby the tender will run toward a preferred side when several of said signal contacts are closed simultaneously so that both branches would otherwise receive equal amounts of energizing current.

13. A machine control system according to claim 10, comprising electric resistors each being connected in series with one of said respective contacts between said current supply means and one of said respective circuit points, whereby simultaneous closing of a plurality of said signal contacts causes said resistors to be connected in parallel to each other relative to the flow of current from said supply means.

14. A machine control system according to claim 10, comprising a slider movable in proportion to the travel of said tender and engageable with said switches to open them in positional dependence upon the travel of said tender.

15. A machine control system according to claim 10, comprising a slider movable in proportion to the travel of said tender and engageable with said switches to open

them in positional dependence upon the travel of said tender, said slider having an electric slide contact connected to said current supply means, and a bank of stationary contacts sequentially engageable by said slide contact during travel of said slider and electrically connected with said respective signal contacts.

16. A machine control system according to claim 15, comprising a number of resistors of which each is connected in series between one of said respective stationary bank contacts and the next one of said signal contacts.

17. A machine control system according to claim 16, comprising additional resistors of which each is connected in series between one of said respective signal contacts and one of said respective circuit points.

18. A machine control system according to claim 17, comprising a number of shunt connections having lower resistance than said additional resistors and being each connected across the series connection of one of said respective signal contacts and the adjacent one of said additional resistors, and a normally open urgency contact connected in said shunt connection.

19. A coil winding machine comprising a multiplicity of serially grouped and mutually independently operable winding stations each having coil rewinding means and sensing means responsive to stoppage conditions, a mobile tender common to said group of stations and having a travel path along said group, said tender having servicing mechanisms engageable with one of said respective winding stations at a time for removing stoppage conditions therein, a reversible propulsion drive connected with said tender for moving it along said path upon call by said stoppage-responsive sensing means, drive control means connected with said reversible drive, and a selective call system connecting said multiplicity of sensing means with said drive control means for controlling said tender to travel in the direction and by the amount required for placing the tender into servicing engagement with a winding station whose sensing means has responded, said selective call system comprising means for controlling said drive means to preferentially shift said tender in a given direction when a plurality of said sensing means are in fault-responsive condition simultaneously.

20. A coil winding machine comprising a multiplicity of serially grouped and mutually independently operable winding stations each having coil rewinding means and sensing means responsive to stoppage conditions, a mobile tender common to said group of stations and having a travel path along said group, said tender having servicing mechanisms engageable with one of said respective winding stations at a time for removing stoppage conditions therein, a reversible propulsion drive connected with said tender for moving it along said path upon call by said stoppage-responsive sensing means, drive control means connected with said reversible drive, and a selective call system connecting said multiplicity of sensing means with said drive control means for controlling said tender to travel in the direction and by the amount required for placing the tender into servicing engagement with a winding station whose sensing means has responded, said selective call system comprising means for controlling said drive means to preferentially shift said tender to the nearest station when a plurality of said sensing means on opposite sides respectively of said tender are in fault-responsive condition simultaneously.

21. A fabricating machine comprising a multiplicity of individually operable fabricating stations arranged in a serial group and having respective working mechanisms of substantially the same design and fabricating performance and having each a stoppage-responsive electric signal contact, a mobile tender common to said group of stations and having a given path of reciprocating travel between the two end points of said group, said tender having servicing mechanisms engageable with one of said respective stations at a time for removing stoppage conditions therein, a reversible propulsion drive connected with said tender for moving it along said path upon call by said signal contacts, drive control means connected with said reversible drive, and a station-signal responsive positional control system comprising said multiplicity of signal contacts in connection with said drive control means for controlling said tender to travel to the position of a station whose signal contact has responded.

22. In a combination according to claim 21, said control system comprising means for storing the signals issued by said signal contacts and controlling said tender to travel to the corresponding stations in the issuing sequence of said signals.

23. In a combination according to claim 21, said control system comprising means for re-grouping the signals issued by said contacts so as to move said tender in accordance with a given economical sequence of said issued signals.

24. In a combination according to claim 21, said control system comprising means for storing the signals issued by said signal contacts, additional call contacts for issuing calls of greater urgency than those of said signal contacts, and circuit means connecting said additional contacts with said control system in bypass relation to said signal contacts, whereby said tender is controlled to travel in response to said additional contacts prior to responding to the stored calls from said signal contacts.

References Cited in the file of this patent

UNITED STATES PATENTS

2,757,874 Marcellus ______________ Aug. 7, 1956