SC2 SELECTIVE CONTROL SYSTEM

GENERAL DESCRIPTIVE INFORMATION

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FIGURES

1. GENERAL

A. Scope

1.01 This section provides general descriptive information on the SC2 selective control system. The SC2 system was developed to provide remote, centralized, fail-safe control and supervision of the facilities of right-of-way companies. It comprises a main, or control, station where all control is centralized, and one or more satellite, or controlled, stations which connect with the customer's equipment.

1.02 Typical applications of this system would be to oil and gas pipeline systems and to power transmission networks where it would control and supervise the position of 2-state devices such as valves, pumps, switches, and perform other control and alarm functions.

1.03 The SC2 system main and satellite stations will normally be located on customer premises and will be connected together by various outside plant line facilities owned by either the Bell System or independent companies.

B. General Operation of System

1.04 The main station has a console-mounted control panel which contains the individual push-button keys used to initiate the transmission of signals to satellite stations. Individual lamps are also provided and give a continuous display of the conditions of the controlled devices. In addition, a common control section of the panel contains keys and lamps common to the system. In operation the main station transmits orders by fail-safe methods to the satellite stations, which perform these orders as directed and then return acknowledgment signals which indicate the new condition of the device to the main station. The main station also transmits individual inquiry signals to the satellite stations and receives return signals indicating the condition of the facility in question. A roll call feature which automatically transmits a series of inquiry signals provides means of checking the condition of all controlled devices. A roll call may be initiated manually at the main station or by automatic action at a satellite if any of the controlled devices undergoes an unordered change of condition. Audible and visible alarms indicate abnormal operating conditions and bring unordered changes in conditions of devices to the dispatcher's attention.

C. Summary of Basic Operational Features

1.05 The basic operational features which are designed to give the SC2 system a high degree of reliability are summarized in the following paragraphs.

1.06 At the main station selective order codes are generated to address and control the operation of a number of customer owned devices located at remote points. These devices will usually have only two conditions; that is, on or off, open or closed, active or inactive.

1.07 Satellite stations are arranged to respond to the order codes and to return noncoded acknowledgment signals automatically to the main station to indicate the status of remotely controlled devices.

1.08 The use of noncoded signals from the satellite results in equipment economies, since there is no need for code sending equipment at the satellite locations and no code translating equipment at the main station.

1.09 However, with the arrangement described in 1.07 and 1.08, a roll call technique must be used to check the system for unordered changes of state of customer's equipment. When such a change occurs, a distinctive pulse is transmitted by the satellite to the main station, which starts a roll call. On finding the particular device which caused the alarm pulse to be generated, the main station gives an audible and visible indication of the alarm.

1.10 Fail-safe reliability results from the "2-out-of-5" pulse length code used for transmitting orders to satellites. These are selective, decimal, time division codes which are self-checking and which result in extremely reliable operation of the system.

1.11 Each device in a system has a particular code or codes associated with it.

1.12 Provision is made in the SC2 system to send selective inquiry codes which simply determine or check the status of any 2-state device. Confirming signals are returned to the main station in the same manner as they are when an order code is sent to the satellite.

1.13 Any number of satellites, up to the code capacity of the system, may be operated over a single narrow band channel.

D. Summary of Supplementary Features

1.14 In addition to the basic operational features summarized above, the SC2 system has a number of supplementary features which contribute toward making it efficient, easy to operate, and adaptable to a wide variety of customer applications. These features are summarized in the following paragraphs.

1.15 All codes are generated by push-button key operation.

1.16 As many as 1000 different codes may be originated at a main station.

1.17 All lamps and keys at the main and monitor stations are mounted in a sloping panel console, providing easy and convenient operation for the station attendant.

1.18 The main station console exhibits a continuous display of the status of all remotely controlled 2-state devices.

1.19 Flashing lamps and audible alarms are used to alert the main station when necessary.

1.20 A monitor station is available which provides remote lamp indications of the status of all 2-state customer devices under control of the main station.

1.21 Arrangements are available to permit connection of the customer's telemetering equipment over the SC2 channel or over an auxiliary channel.

1.22 Means are provided so that a remote device can be under direct control from the main station over the regular SC2 channel.

1.23 Optional arrangements also provide a means for sending an alerting call to the main station attendant.

1.24 It is also possible to initiate action at a satellite which will result in the main station's sending a system signal to all satellites in the system.

1.25 Building block equipment design is used so that only the necessary equipment in required amounts need be used for any particular system.

1.26 Plug-in equipment units provide for rapid and easy maintenance of the system.

1.27 Junction is made with the customer's equipment at a low-voltage point.

2. DETAILED DESCRIPTION OF FEATURES

A. Main Station

2.01 The SC2 main station, which controls all operations in the SC2 system, consists of a floor-mounted console as shown in Fig. 1, and two or more control equipment cabinets as shown in Fig. 2.

2.02 The SC2 main station console contains all keys and lamps required to initiate orders to a satellite and to indicate visually the status of the customer's devices connected to the satellite. Up to 60 devices may be controlled from a single console. Each 2-state device to be controlled from the main station requires three different selective codes; one to turn it on, one to turn it off, and one to determine the status of the device.

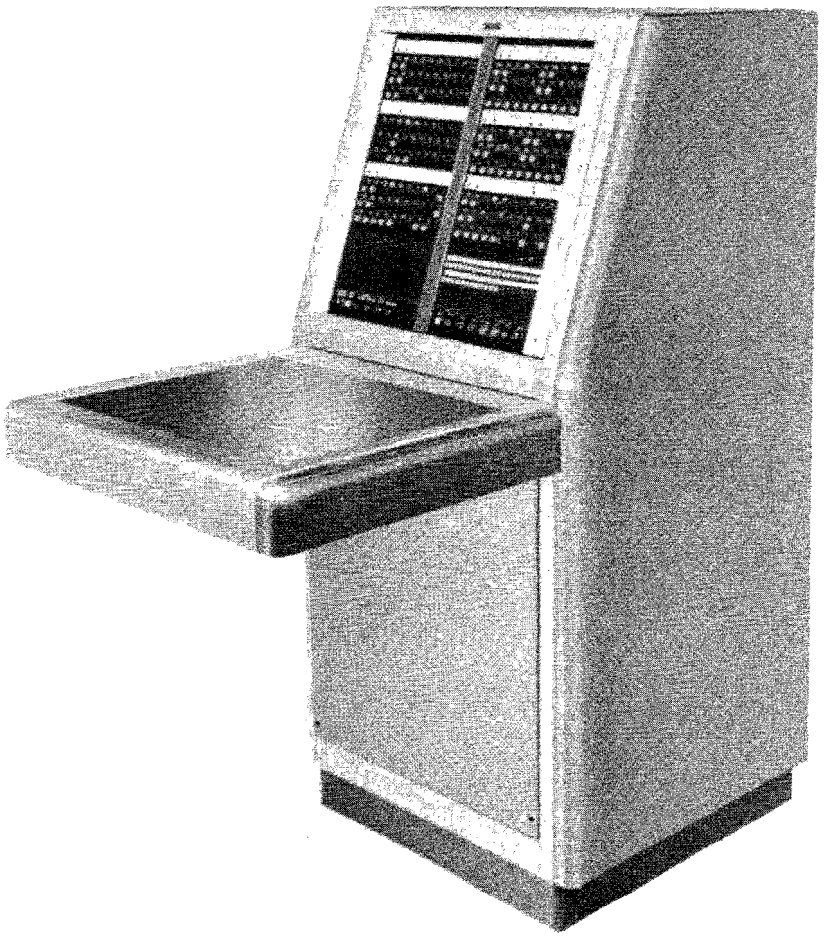

Fig. 1 - Main Station Console

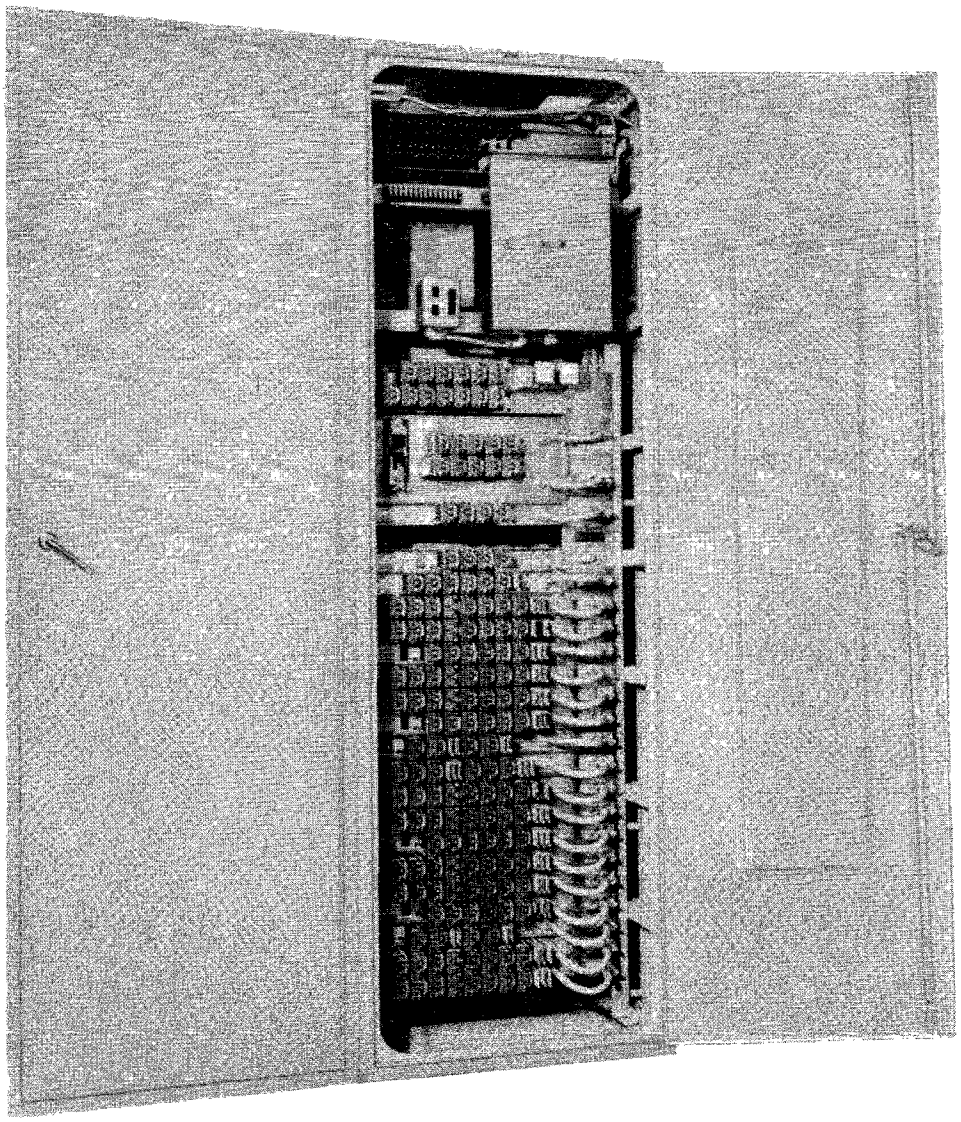

Fig. 2 - Typical Main Station Equipment

B. Satellite Station

2.03 The satellite station, which connects to the customer's equipment, consists of one or more bays of control equipment, depending upon the number of devices the customer wishes to control. The individual satellite equipment bays are the same size and similar in appearance to the main station equipment.

2.04 The SC2 satellite station receives from the main station coded signals which initiate the operation of customer's devices.

2.05 In normal installations, there are no lamps or keys associated with the SC2 satellite equipment; however, means are available so that they may be provided externally.

C. Reliability

2.06 Codes transmitted from the main station to the satellite provide for extreme fail-safe reliability. Because of the inherent self-checking features of the code, any mutilation of the code from line hits, breaks, or other causes results in the rejection of the code by the satellite station.

Thus, instead of a wrong operation, no operation results.

2.07 In order to minimize operator errors due to accidental operation of an order key, a MASTER OPERATE key is provided at the main station. Both this key and an individual order key must be operated simultaneously or no action will result.

D. Order Codes Transmitted to Satellite Stations

2.08 Two individual order keys, representing the two conditions a controlled device may have, are provided for each device. These are located directly under the corresponding red and green indicating lamps for that device as shown in Fig. 3. Following an order, a remote device operates and the satellite station then sends back either a short or a long pulse, representing the condition of the device.

2.09 In the SC2 system a short return pulse from the satellite station indicates the open, off, or inactive state whereas a long return pulse indicates the closed, on, or active state.

2.10 If the device does not operate within 6 seconds from the end of an order signal, the satellite sends back a pulse indicating that the device is still in the same position as it was before the order was sent.

2.11 In either case, the system restores to normal and is ready for another operation after the reply is received. If no reply is received it restores after a time-out period of about 12.6 seconds.

2.12 The lamps and alarm conditions which result from various operations are described in 2.30.

2.13 From the initiation of an order until the reply is received a white STA BSY (station busy) lamp is lighted on the common control panel located at the bottom of the main station console face. This lamp lights for all types of functions until the main station returns to its normal condition and is ready for the next operation.

2.14 Provisions are made for using either 2- or 3-digit order codes in the SC2 system. These codes may be all 2-digit, or all 3-digit, or a combination of two and three digits. The coding arrangement to be used in an installation will depend upon the application and the customer's potential expansion of his use of SC2.

Double Transmission of Codes

2.15 Optional arrangements are available in the SC2 system which result in the double transmission, in rapid succession, of order codes to the satellite station. These individual transmissions must agree at the satellite or no action takes place. See 5.03 for the time required for single- and double-transmitted codes.

2.16 The use of double transmission is dependent upon the fail-safe requirements of the customer. However, it should be noted that one transmission alone gives extremely good reliability.

E. Inquiry Codes Transmitted to Satellite Stations

2.17 The main station attendant may at any time verify the condition of any of

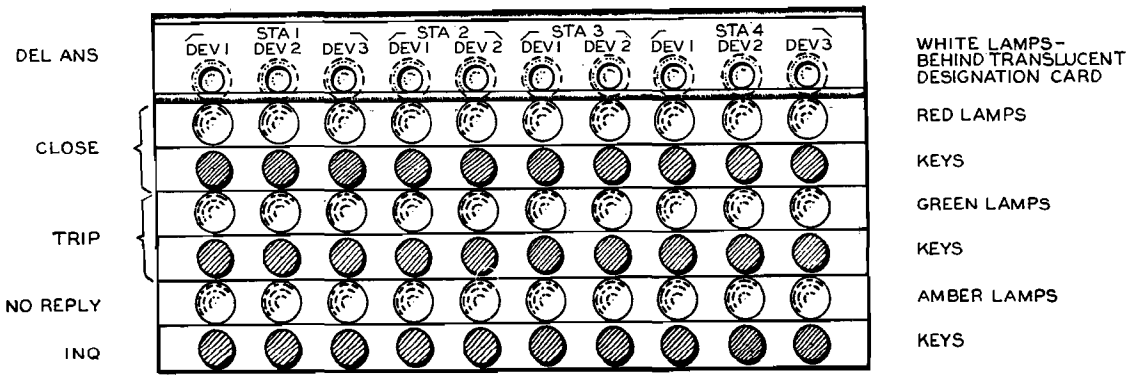

Fig. 3 - Section of Main Station Console Illustrating Layout of Individual Keys and Lamps

the devices controlled from his location. For this purpose an INQ (inquiry) key is associated with each controlled device. It is not necessary to operate the MASTER OPERATE key when sending inquiry signals.

2.18 Following the transmission of an inquiry signal, either a short or long pulse is returned from the satellite station representing the current status of the device. The lamp and the alarm conditions which result are described in 2.30 below.

2.19 The station busy lamp is lighted from the start of the inquiry until the station returns to normal.

2.20 Inquiry codes, like order codes, can be either two or three digits. However, double transmission is not used since inquiry is not a critical function.

F. Roll Call

2.21 The roll call feature of the SC2 system provides an automatic sequence of inquiries to all 2-state controlled devices, and will provide a complete check of the status of all such devices in the system. A roll call may be initiated by any of four methods shown below.

(a) If a device changes condition by any means except in direct or immediate (within 6 seconds) response to an order from a main station, a signal is transmitted to the main station alerting it to start a roll call to find the device. Flashing lamp indications are provided when such changes occur.

(b) Roll calls may be started automatically at periodic intervals by a preset roll call timer in order to provide a check on the line facilities. These intervals may be selected to agree with the customer's mode of operation.

(c) The main station operator may start a roll call at any time by depressing the ROLL CALL START key located on the control panel at the main station.

(d) Similarly, the monitor station attendant may start a roll call.

2.22 Roll calls start from the beginning of a sequence to make certain that all devices are checked. The most important functions should be arranged to appear early in the sequence. To mark the progress of a roll call, white roll call progress lamps located on the main station console light in sequence.

2.23 In the event that a device changes condition during the time in which the system is occupied with another task, this change is stored in the satellite. When the system is free, the satellite sends in a pulse which starts a roll call.

2.24 If a device changes state during a roll call, the change may occur either before or after the device has been reached in the roll call.

2.25 If a device which has changed state has not yet been passed by the roll call, the current roll call sequence will detect and report the change.

2.26 If a device has already been passed by the roll call, the satellite will automatically request a new roll call at the completion of the first.

2.27 The time required for a roll call is from 1 to 3 seconds per device, depending upon the number of digits in the code and the pulsing speed.

2.28 Roll call lamp and alarm conditions are the same as for individual inquiries. In addition, a white ROLL CALL BSY lamp on the common control panel is lighted during a roll call. A ROLL CALL STOP key on the common control panel provides means for stopping a roll call at any time before the end of the sequence.

G. Console Lamps and Keys

2.29 For operating convenience, all lamps and keys which control and display the status of individual customer devices are located on a sloping panel console at the main station. Also located on this panel are the lamps and keys which are associated with common systems operation.

2.30 Each individual 2-state device is represented on the face of the main station console by a vertical strip of seven lamps and keys as shown in Fig. 3. Starting at the top of a strip and continuing downward the functions of the keys and lamps are as follows:

Position	Lamp or Key
(1)	White Lamp: This is an optional arrangement for use in connection with customer devices which are expected to take longer than 6 seconds (actually 6.3 ±1.3 seconds) to function.
(2)	Red Lamp: This lamp lights when a customer's device is in the "on" condition.
(3)	This key position is used to operate the customer's device to the "on" condition.
(4)	Green Lamp: This lamp lights when a customer's device is in the "off" condition.

Position	Lamp or Key
(5)	This key is used to operate the customer's device to the "off" condition.
(6)	Amber Lamp: This lamp lights when no reply is received in response to the sending of an order or inquiry code.
(7)	This key is used to initiate the sending of an inquiry code to a satellite.

2.31 Portions of these individual lamps and key strips are used for other control and alarm features, such as monitoring single-state devices, and customer owned telemetering over the SC2 channel. In such cases, only the necessary lamps and keys are equipped and the unused portions are occupied by equipment blanks.

2.32 In addition to the strips of individual keys and lamps, the console also contains a horizontal row of common keys and lamps, located at the bottom. These are shown in Fig. 4.

2.33 Fig. 5 shows a typical console face layout. In this case the customer's terminology of "close" and "trip" was used instead of "on" and "off."

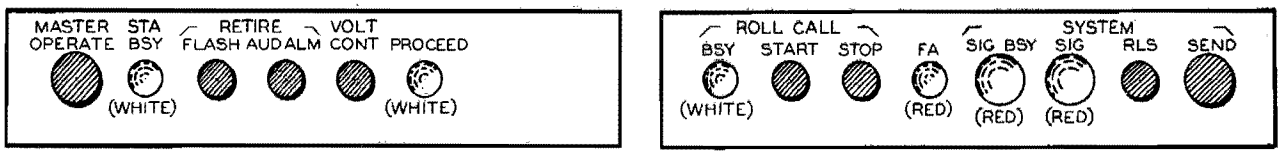

Fig. 4 - Common Control Keys and Lamps on Main Station Console

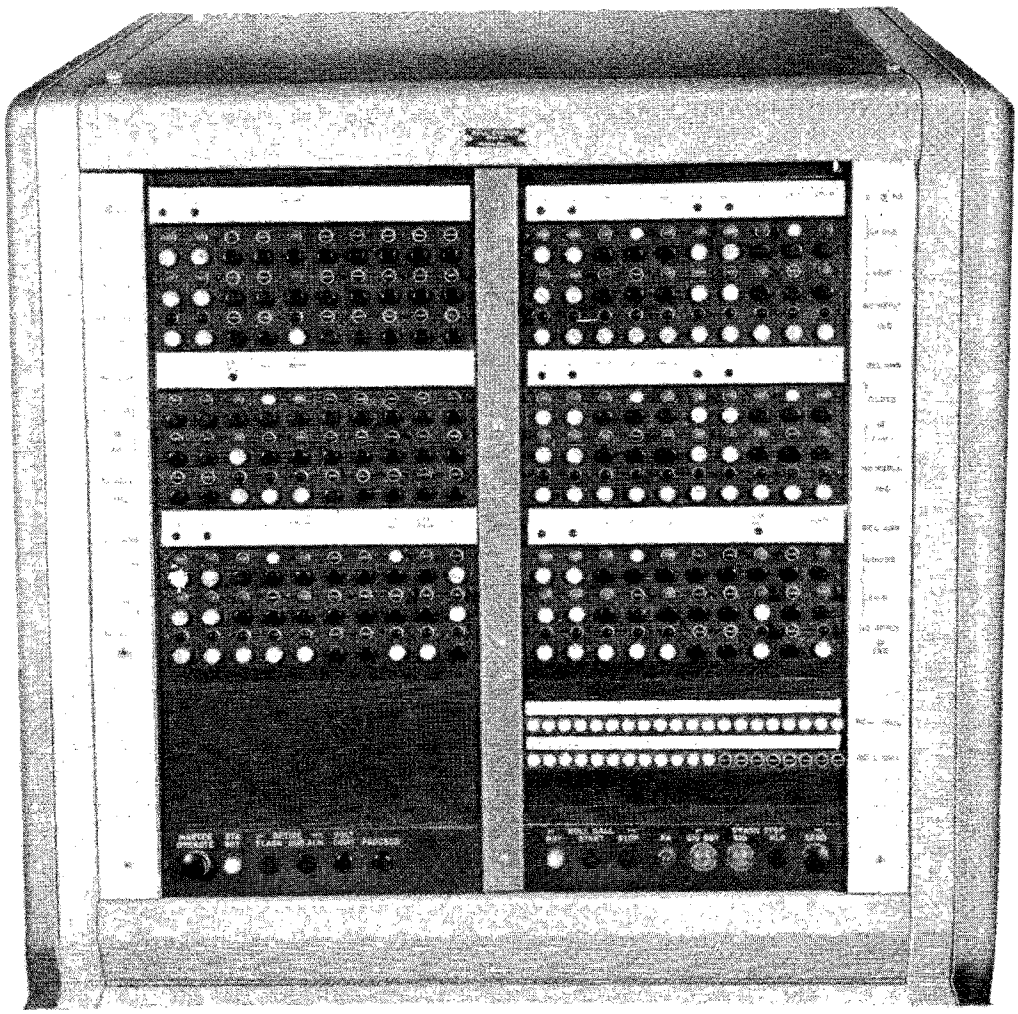

Fig. 5 - Typical Console Face Layout

H. Reply and Alarm Signals

2.34 Following the transmission of order and inquiry signals to satellite stations, long or short pulses are returned to indicate the current status of the remote device. A short pulse represents the off, open, or inactive condition and a long pulse represents the on, closed, or active condition. The lamp and alarm condition which result are as follows:

(a) The appropriate red or green lamp lights when a device operates to the red or green condition respectively. The previous lamp indication then is extinguished.

(b) The red or green lamp which was lighted before an inquiry remains lighted when an inquiry finds a device in the same condition as previously indicated.

(c) A flashing red or green lamp indicating the correct condition of a device results if, in response to an inquiry, a device is found to be in a condition opposite to that previously indicated.

(d) A flashing red or green lamp corresponding to the actual condition of the device results if the device fails to respond to an order.

(e) An amber lamp and the extinguishing of the red or green lamp results in the event that no return signal is received from an order or an inquiry signal.

2.35 If a device changes condition by means other than a main station order, a satellite station sends back a single short pulse which initiates a roll call.

I. Audible and Visible Alarms

2.36 Certain audible and visible signals are provided to assist the main station operator in recognizing abnormal operating conditions. Flashing red or green lamps and the sounding of a bell are used in this connection. See 2.30 for details.

2.37 Separate keys are provided on the common control panel to retire the flash to a steady condition and to silence the bell. These are designated as the RETIRE FLASH and RETIRE AUD ALM keys.

2.38 The common control panel also contains a red FA (fuse alarm) lamp which lights in the event that any SC2 load fuse operates.

J. Building Block Design

2.39 The equipment for all stations is designed on a building block basis. With this arrangement only the necessary elements need be used for any particular system.

2.40 The SC2 system can be easily expanded to handle more functions. If necessary, a 2-digit system can be expanded to a 3-digit system and a single code transmission system can be converted to a double transmission system for some or all of the functions.

K. Plug-in Units

2.41 Plug-in panels provide for rapid and easy maintenance. The lower portion of the control equipment cabinet as shown in Fig. 2 shows these units.

3. OPERATIONAL FEATURES

3.01 The main purpose of the SC2 system is to provide signals to initiate and supervise the operation of customers' 2-state devices, such as pumps, valves, and switches. In addition, the SC2 system has been designed to perform a variety of other functions, as will be described in the paragraphs to follow. Because of the building block design of the system, any of these functions can readily be added to the system at any time depending upon the operational needs of the customer.

3.02 The description of SC2 2-state operation is presented in detail since it is a most important feature and will serve to illustrate other console operations which in general are similar.

A. Control of 2-state Devices

3.03 All operations of 2-state and other functions are controlled from the main station console, each device being controlled by a vertical row of keys and lamps which are used to generate order codes and to display the status of the controlled device. The main station console also has a section containing keys and lamps common to all of the system. Fig. 3 and 4 show both the individual device controls and the common controls.

3.04 In operation the main station transmits orders by fail-safe methods to the satellite stations, which perform these orders as directed, and then return acknowledgment signals which indicate the new condition of the customer's device to the main station.

3.05 The main station also transmits inquiry signals to the satellite station, and receives return signals indicating the condition of the device in question.

3.06 A roll call provides means for checking the condition of all controlled devices.

3.07 Audible and visual alarm signals indicate abnormal operating conditions and call unordered changes in the state of customers' devices to the dispatcher's attention.

Typical Console Operation

3.08 In a typical operation a power company dispatcher may wish to operate a device from the open position to the closed position. Fig. 3 shows the individual lamps and keys on the control panel relating to such a device. The common control section of the panel is shown in Fig. 4. Because the device is presently open, the green lamp of Fig. 3, associated with this device, is on.

3.09 To close the device, the attendant operates the CLOSE key shown in Fig. 3, at the same time operating the MASTER OPERATE key. At this time, a code is sent out on the line to all satellite stations. In 2 or 3 seconds the transmission of the code is complete and the proper satellite station operates the designated device.

3.10 As soon as the device has operated, the satellite station sends back a pulse from the customer's device confirming this.

3.11 At the main station, the return pulse extinguishes the green lamp and lights the red lamp. The operator now has an indication that the operation has been performed.

3.12 The lamp display is continuous, thus allowing an operator to tell at a glance the status of all devices under his control.

3.13 If the device fails to close immediately, the satellite station waits for the closure and sends back the reply as soon as the closure takes place. If the device does not close within 6 seconds after receiving the order, the satellite station sends back a reply indicating that the device is still open. In this case, the green lamp associated with the device changes from steady to a flashing condition.

3.14 The dispatcher may restore the lamp to the steady condition by operating the RETIRE FLASH key shown in Fig. 4.

3.15 As discussed beginning in 3.19, special arrangements are made for devices which are expected to take more than 6 seconds to operate after the initiation of an order signal.

3.16 If a dispatcher wishes to verify the condition of a device under his control, he may do so by operating the associated INQ key shown in Fig. 3. This sends out a code to inquire about the condition of the device. A signal is returned indicating to the main station the status of the device.

3.17 In the event that an order or inquiry code is transmitted and acknowledgement is not received at the main station, the amber (no reply) lamp will light.

B. Control of Single-state Devices

3.18 In some cases operation to one condition only is desired. An example of this is the ringing of a bell with automatic time-out or manual release at the satellite station. In such cases one key, a white lamp, and an amber lamp are provided in vertical order. The white lamp lights momentarily when a reply is received that the order code reached the satellite station.

C. Provision for Delayed Operation

3.19 There are some devices that take more than the normal 6-second interval to function. For instance, in an oil pipeline the opening and the closing of valves takes several minutes. Provisions are made in the SC2 system to accommodate such devices.

3.20 In cases where devices are not expected to operate within a few seconds (up to 6 seconds) following the transmittal of an order code, a white DEL ANS (delayed answer) lamp lights. This lamp is located at the top of the column of keys and lamps associated with individual 2-state devices, as shown in Fig. 3.

3.21 If one of these devices is ordered to operate, an equipment option provides for immediate reply from the satellite, which, in this case, is merely an indication that the SC2 terminal equipment functioned to initiate the operation of the device, although the device has not yet operated.

3.22 During the time that a white lamp or lamps are lighted, indicating that a slow-acting device has been ordered to operate, the SC2 system is free to handle other orders, alarms, or inquiries for the rest of the system.

3.23 The associated white lamp lights in addition to the green or red lamp that was already on. When the device operates it sends back a short pulse to the main station which then starts a roll call of all 2-state devices having a lighted white lamp associated with them.

3.24 When a roll call finds that the device has operated, the previous red or green indication and the white lamp are extinguished and the red or green lamp representing the new condition lights.

3.25 Special arrangements are provided in SC2 system to speed up and minimize the time required to locate ordered changes in state of devices associated with white lamps. A special white lamp roll call is made whenever a short uninvited alarm pulse is sent to the main station while a white lamp is lit. When there are no white lamps lit, an uninvited short or long alarm pulse received at the main station starts a regular roll call which polls all devices including those associated with white lamps.

3.26 If, when a white lamp is on, a device not associated with the lamp operates remotely, the white lamp roll call occurs first but will not affect any white lamp device conditions. Immediately following this, a regular roll call then takes place to find the device that operated remotely.

D. Section Control Functions

3.27 In addition to the individual operation of certain devices, it may be desirable to operate a certain group of devices simultaneously. Arrangements can be made so that the transmission of a single code causes the operation of two or more devices located at the same or different satellites. In these cases, options provide for a reply signal from any selected satellite. However, usually the most remote is selected for this purpose as a check on the line facility.

3.28 In this type of control the operation of the devices may be regarded as being from local action and not from a main station order. Therefore the operation of these devices will cause one or more pulses to be sent to the main station to start a roll call and establish the correct lamp indication for each device.

E. Main Station Indications of Momentary Alarms at Satellite Stations

3.29 Sometimes it is necessary to send an indication to the main station and to the monitor station, where used, of a temporary closure of a device at a satellite station. An example might be the temporary closing of a switch when a scraper, used to separate fluids in a pipeline, passes by a particular point.

3.30 In cases such as this, an option is provided so that such a closing locks up a relay and sends a pulse to a main station, starting a roll call. The roll call inquiry that finds the relay locked up also releases the relay, thus restoring the satellite to normal and making it ready for subsequent similar operations. At this time visible and audible signals occur at the main station and monitor stations.

3.31 The attendants at these stations may retire the alarm indications, leaving the system ready to indicate the passage of the next scraper.

F. Device Lock Circuit to Provide Continuous Closure Path to Customers' Devices

3.32 Normally an order to start or stop a device appears at the satellite station as a closure of about 350 milliseconds on one of two pairs. Closure of one pair initiates the start and closure of a second pair initiates the stop. Arrangements are available however, so that these closures can be used instead to operate and release a device lock relay in the satellite.

3.33 The device lock relay provides a continuously open circuit to the customer for the device open condition and a continuously closed circuit for the device closed condition. Contacts are available on these relays, and terminals are brought out to a cross-connection field which permit the association of lamps to indicate the condition of the satellite for any particular device, if the feature is desired by the customer.

3.34 Thus, if the customer disconnects a device from the satellite station, he can check the condition of the satellite for that device before it is reconnected.

G. Initiation of Control Orders From Satellite Stations

3.35 A feature is provided in the SC2 system which permits any satellite station to initiate a signal (system signal) which will cause a predetermined operation at every satellite. For example, it may be operationally desirable to control the complete shutdown of a pipeline by either a main station dispatcher's action or by a satellite attendant's action. The way this is accomplished is shown in the following paragraphs.

3.36 To initiate an order from a satellite station, the attendant must operate a special system signal switch which sends a pulse to the main station to start a roll call. When the station which requested the system signal is found (devices in this category will normally be placed early in the roll call), the roll call is automatically stopped and a system signal is automatically transmitted by the main station to perform the desired operation at every satellite.

3.37 If the system is divided into a number of sections, with a main station at the beginning and a monitor station at the end of each section, the monitor station of the originating section automatically

alerts the next main station to cause it to transmit a signal to its section. This action continues to all sections in the forward direction. Also, the main station of the originating section causes the preceding monitor to send a pulse to its main station to initiate the same action in all preceding sections.

3.38 The red SYSTEM SIG BSY lamp lights when a system signal is originated and is extinguished when the order has been carried out in the originating section and the previous section. The red SYSTEM SIG lamp also lights during a system signal. It can be extinguished by operation of the SYSTEM RLS (release) key if the satellite which initiated the system signal is not in that section. If it is in that section, it can be extinguished only after the system signal switch of the satellite originating the signal is restored to the normal condition.

3.39 It is also possible to initiate a system signal from the main station. This is accomplished by operating the SYSTEM SEND key located on the common control panel of the console, and the MASTER OPERATE key. As a result, system signals are automatically transmitted to preceding and following sections by action similar to that caused by a system signal originated at a satellite.

H. Telemetering

3.40 The SC2 can be used to connect and disconnect customer owned telemetering transmitters and receivers to the existing control channel, or to one or more auxiliary channels.

Over SC2 Channel

3.41 When an existing control channel is used, the system is arranged for telemetering equipment of the 5-second cycle pulse duration type. The operation is described in the following paragraphs.

3.42 The main station attendant operates a single telemeter key on the control panel. This lights an individual white telemeter lamp and the STA BSY lamp on the common control panel. A code is then transmitted to the satellite station.

3.43 When the satellite station receives the code it connects the proper telemeter transmitter to the line. The main station then connects the proper pulse duration type receiver to the line.

3.44 The receiver remains connected for 9 seconds and then automatically disconnects. The 9-second interval is adequate time to guarantee a correct reading on the meter regardless of at which time in the 5-second cycle the receiver was connected to the line.

3.45 The telemetering transmitter is then automatically disconnected, and both stations return to the idle condition and the station busy lamp at the main station is extinguished. The entire operation takes about 18 seconds.

Over Auxiliary Channel

3.46 When telemetering is done over an auxiliary channel, the SC2 equipment is used only to connect and disconnect the telemetering equipment to the auxiliary channel. Thus any particular reading may be held as long as desired and the SC2 system may be used for other functions during this period.

3.47 Any type of telemetering which can be adapted to the auxiliary channel can be used.

3.48 A push-button key and a lamp are provided for each telemetering transmitter to be connected to the auxiliary channel. When any one of the push buttons is operated, a code is transmitted which disconnects the previous telemeter transmitter and connects the new transmitter. The line is also switched to a new receiver at the main station if necessary. A signal is returned which lights the lamp associated with the new telemeter, indicating that the order has been carried out. If desired, a key and lamp can be provided for disconnecting all telemetering equipment.

I. Direct Control

3.49 Provision is made in the SC2 system so that the main station can directly control, at a satellite station, a device such as the raising or lowering of voltage on a rheostat motor. An order signal is transmitted which sets up either a raise or lower control path directly to this device. Receipt of an acknowledgement signal at the main station lights a red signal lamp to indicate that the correct path has been established. The white PROCEED lamp shown in Fig. 4 also lights and the VOLT CONT is then used to control the device.

3.50 An option is provided so that either the remote mechanism is actuated as long as this key is operated and is released when the key is released, or the remote mechanism is actuated one step for each time the key is depressed, the established path being released after a time-out interval of 8 seconds.

3.51 In both cases means are provided to assure that operation of this key at times when a control path is not established will have no effect on the system operation.

J. Monitor Station

3.52 The SC2 system has provision for a monitor station which provides, at a remote location, visual indication of the status of control devices at the various associated satellites.

3.53 The SC2 monitor station consists of a floor-mounted console and two or more equipment bays, similar in appearance to the main station equipment.

3.54 The system is arranged so that a red and green lamp associated with each 2-state device gives the same indications as the corresponding main station lamps, thus giving a continuous indication of the status of the devices. An audible alarm and a flashing lamp indication are given whenever a change takes place at any of the satellites. Keys are provided to retire each of the alarm indications.

3.55 The monitor station attendant can start a roll call by operating a key which sends a pulse back to the main station. Except for this the monitor does not have the ability to initiate any SC2 operations.

3.56 Individual white lamps at a monitor station light momentarily each time an order or inquiry is recognized by the monitor. In this capacity, they serve as roll call progress lamps.

3.57 Common red and green lamps light momentarily on the monitor console whenever a reply signal is sent from a satellite station. A mutilated code alarm lamp and buzzer indicate when a code is distorted.

3.58 One or more monitor stations may be located anywhere on the line.

K. Control From Alternate Locations

3.59 Satellite stations may be controlled from any one of a number of main stations which may be associated with a system. The main stations not in use at any particular time must be manually disconnected from the line.

4. SIGNALING CODES

A. Basic Code

4.01 The high degree of reliability of the SC2 system is based on the structure of the "2-out-of-5" pulse length code used for transmitting orders.

4.02 Each digit of a code, which may contain either two or three digits, is composed of a combination of short and long pulses. The pulse form for individual digits is shown in Fig. 6.

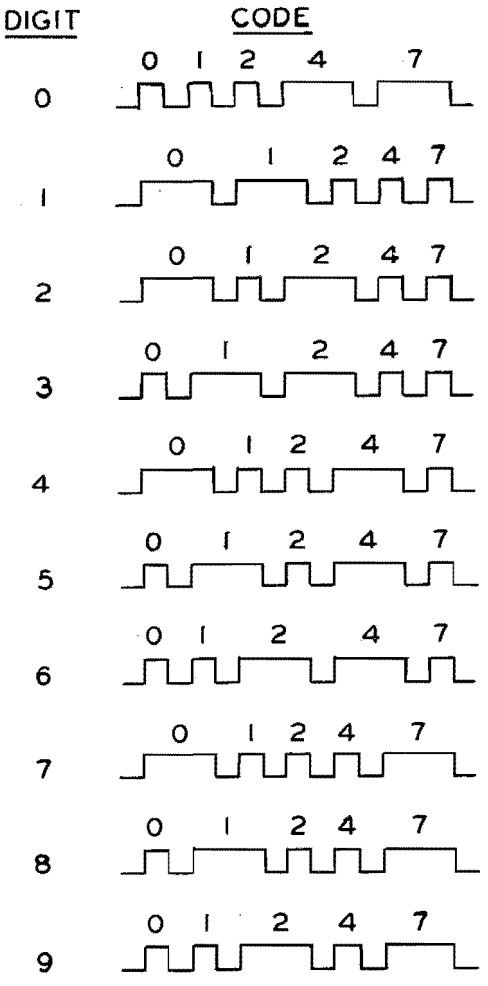

Fig. 6 - Two-out-of-five Pulse Length Code

4.03 Each transmitted digit must have two, and only two, long pulses and three short pulses. Any other combination represents a false code and no action will take place at the satellite station.

4.04 In addition, a parity check at the satellite assures that only five pulses are received for each digit of a code. If more or fewer than five are received, no action will take place.

(a) The five pulses of a digit are designated in order, 0, 1, 2, 4, 7, as shown in Fig. 6. The value of any digit is given by adding the designation of the long pulses. An exception to this arises if the long pulses occur in positions 4 and 7. In this case the digit value is zero. A typical 2-digit code is shown in Fig. 7.

B. Assignment of Codes

4.05 Since the individual digits of a code are decimal, 100 codes numbered from

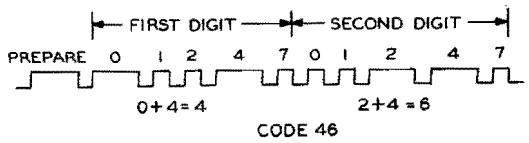

Fig. 7 - Typical 2-digit Pulse Length Code

00 to 99 are available when using only 2-digit codes, and 1000 codes numbered from 000 to 999 are available when using only 3-digit codes.

4.06 Although a large amount of flexibility in the assignment of codes is possible, it will be advantageous to follow certain fundamental rules. These are as follows.

(a) If possible only 2-digit codes should be used for inquiries. This will save time in the roll call, when many such codes are transmitted sequentially. It should be noted here that if a 3-digit code is used for the inquiry signal of the device, then the design of the system requires that the order codes associated with this device also must be three digits.

(b) If a system of 100 or almost 100 codes is to be installed and is expected to expand to more than 100 codes, the initial codes should be assigned so that a minimum of cross-connection changes will be necessary when the system is expanded.

(c) At any satellite station, the number of different first digits for both 2- and 3-digit codes should be kept as small as possible. For 3-digit codes which are alike in the first digit, the second digits should also be alike if possible. These factors keep the required number of translating relays to a minimum.

In addition to the above there are two restrictions in the assignment of codes.

(d) No 2-digit codes can be the same as the first two digits of any 3-digit code. For example, if code 46 is used, then codes 460 to 469 cannot be used.

(e) If a 2-digit code and a 3-digit code are alike in the first digit, then the second digit of each must be in a different 0 to 4 or 5 to 9 group.

4.07 The following is an example of how a very large satellite station could be arranged to receive codes.

00-34	35 2-digit codes
350-399	50 3-digit codes
40-59	20 2-digit codes
600-749	150 3-digit codes
75-99	25 2-digit codes

The above group contains 80 2-digit codes and 200 3-digit codes.

4.08 At the main station, a common sending unit is used to transmit either 2- or 3-digit codes. At a satellite station the same receiving circuit is used for the reception of both types of codes. Minor changes in the satellite translator of a 2-digit system will expand it to a 3-digit system. A wiring option at the main and satellite stations determines the number of digits in each code.

C. Signals From Satellite Stations

4.09 Acknowledgment signals are returned to the main station from the satellite stations in reply to orders and inquiries. These signals are simple, being either a single long or short pulse. The long pulse indicates the "on," closed, or active condition of a customer's device and a short pulse indicates the "off," open, or inactive condition of the device. These same signals when uninvited, are used to initiate a roll call when a device undergoes an unordered change due to some local action.

4.10 The simplicity of the return signal arrangements permits relatively inexpensive satellite sending equipment and main station receiving equipment, without any sacrifice in reliability.

5. LINE FACILITIES AND PULSING SPEEDS

A. Line Facilities

5.01 The SC2 system is arranged for operation over a variety of line facilities with different pulsing speeds as follows:

	Type of Facility	Pulses per Second
(a)	2000-ohm loop metallic-wire	10
(b)	Telegraph circuit using standard telegraph facilities (without regenerative repeaters)	10
(c)	E and M leads such as CX, DX, SX, N1, O, and SF	10
(d)	43A1 carrier telegraph channel or equivalent	25

5.02 In each of the above, signaling is done in only one direction at a time. The different types of available lines allow the customer if he so desires, to sacrifice speed for economy.

B. Pulsing Speeds

5.03 The approximate times for transmitting different types of selected codes at two different speeds are shownbelow.

	Number of Seconds for Each Code	
	10 pulses per second	25 pulses per second
2-digit, single transmission	1.7	0.7
3-digit, single transmission	2.5	1.0
2-digit, double transmission	3.9	1.9
3-digit, double transmission	5.5	2.5

6. CROSS CONNECTIONS

6.01 In the SC2 system flexibility of application and operation is provided through the use of cross connections. This permits easy code reassignment, convenient addition or subtraction of control functions, and other modifications in operation that the customer may require as his needs change. Below is a summary of items requiring cross connections and the stations affected.

Item	Cross Connections Required Main Station	Satellite Station	Monitor Station
(1) Individual codes	✓	✓	✓
(2) 2- or 3-digit codes	✓	✓	✓
(3) Single or double transmission of codes	✓	✓	✓
(4) Immediate or delayed operation of customer's equipment	✓	✓	-
(5) Coded output to customer's terminals	-	✓	-
(6) Satellite and monitor alarms, and miscellaneous	✓	✓	✓

7. INTERCONNECTION WITH THE CUSTOMERS' EQUIPMENT

7.01 As discussed in 3.31 and 3.32, the SC2 system is arranged to provide to the customer two pairs of momentary closure paths, one for the trip and one for the close condition, or a single path which remains permanently open or closed for either of the two conditions.

7.02 Connections to the customer's equipment are not made in the SC2 cabinet, but are brought out through a cable to a demarcation strip. Customer connections are made to terminals on this strip, thereby completing the circuit to the SC2 equipment.

7.03 Fig. 8 shows a typical method by which SC2 momentary closures operate the customer's interposer relays. These closures are about 350 milliseconds in duration, during which time the customer's interposer relay must operate. Locking of these relays is taken care of in the customer's circuit.

7.04 Fig. 9 shows how the SC2 output may be arranged to operate and lock a customer's interposer relay. In this case the locking circuit is provided by the SC2 system. In order to limit the current drain on the SC2 system when this method is used, the customer's interposer relays should be of greater resistance than 500 ohms.

7.05 In both of the above interconnection arrangements, indications of the status of a customer's device is the same. The presence of ground on either one of two leads indicates whether a device is in the closed or open condition.

8. EQUIPMENT

8.01 Each main, satellite, and monitor station usually has associated with it a number of 7-foot equipment cabinets arranged for indoor mounting. A floor-mounted console containing the control lamp and keys is provided with each main and monitor station. Through this arrangement the equipment cabinets can be placed in an out-of-the-way location and the operating console may be located in a dispatcher's office.

8.02 Each station location requires, in addition to the SC2 bay equipment, a 7-foot cabinet for 48-volt power equipment. Batteries are included in this cabinet to provide stand-by power reserve.

8.03 Normally a single power cabinet can be used for all the SC2 equipment at a given location, even if a location should have main, satellite, and monitor equipment located on the premises.

9. MAINTENANCE

9.01 Rapid and easy maintenance is important in the SC2 selective control system. When service interruptions occur, procedures must be available which allow

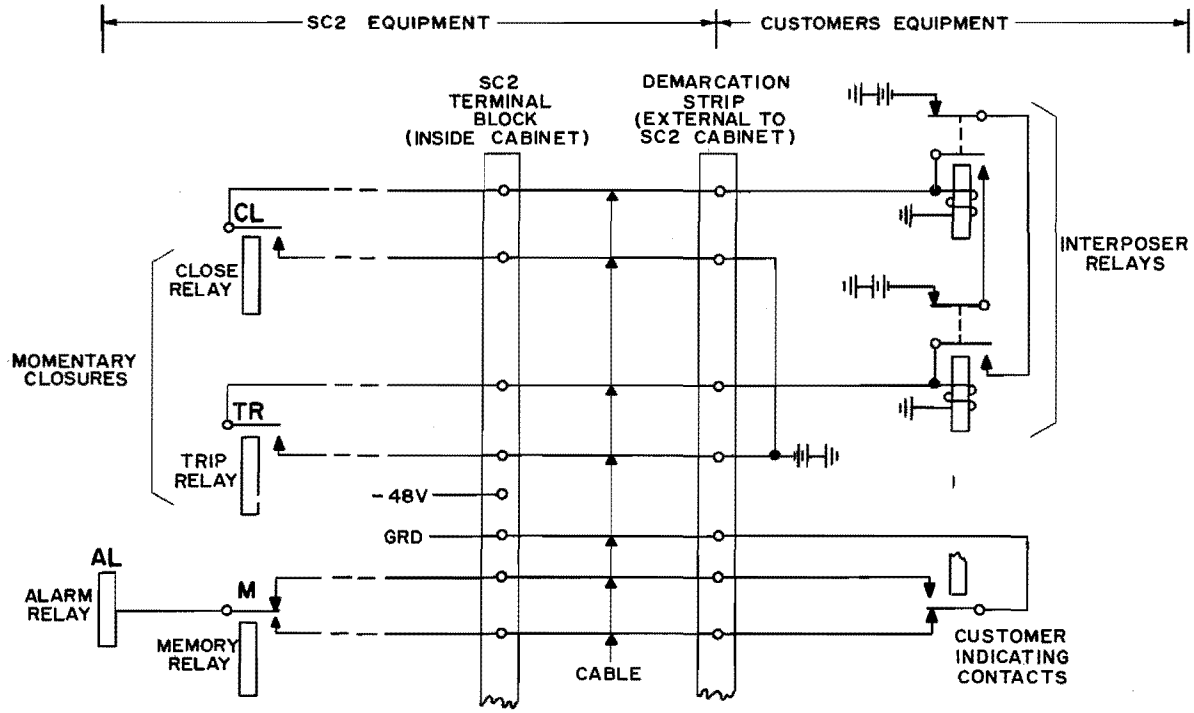

Fig. 8 - Typical Connection to Customer's Equipment When Supplying Only Momentary Closures

the telephone company to determine the trouble quickly. Without this, valuable time might be lost in traveling from one satellite station to another in attempting to locate trouble. This is especially true when such locations are a great distance from one another or from the nearest plant force location.

9.02 Once a source of trouble is found, the plug-in feature of the system allows for rapid and easy restoration of service by merely replacing the defective unit. The defective unit can then be taken to a central point for repair.

9.03 The SC2 system is designed so that a number of its features serve to recognize trouble soon after it occurs. Some of these features are as follows:

(a) The routine operations, particularly the periodic roll calls, provide means of checking all the associated equipment. No reply to an order or inquiry indicates trouble.

(b) Individual device white lamps at a monitor station light when an order or inquiry is known to have been sent. Failure to light these lamps under this condition is an indication of trouble.

(c) Common red and green lamps on the monitor console light momentarily when satellite stations reply to orders and inquiries. Failure to light these lamps under these conditions is an indication of trouble.

(d) A lamp is provided at monitor stations which lights in the event that a code is distorted during transmission.

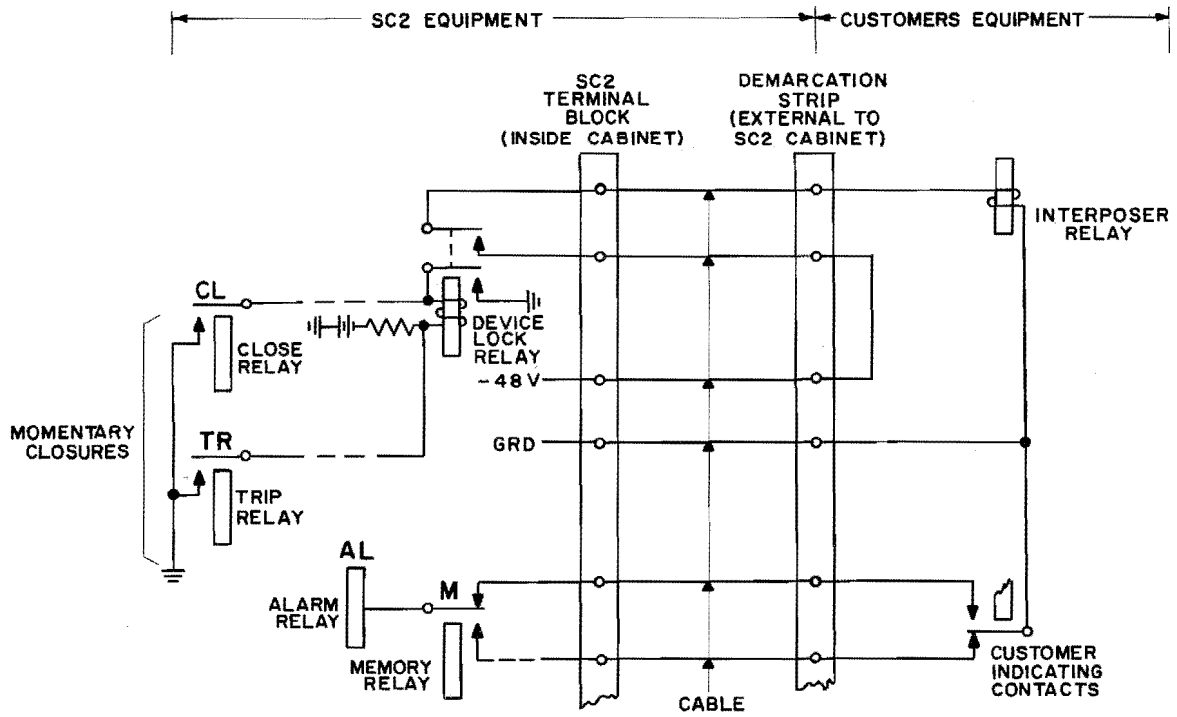

Fig. 9 - Typical Connection to Customer's Equipment When Supplying a Continuous Closure

(e) The individual red and green lamps at the main and monitor stations should be in exact agreement. Otherwise trouble is indicated.

(f) At satellite stations which are equipped with device lock circuits (see 3.32) contacts are provided to which lamps can be wired to indicate the condition of the satellite station device lock circuit for any of the devices. A disagreement between such a lamp and the actual condition of the customer's equipment indicates trouble unless the customer's equipment happens to be disconnected from the satellite at the time.

9.04 Once a trouble is reported, close cooperation between the telephone company and the customer can, in most cases, localize the trouble very rapidly.

9.05 Satellite stations can be readily disconnected from a line by a simple plug arrangement in the satellite cabinet or on the local telegraph switchboard, depending upon the type of signaling being used.

9.06 Localization of trouble will be aided by a multipoint separation switch provided by the customer, between his equipment and the SC2 equipment.

9.07 In locating the source of the reported trouble it is expected that conventional means will be used to maintain the signaling network. For maintenance of the

SC2 equipment several types of test instruments will be used. Some of these are as follows:

(a) Checks of the operation of satellite and monitor stations may be made by the use of a dial test set designed specifically for this purpose, but only at the site of these installations. This test will not check the margins but will give an adequate operational check.

(b) Checks on the satellite and monitor stations may be made from telephone testboards by the use of a pulse length code test set. This test set is for use only on telegraph circuits employing 10-pps speed. In many cases, this will make it unnecessary for a maintenance man to make a special visit to an installation.

(c) Main stations can be tested for their ability to send correct codes by the use of a pen recorder. A suitable place for this recorder might be in the control test room which serves the main station.

9.08 When any doubt exists as to the adjustment of some of the timing and pulsing relays in the system, they may be checked and adjusted with the aid of test sets such as a timing test set and a pulse checking test set. The station should be disconnected from the line when this is being done.

10. PROTECTION

10.01 Arrangements are provided with the system so that there is sufficient protection from electrical storms and other hazards to personnel, customer's equipment, and the SC2 system.