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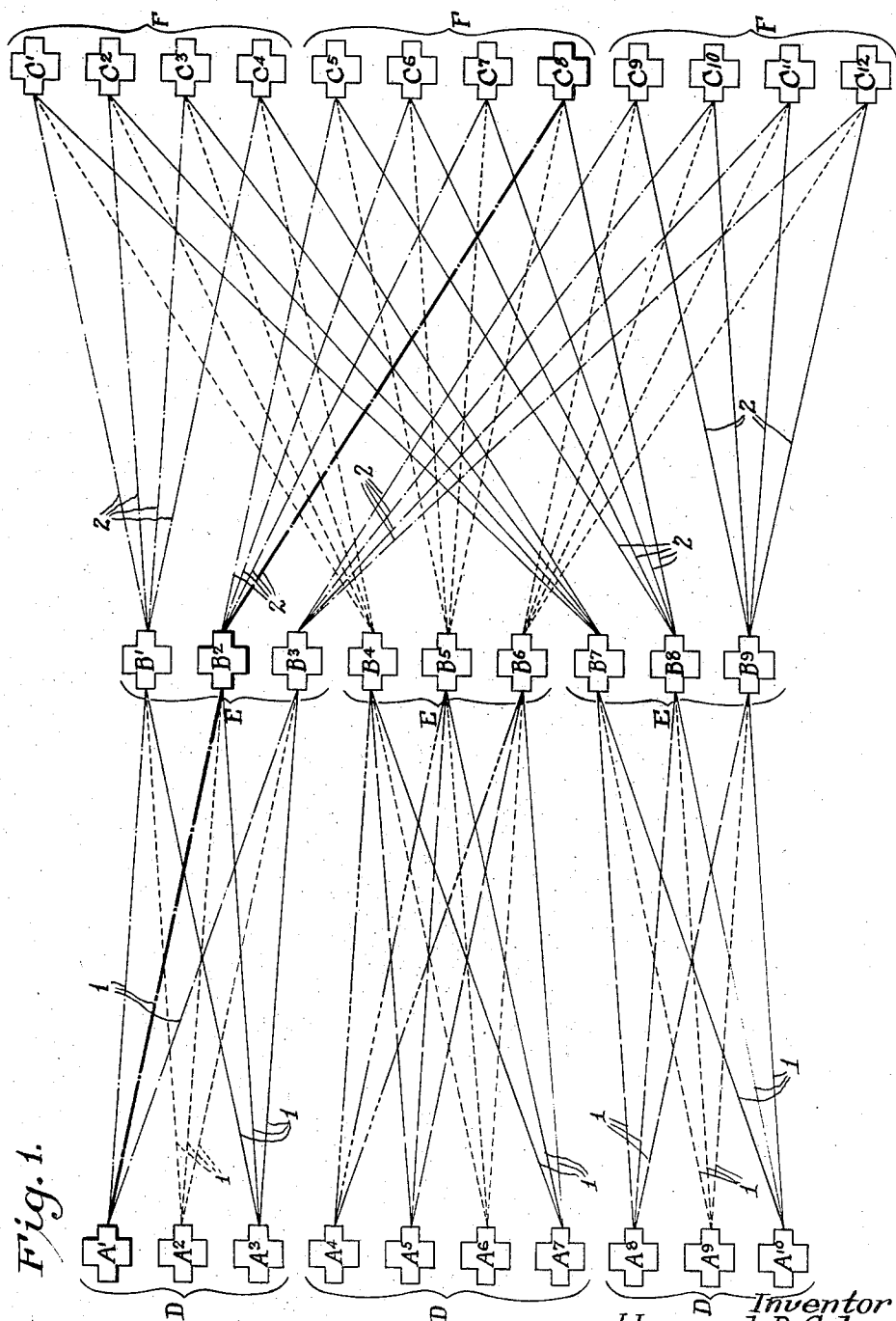
H. D. COLMAN

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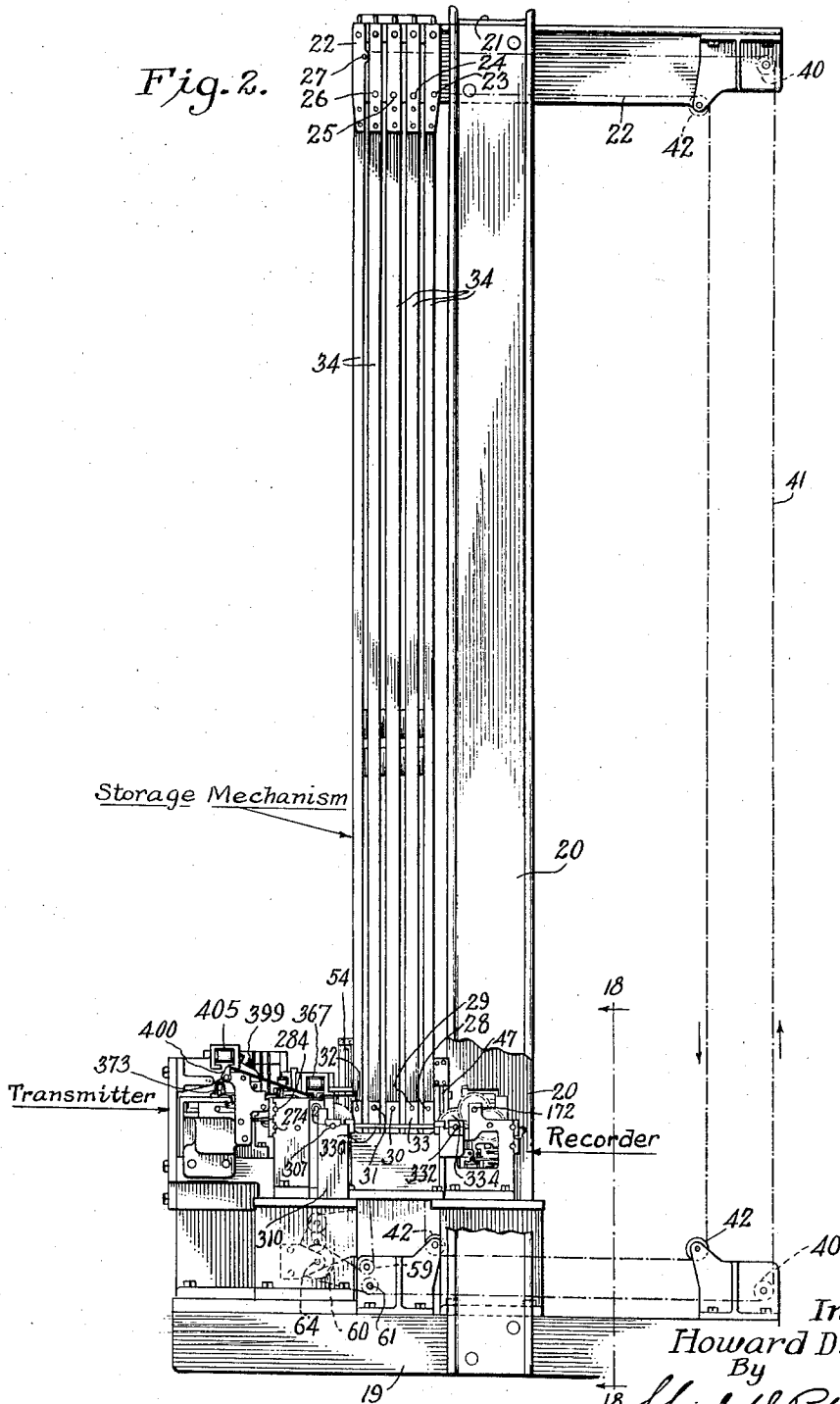
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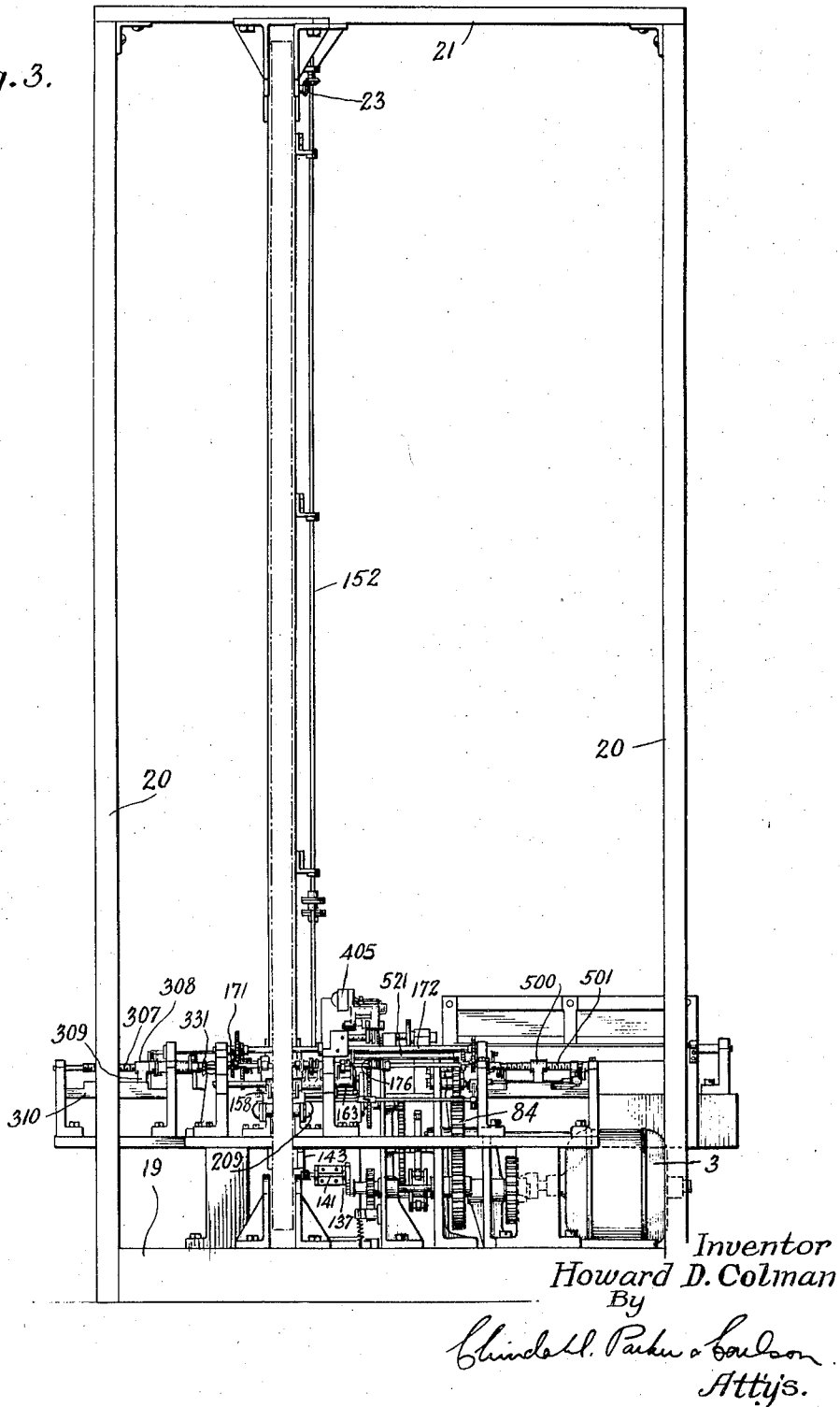
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Fig. 3.



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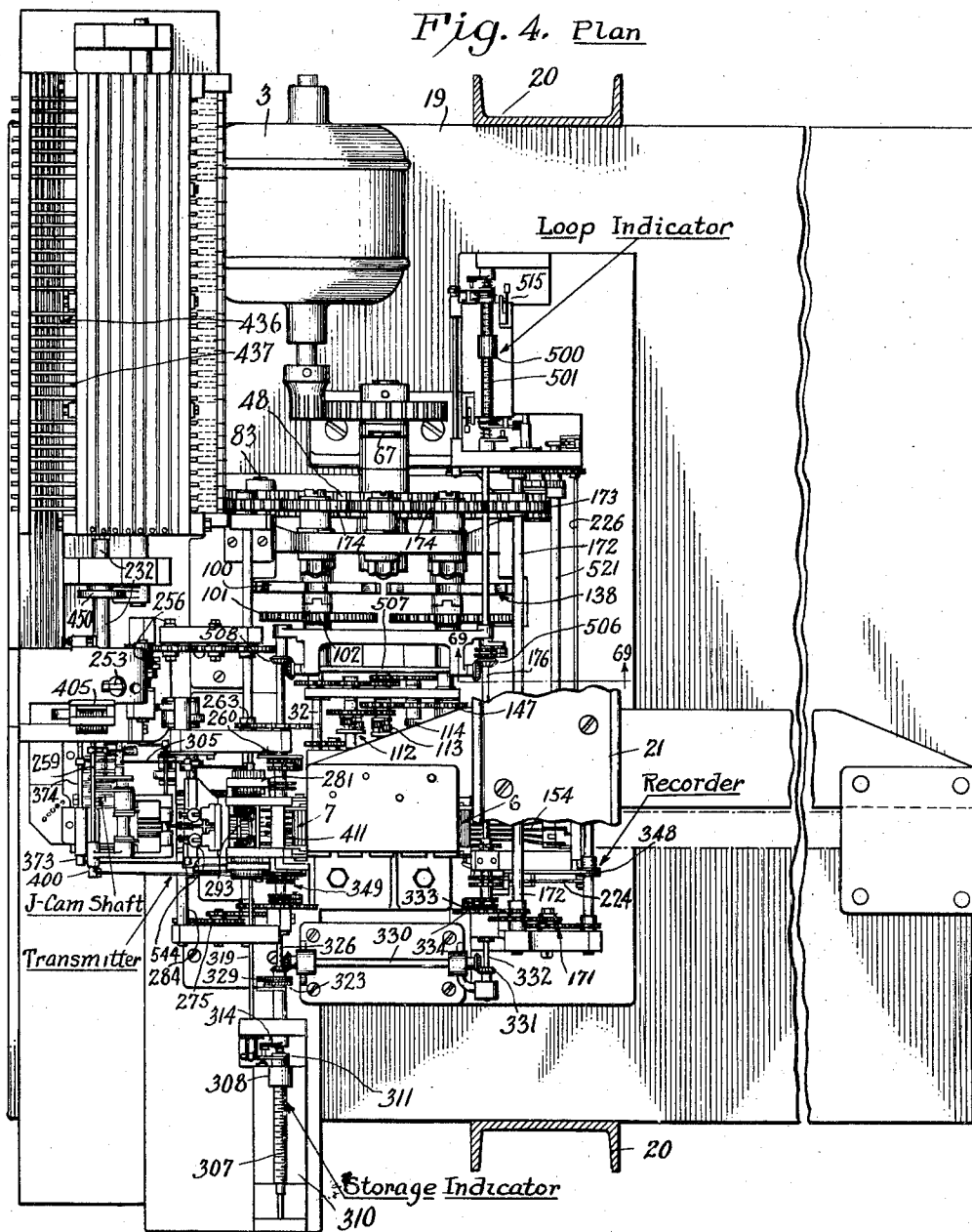
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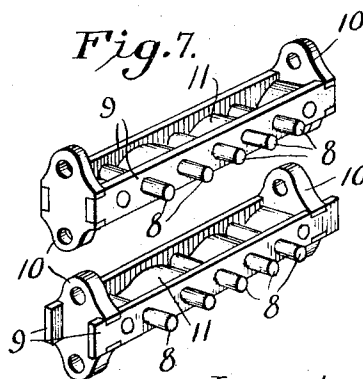
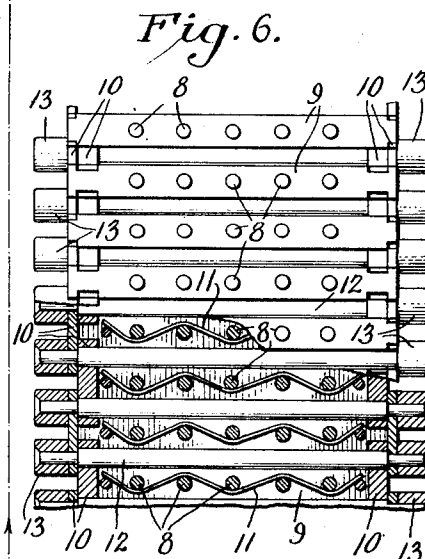
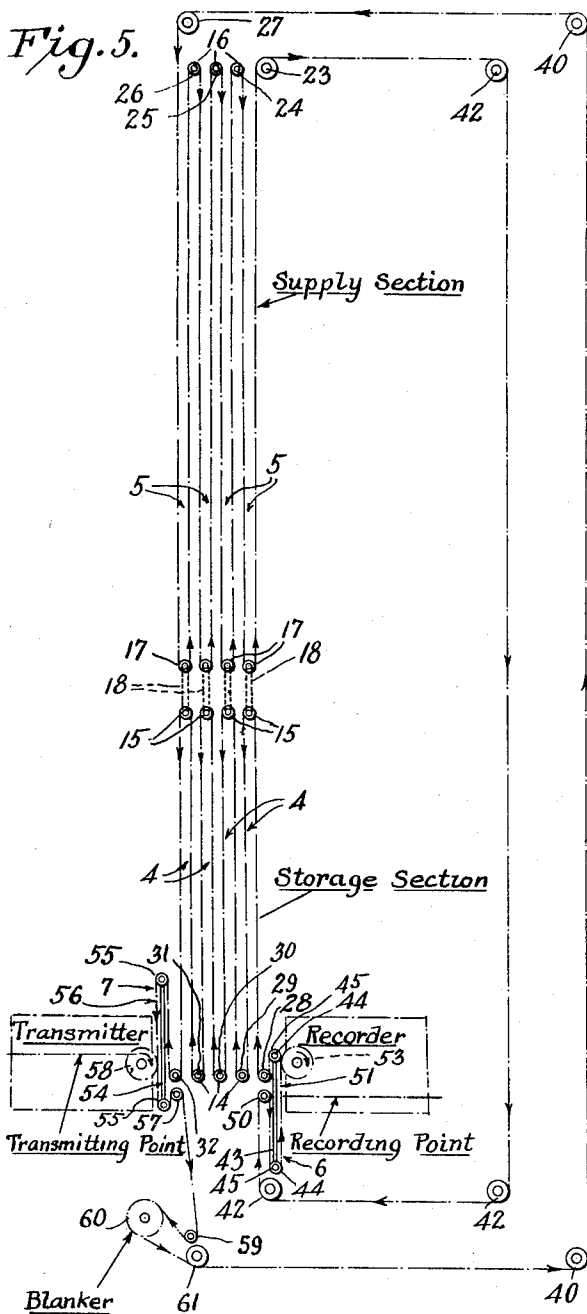
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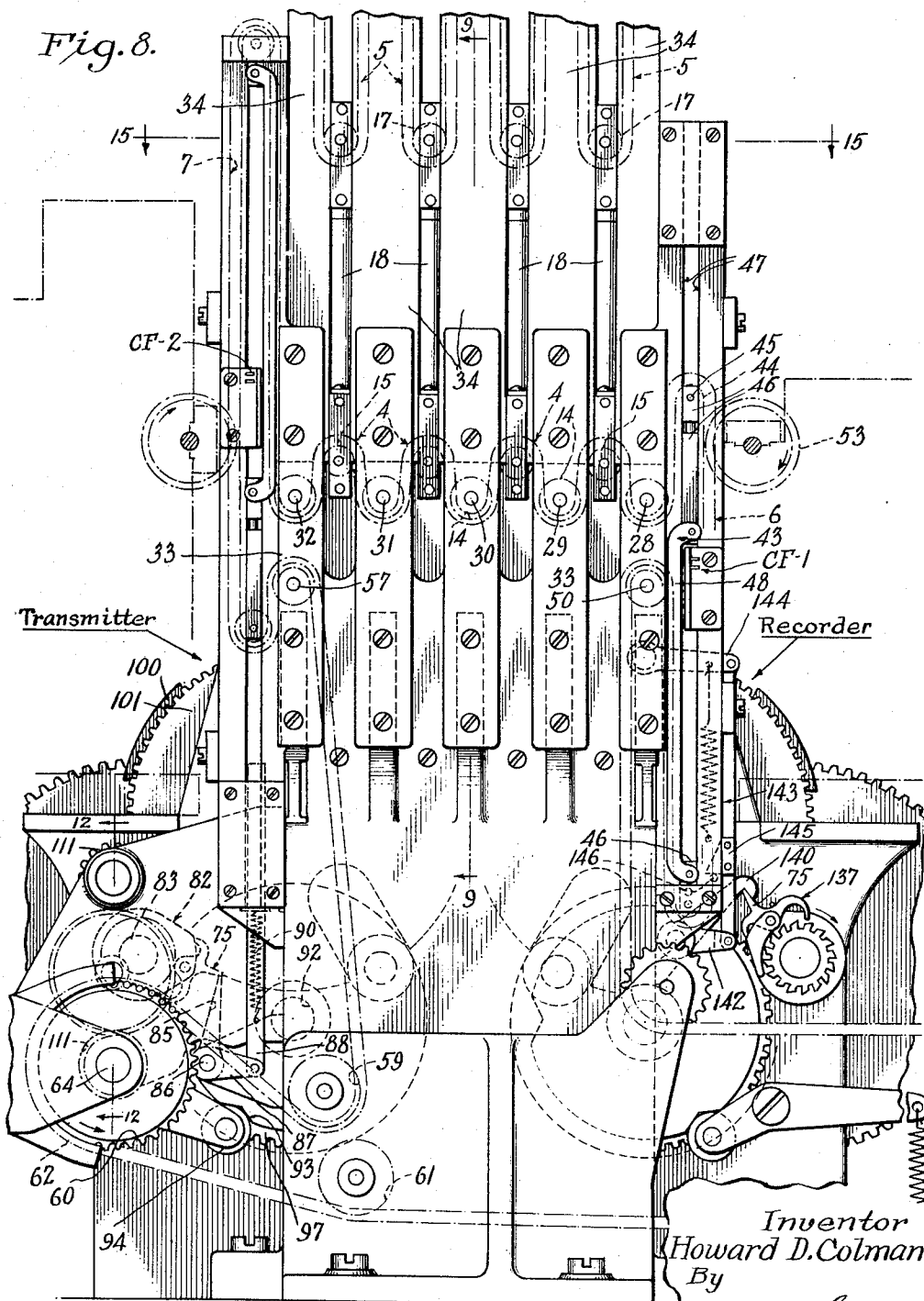
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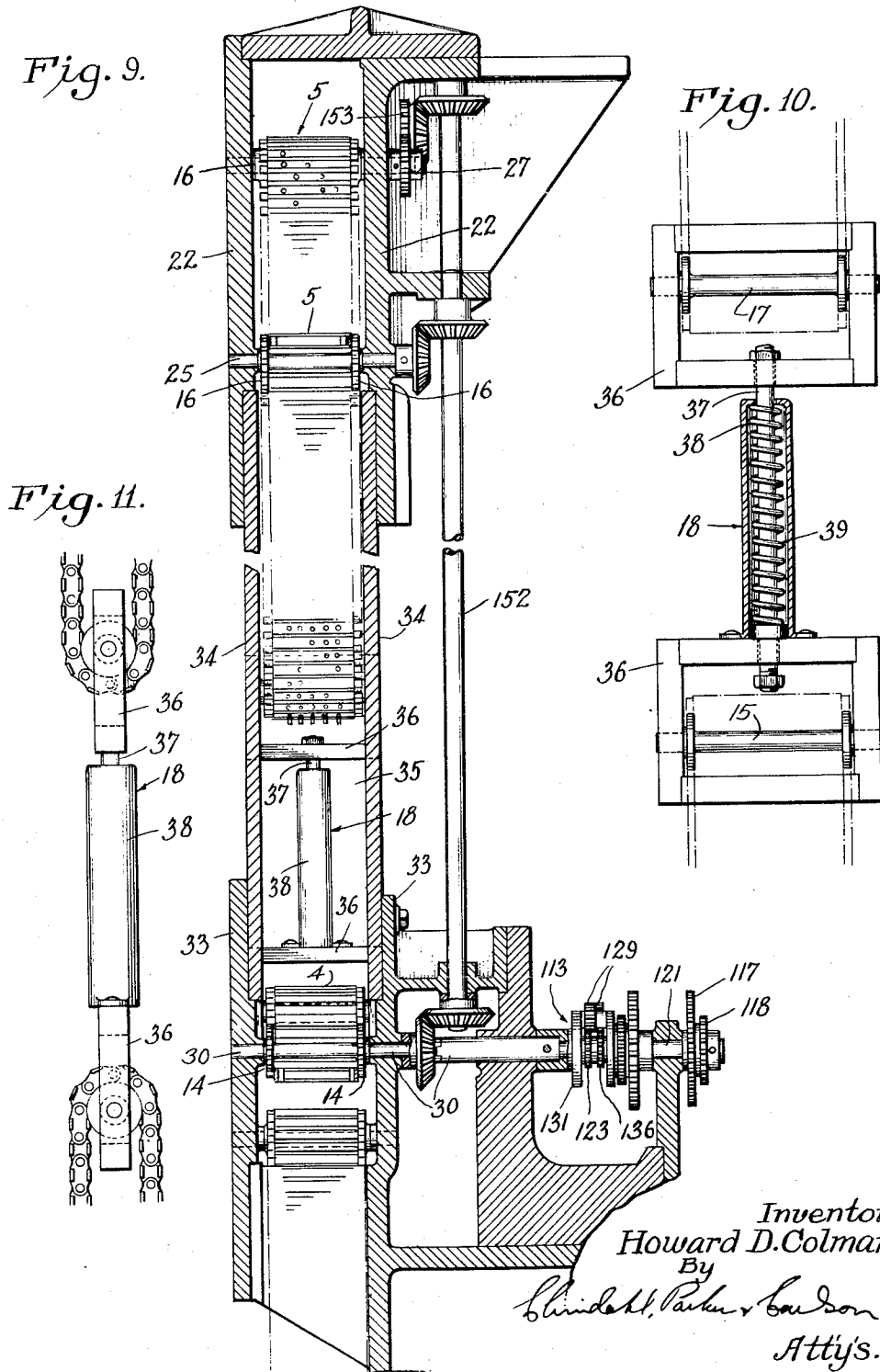
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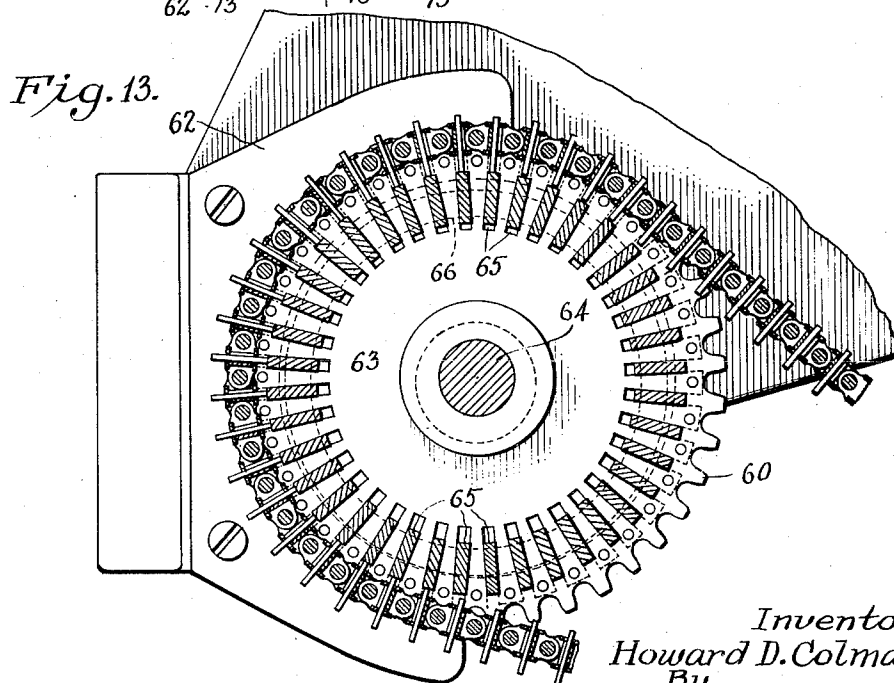
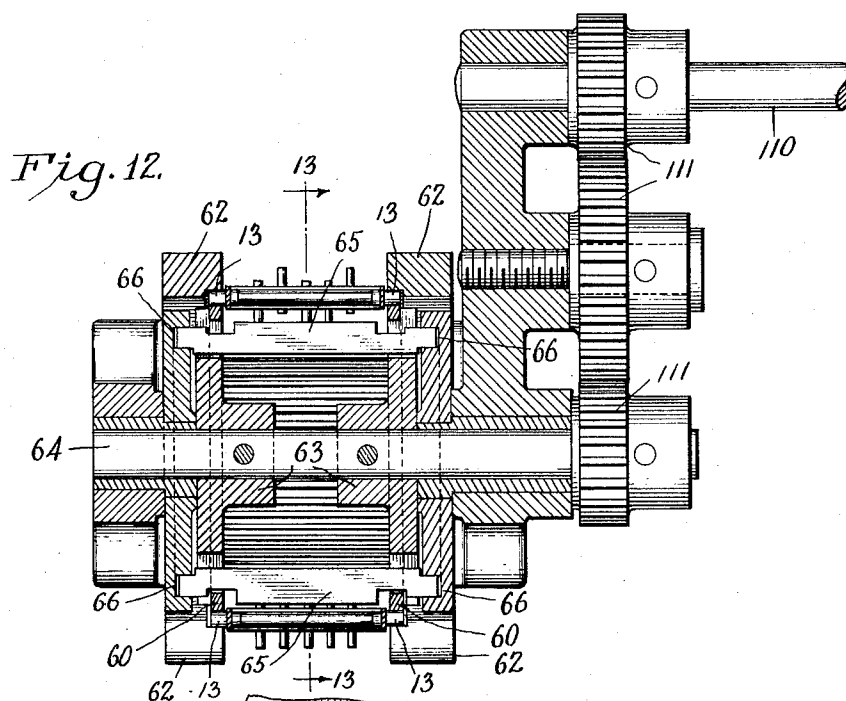
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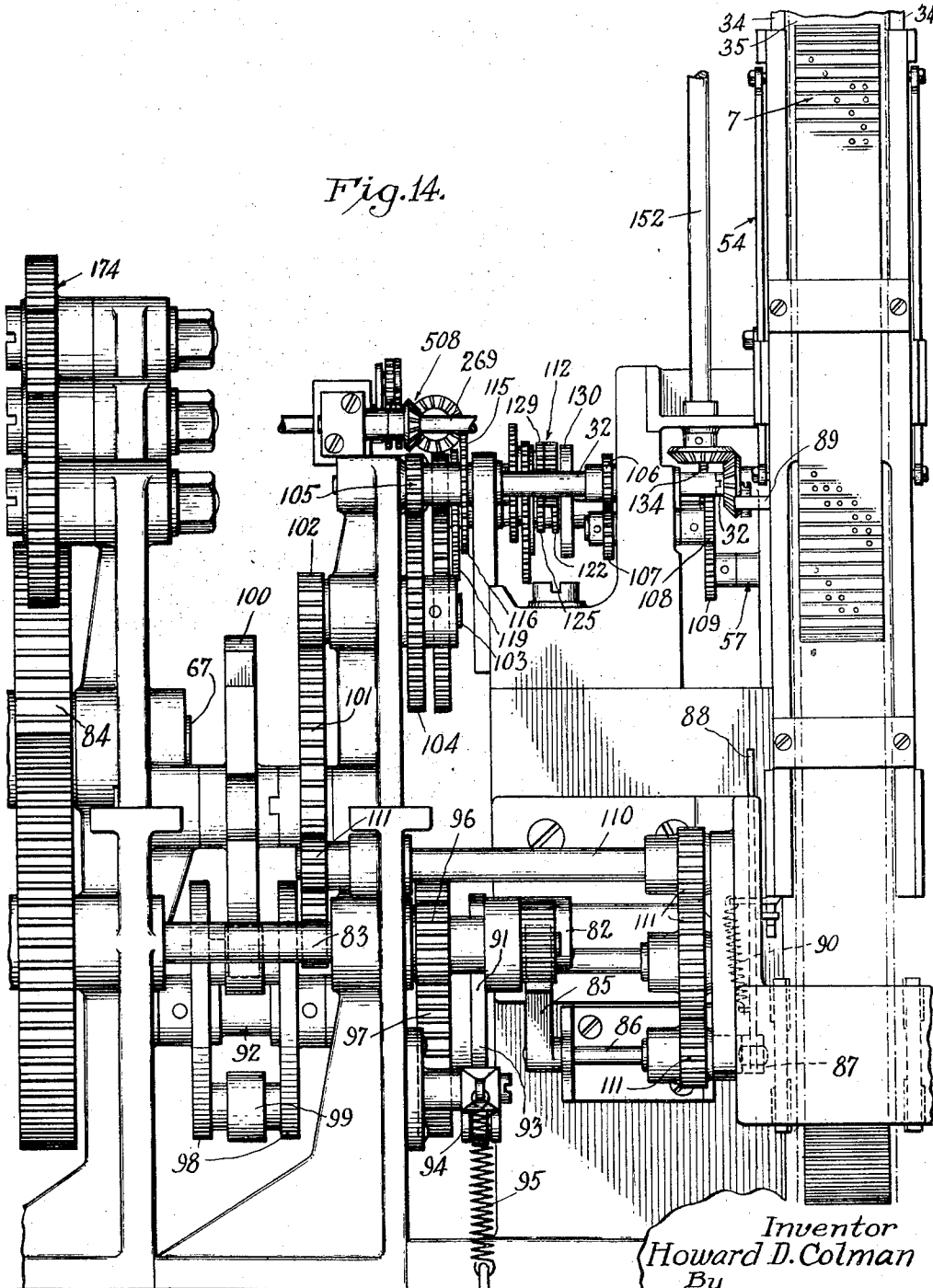
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52 Sheets-Sheet 9

Fig. 14.



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52 Sheets-Sheet 10

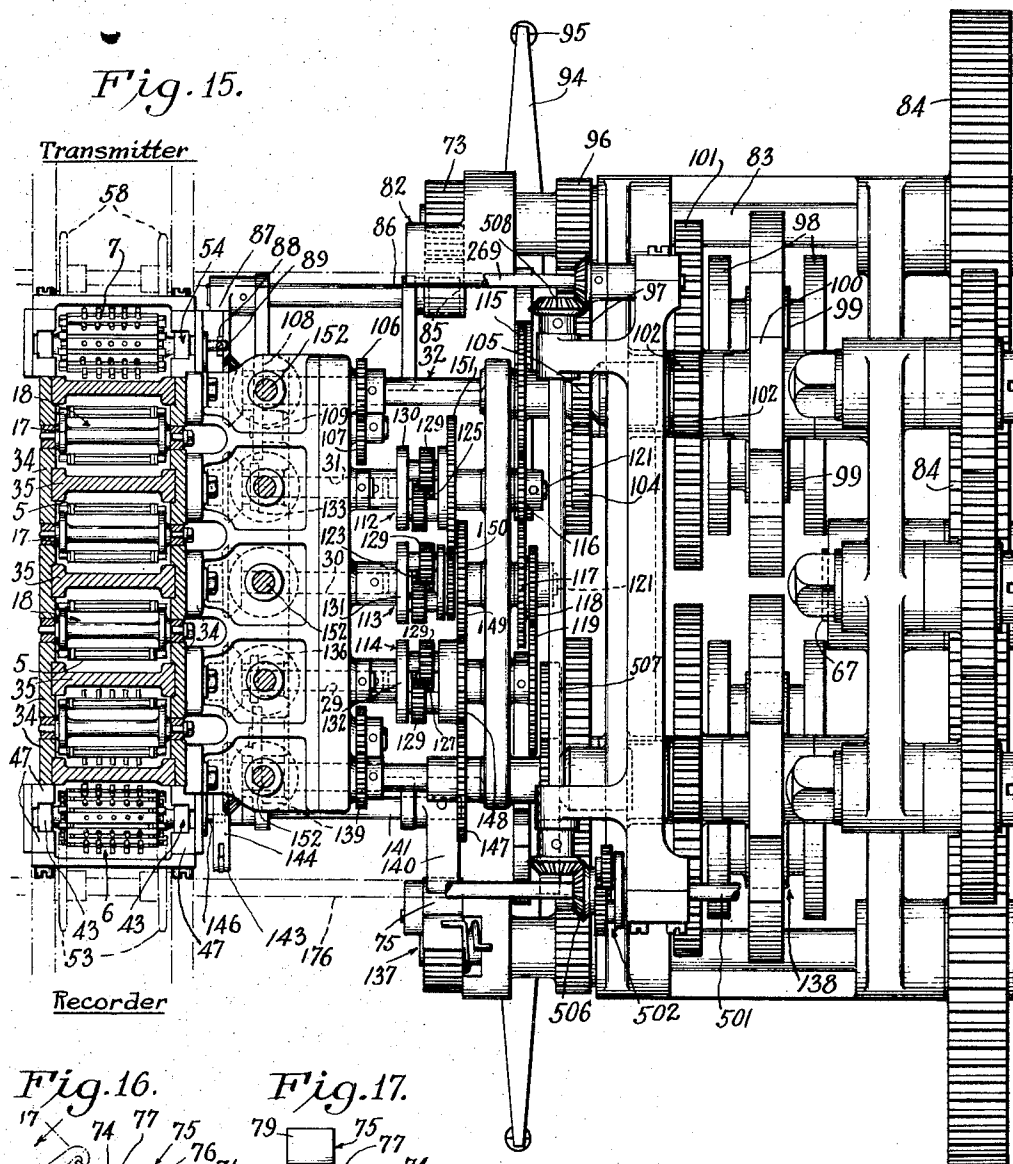


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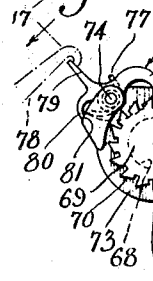
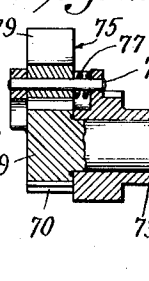


Fig. 17.



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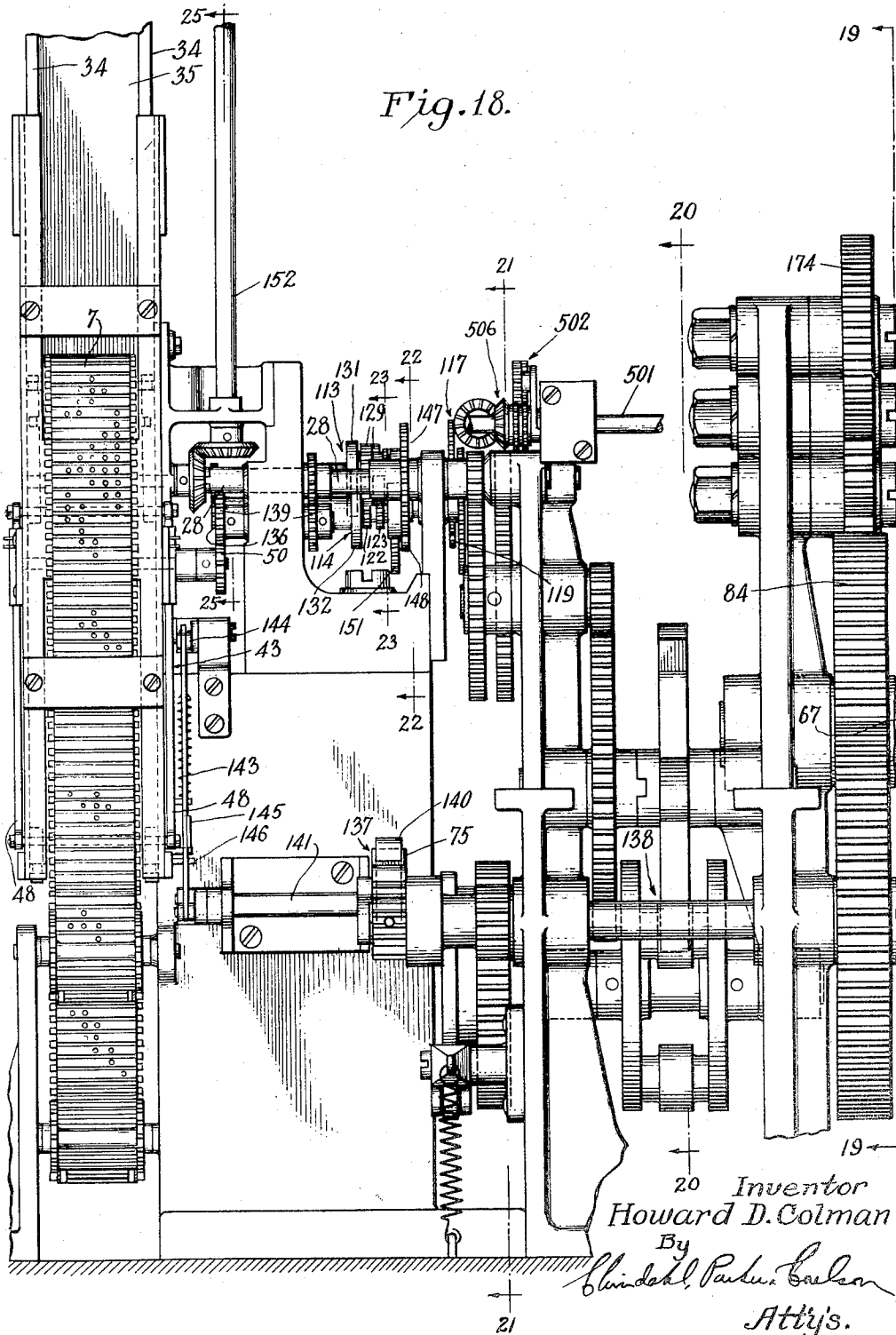
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Fig. 18.



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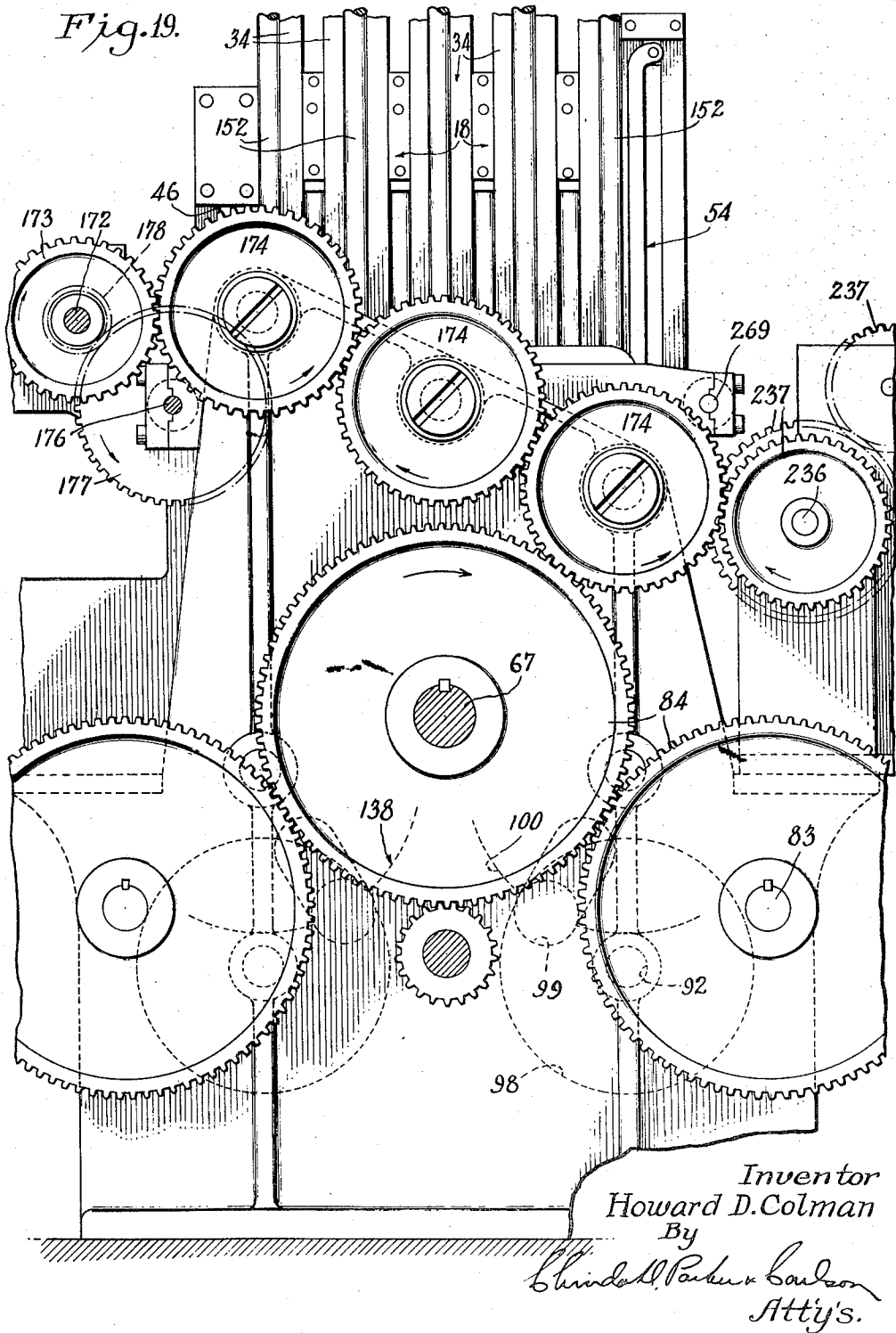
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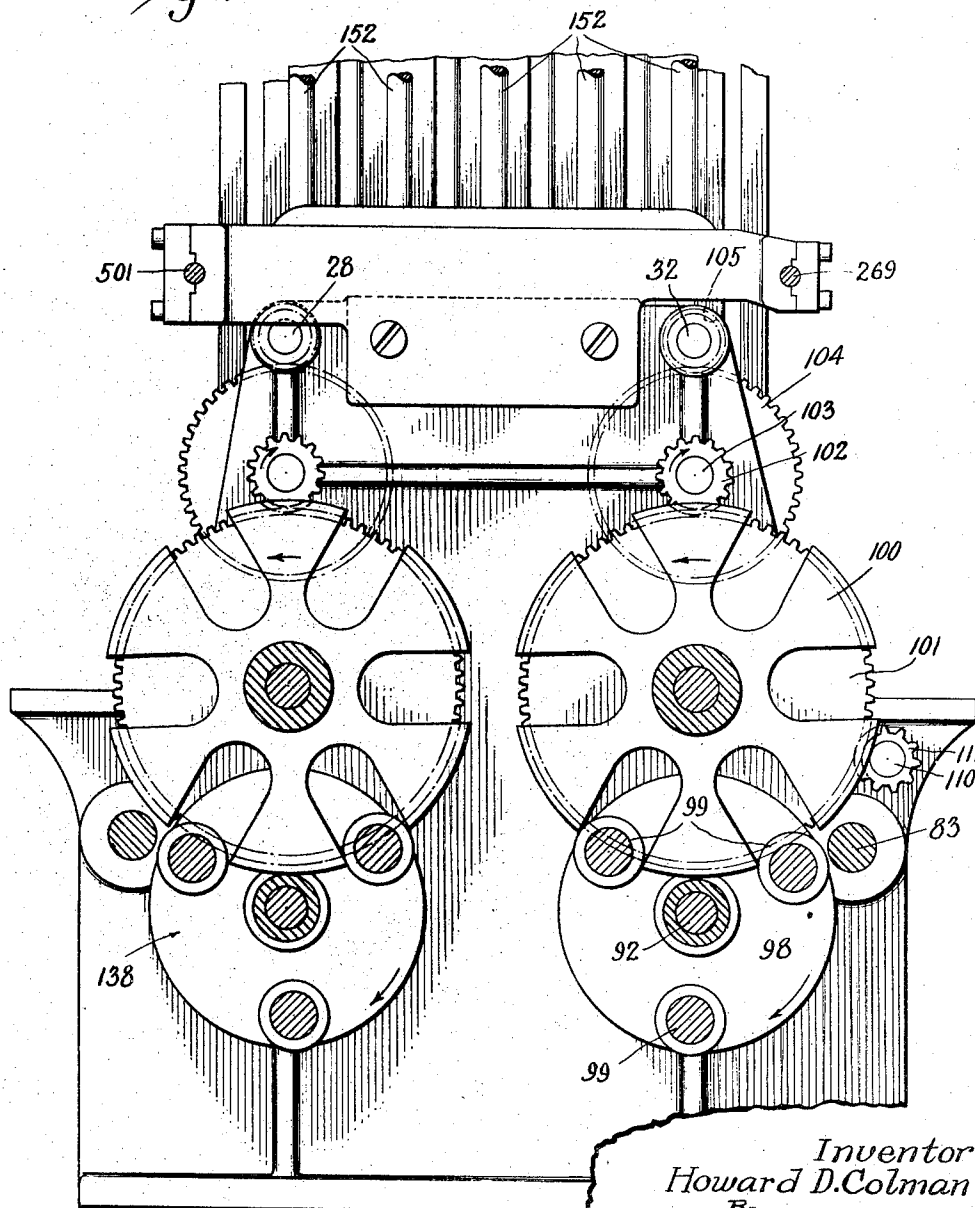
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Fig. 20.



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Howard D. Colman
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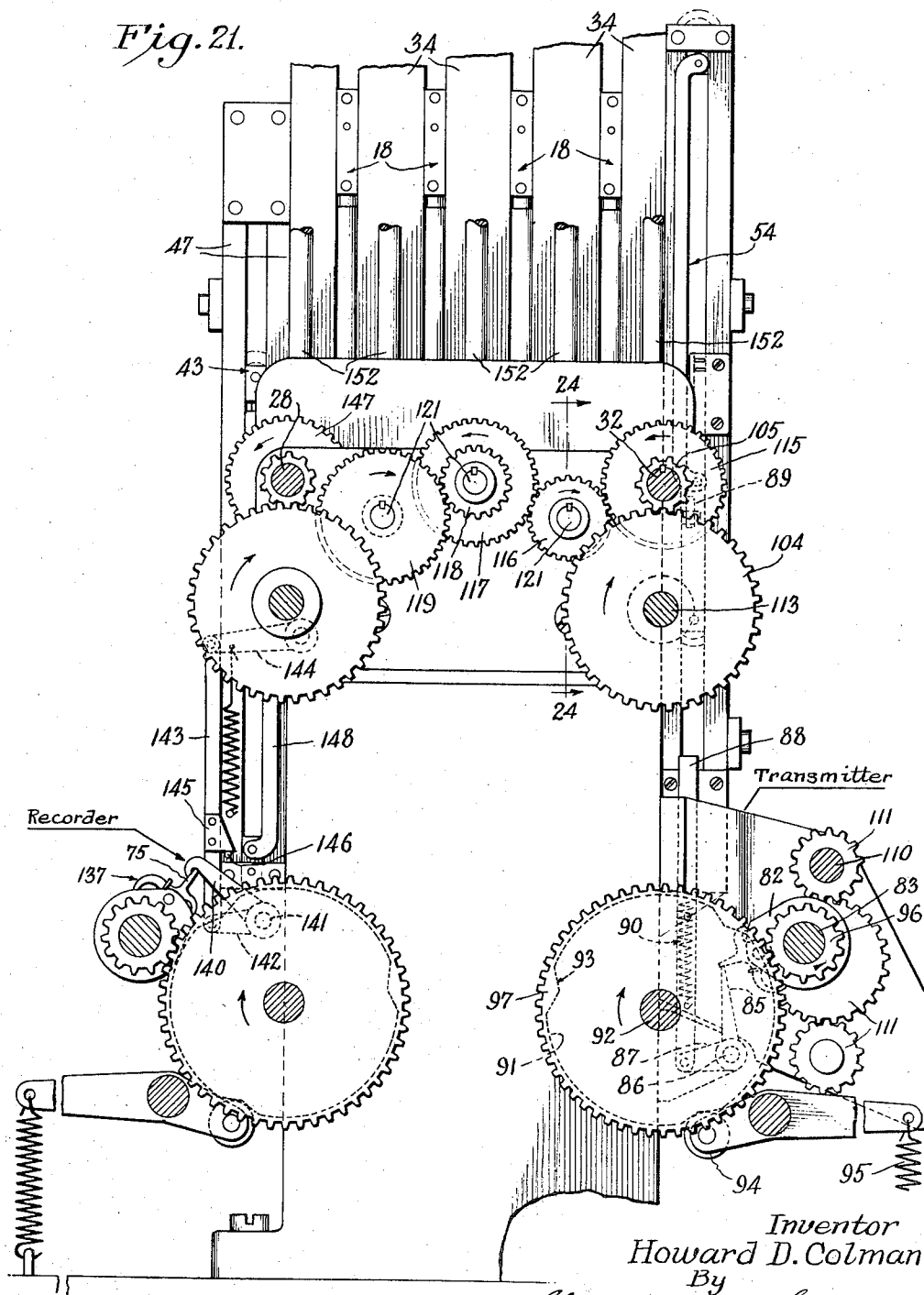
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Fig. 21.



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Fig. 22.

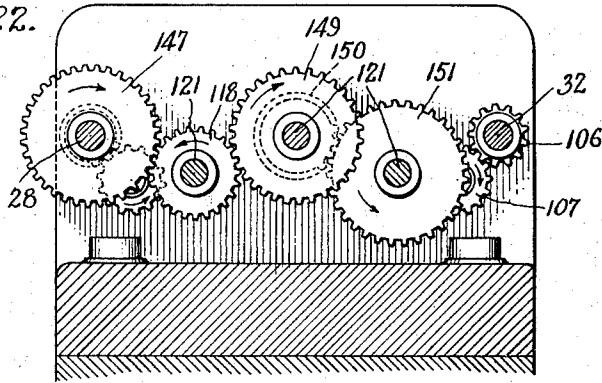


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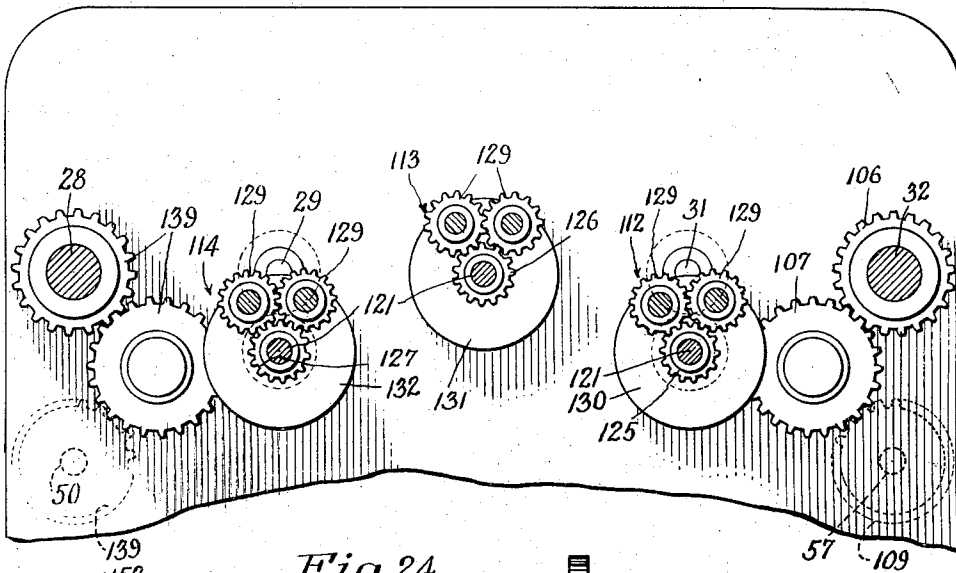
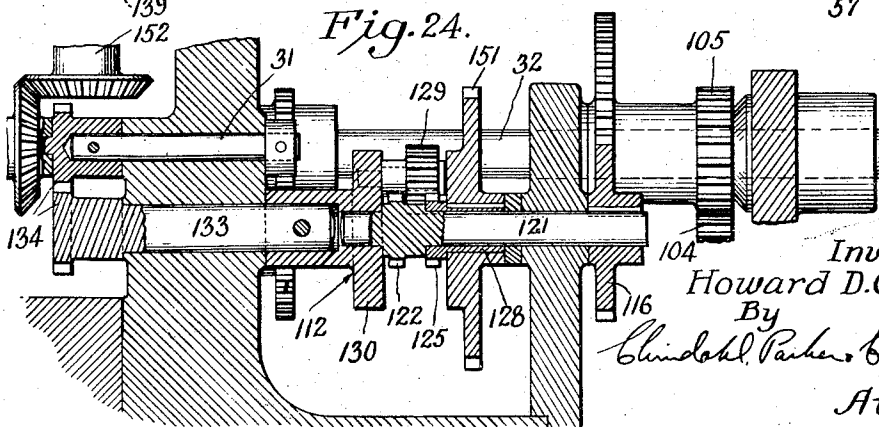


Fig. 24.



Inventor
Howard D. Colman
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Clintock, Parker, Carlson
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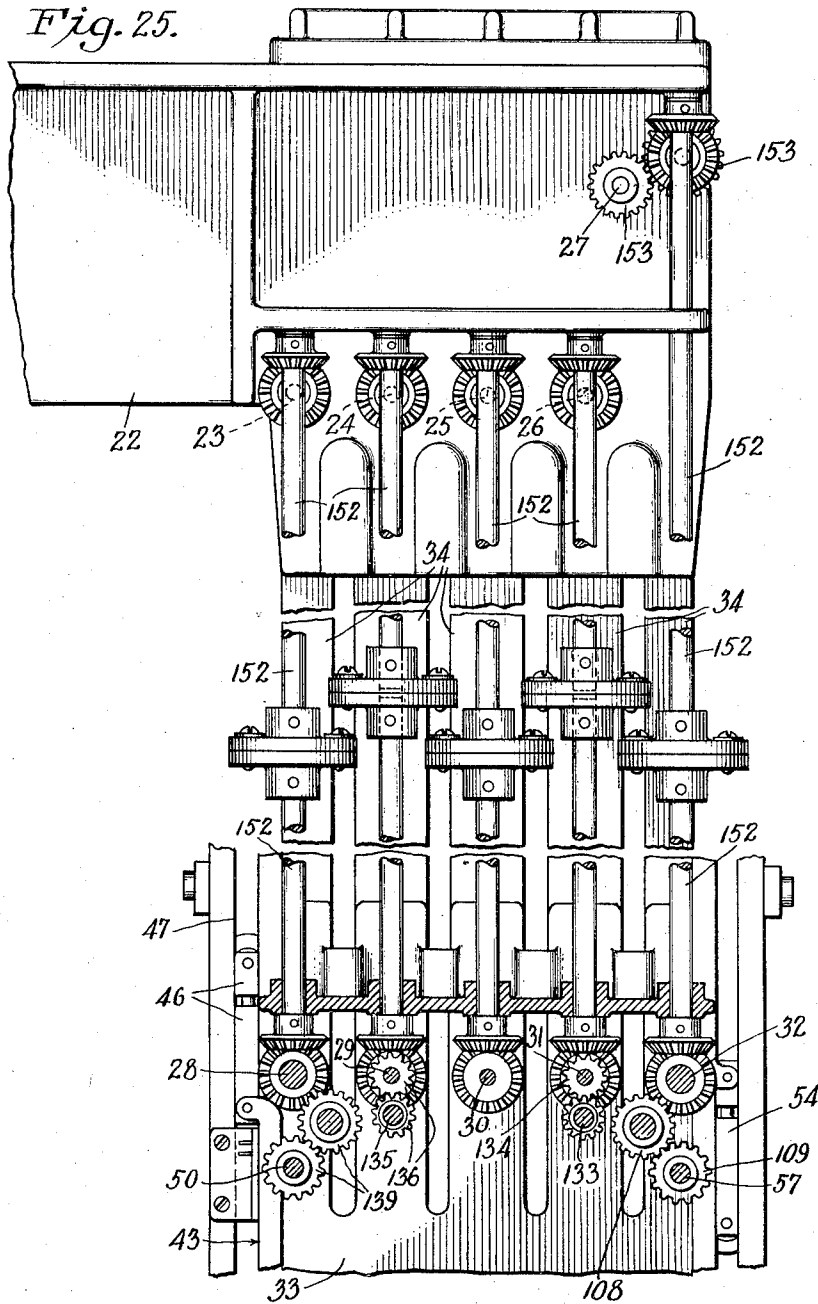
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Fig. 25.



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Howard D. Colman
By
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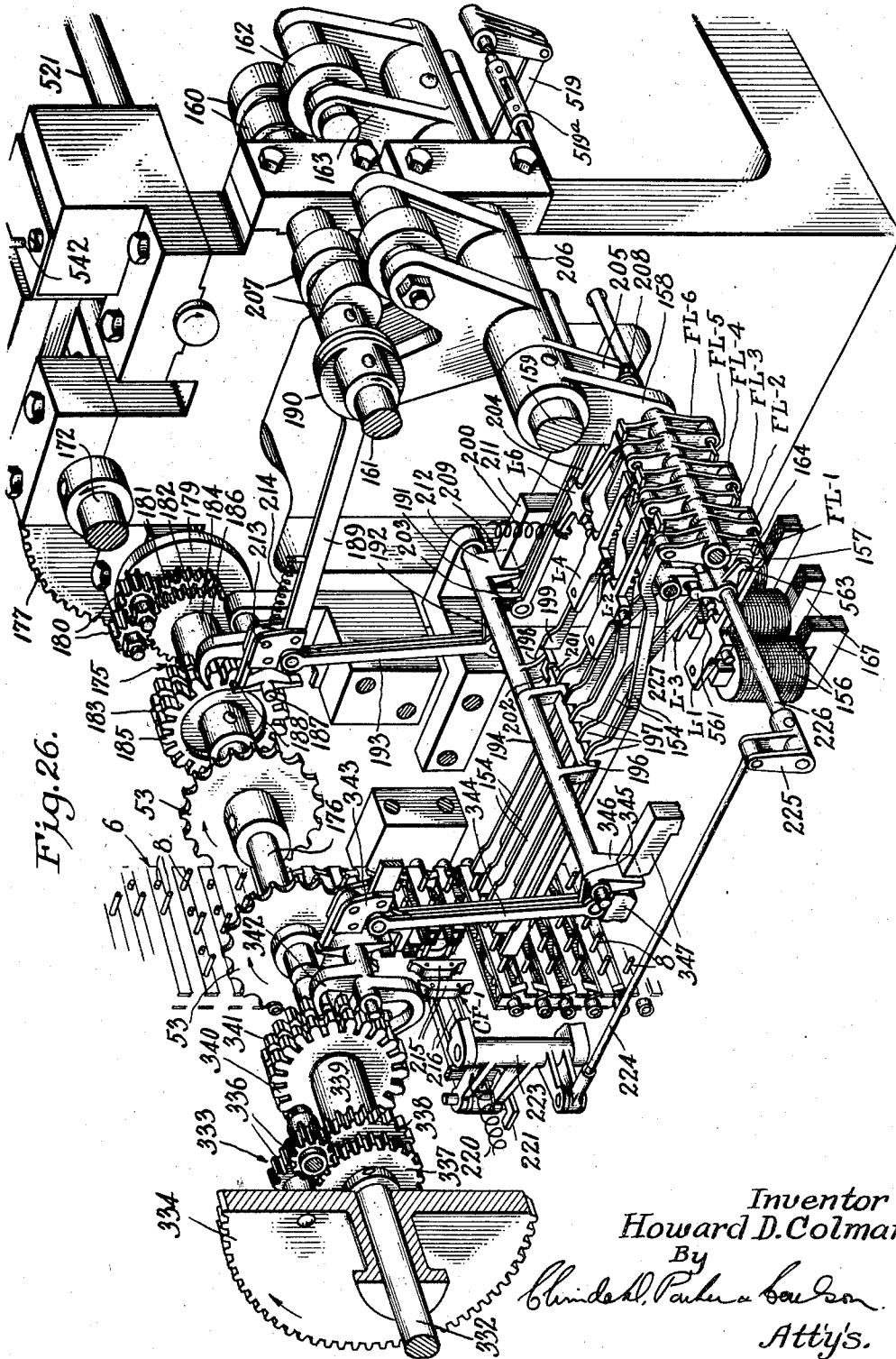
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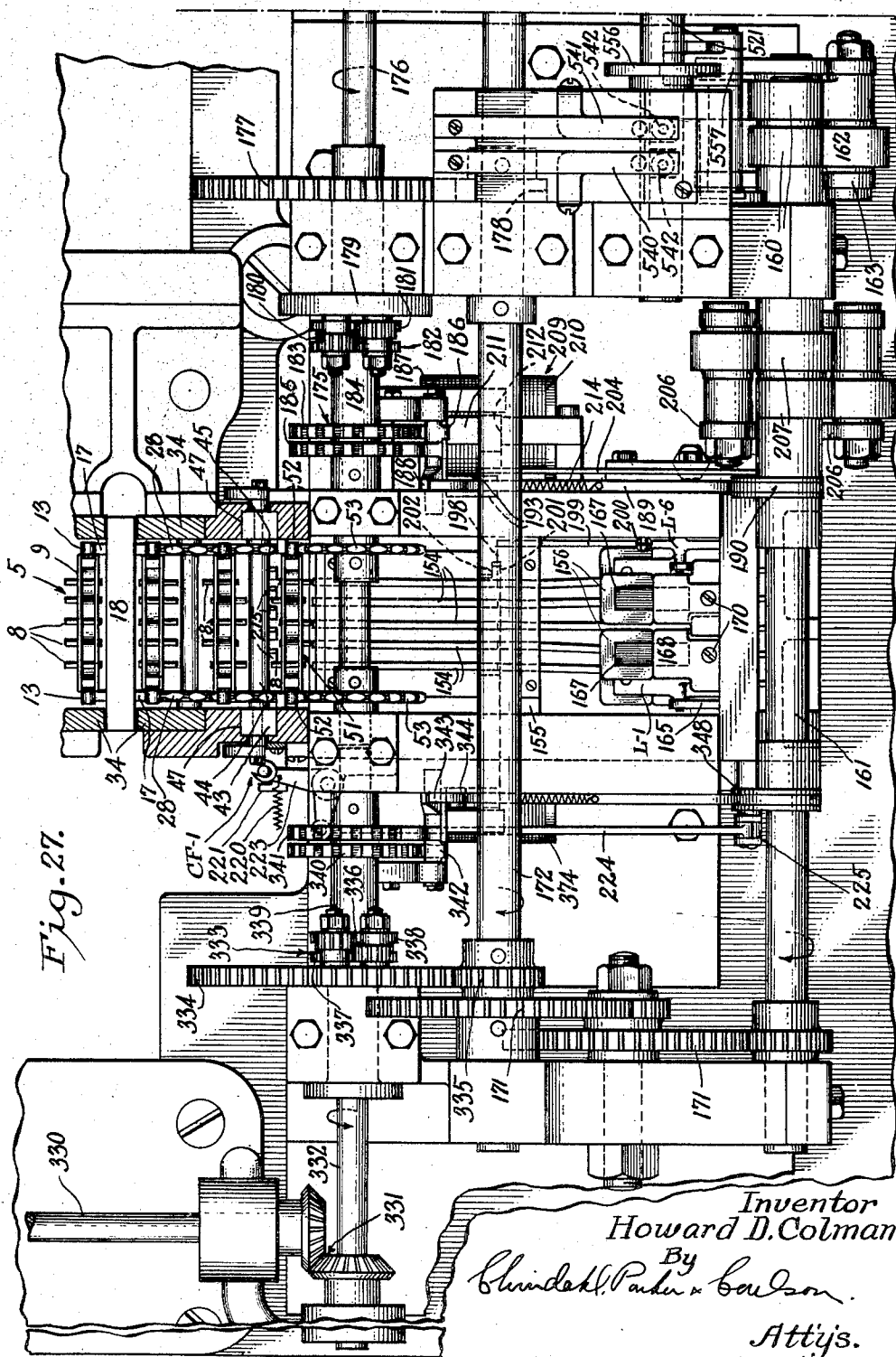
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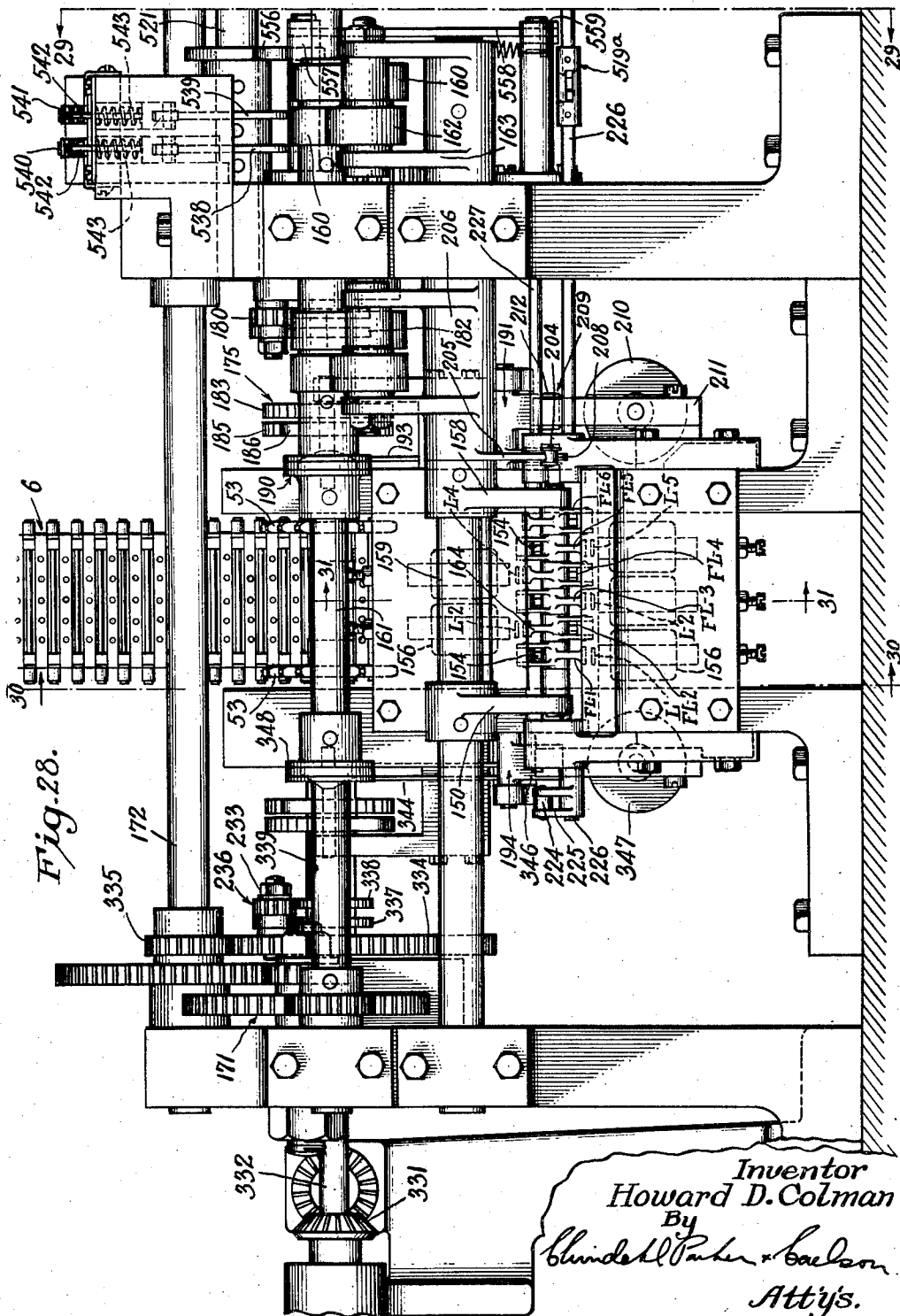
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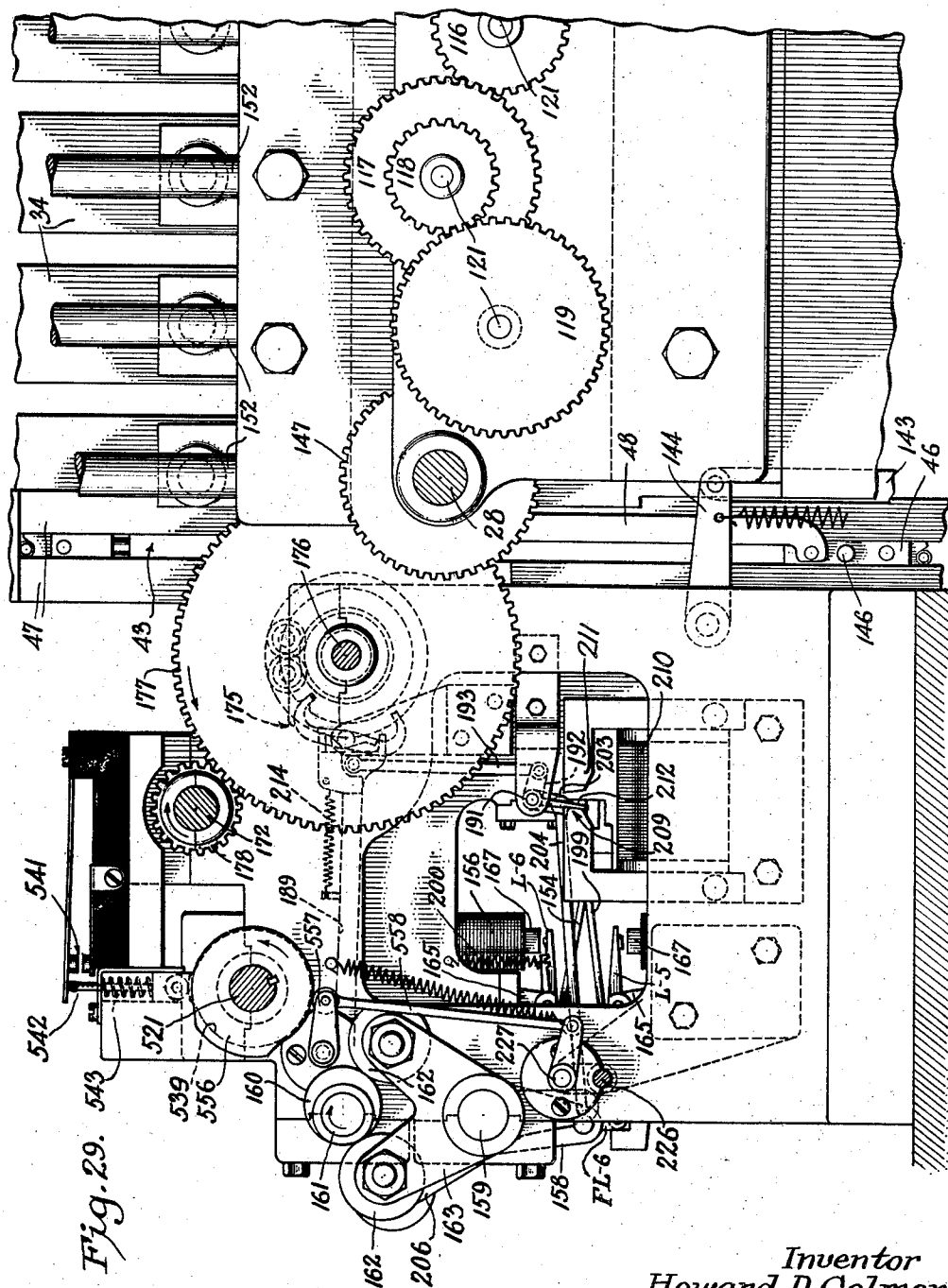
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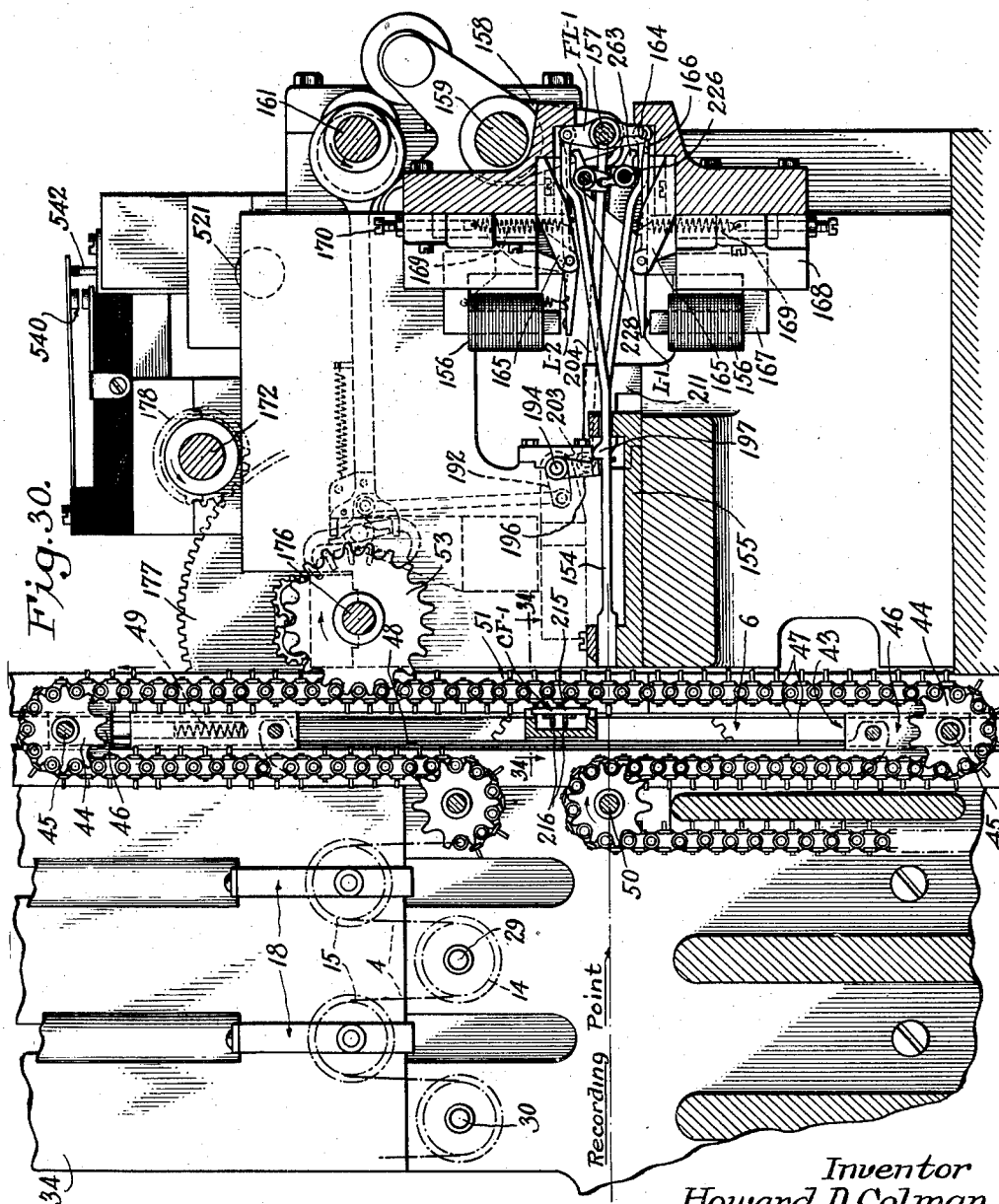
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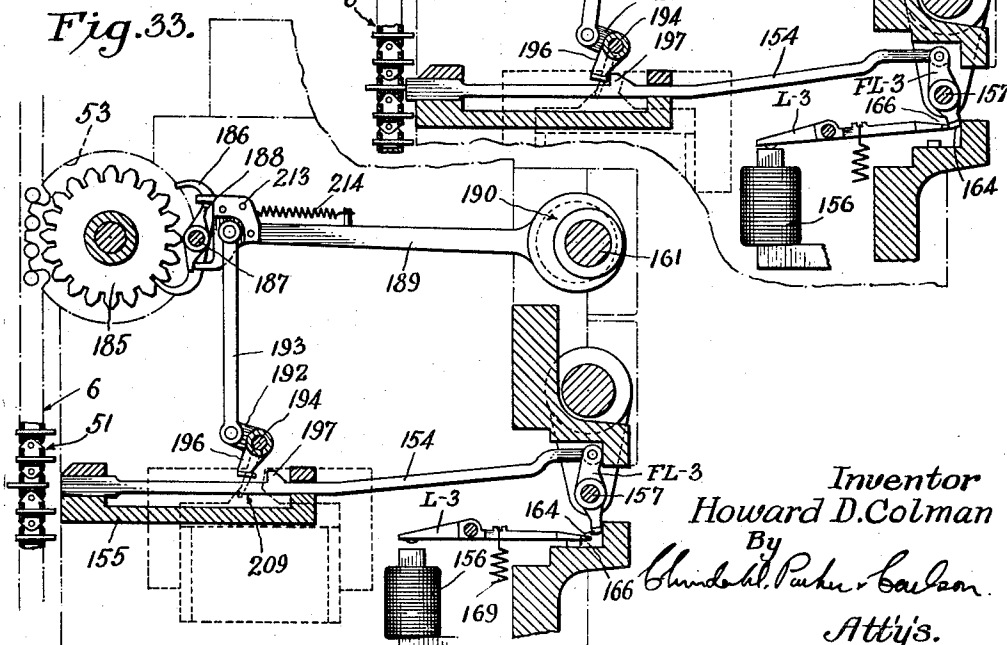
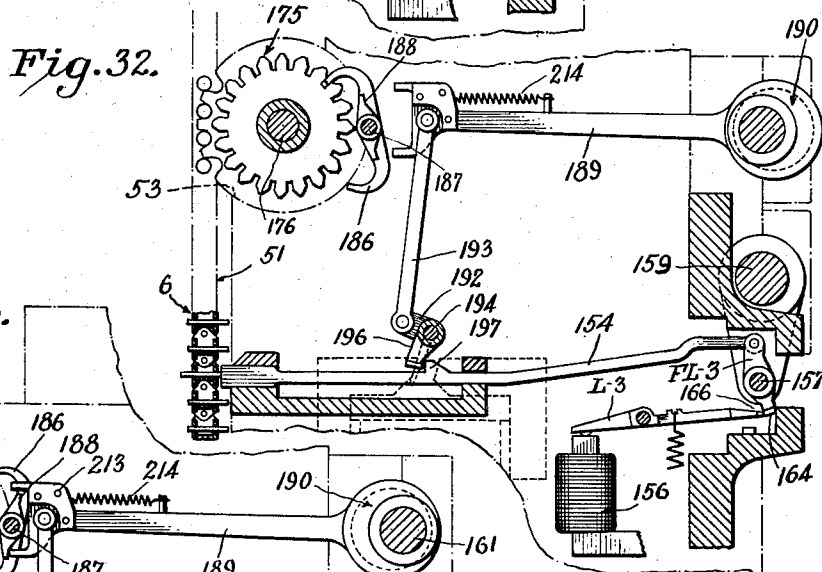
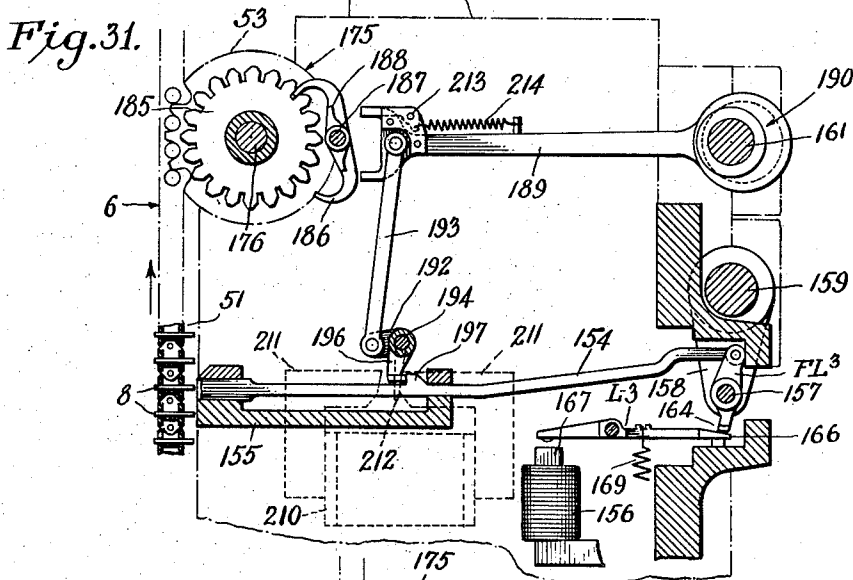
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52 Sheets-Sheet 23

Fig. 34.

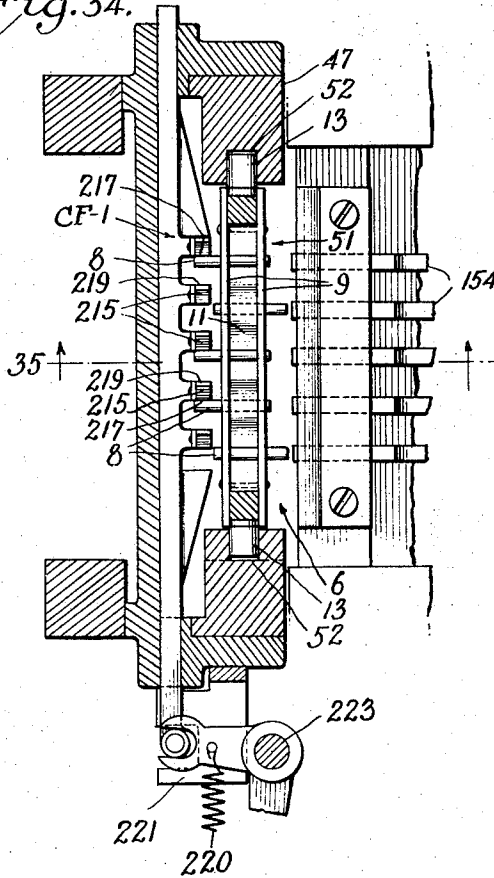


Fig. 35.

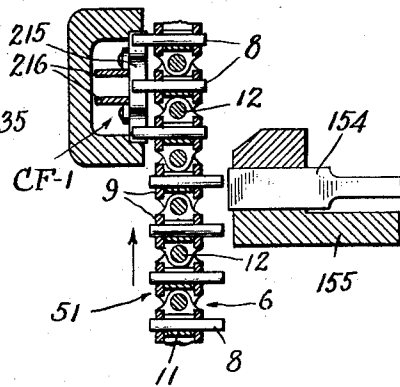
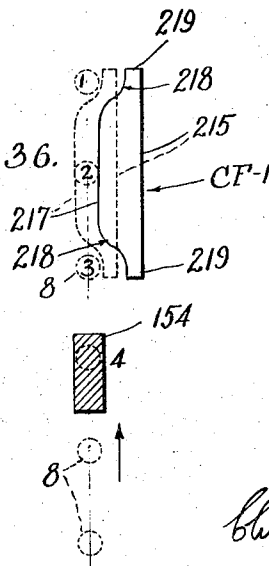


Fig. 36.



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Howard D. Colman
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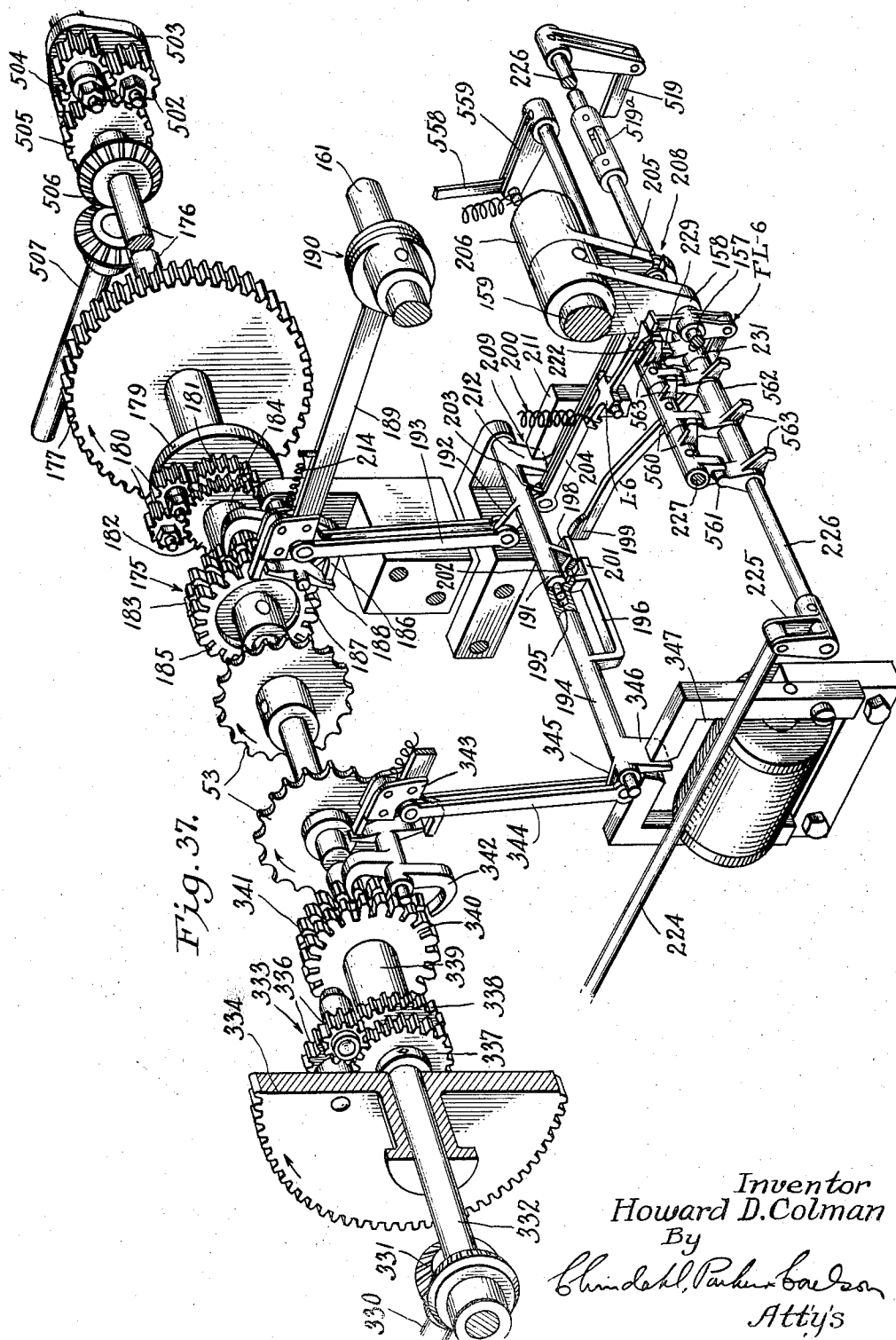
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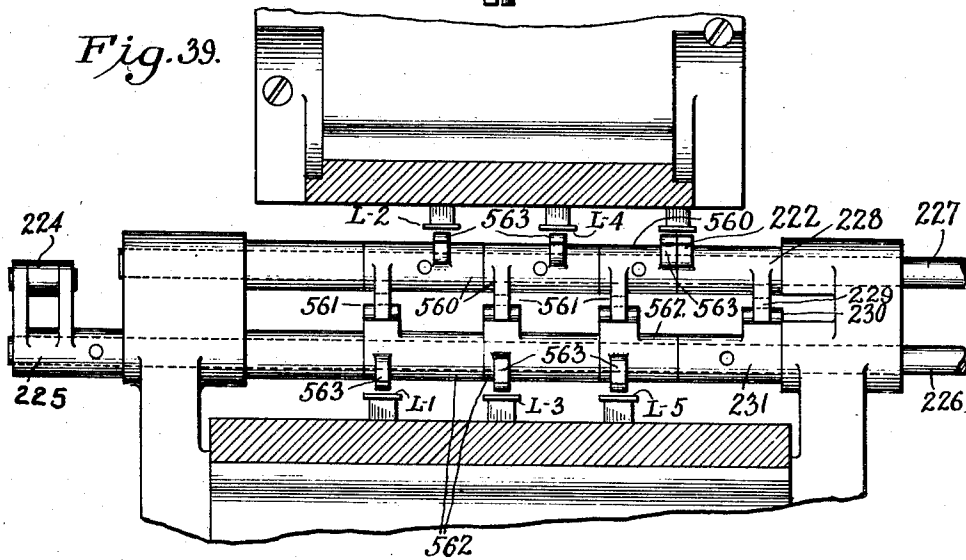
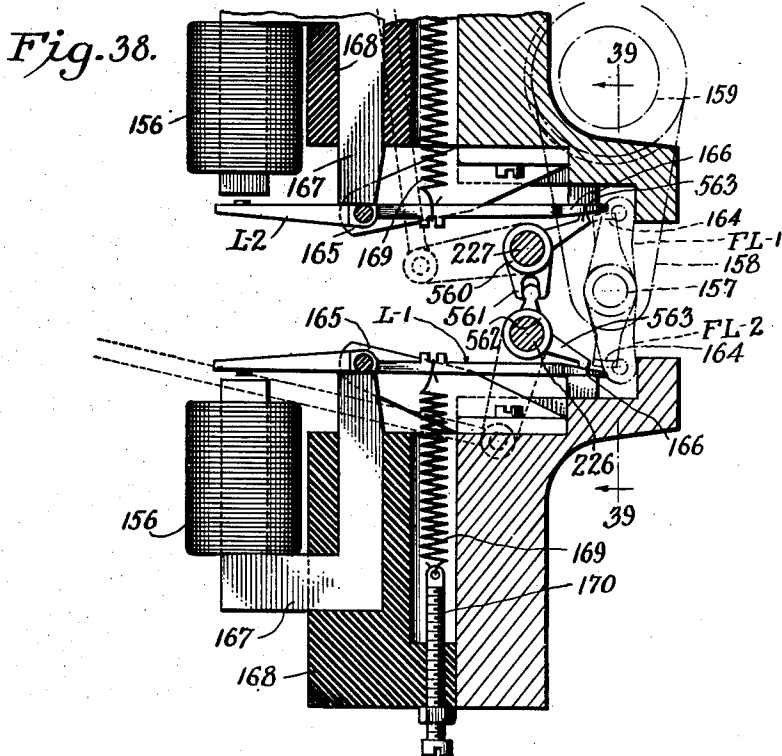
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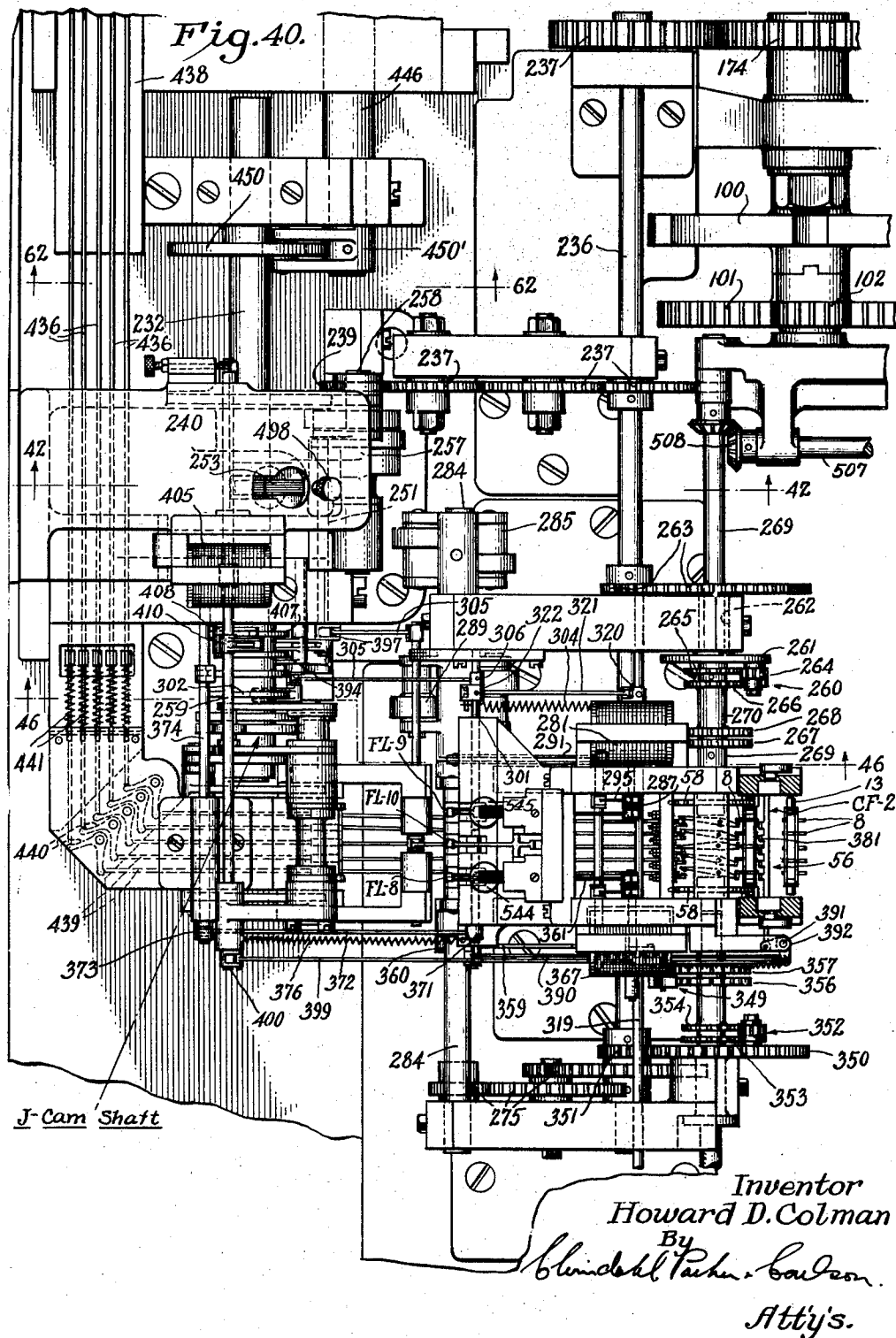
By
Chas. H. Parker & Carlson
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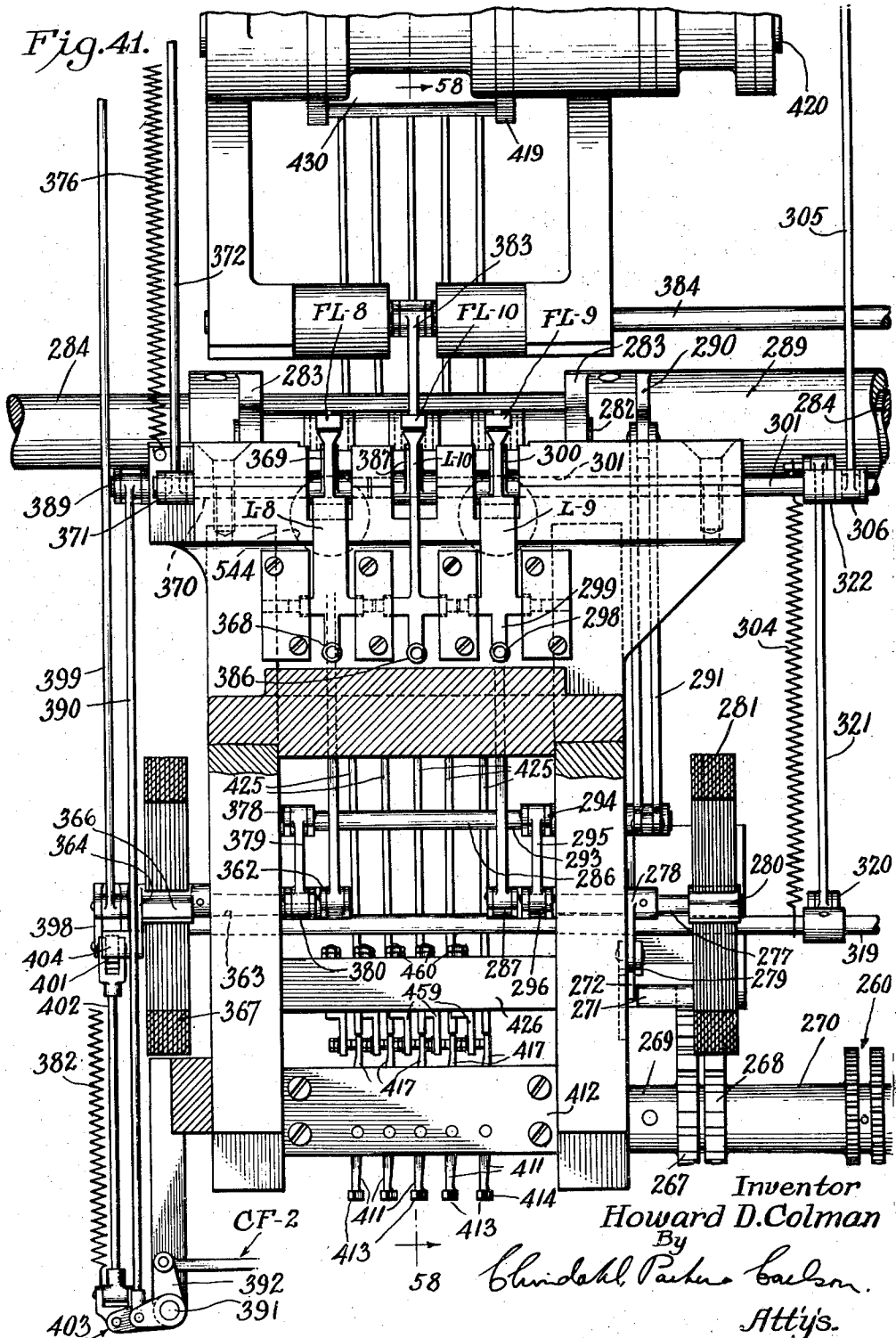
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52 Sheets-Sheet 27



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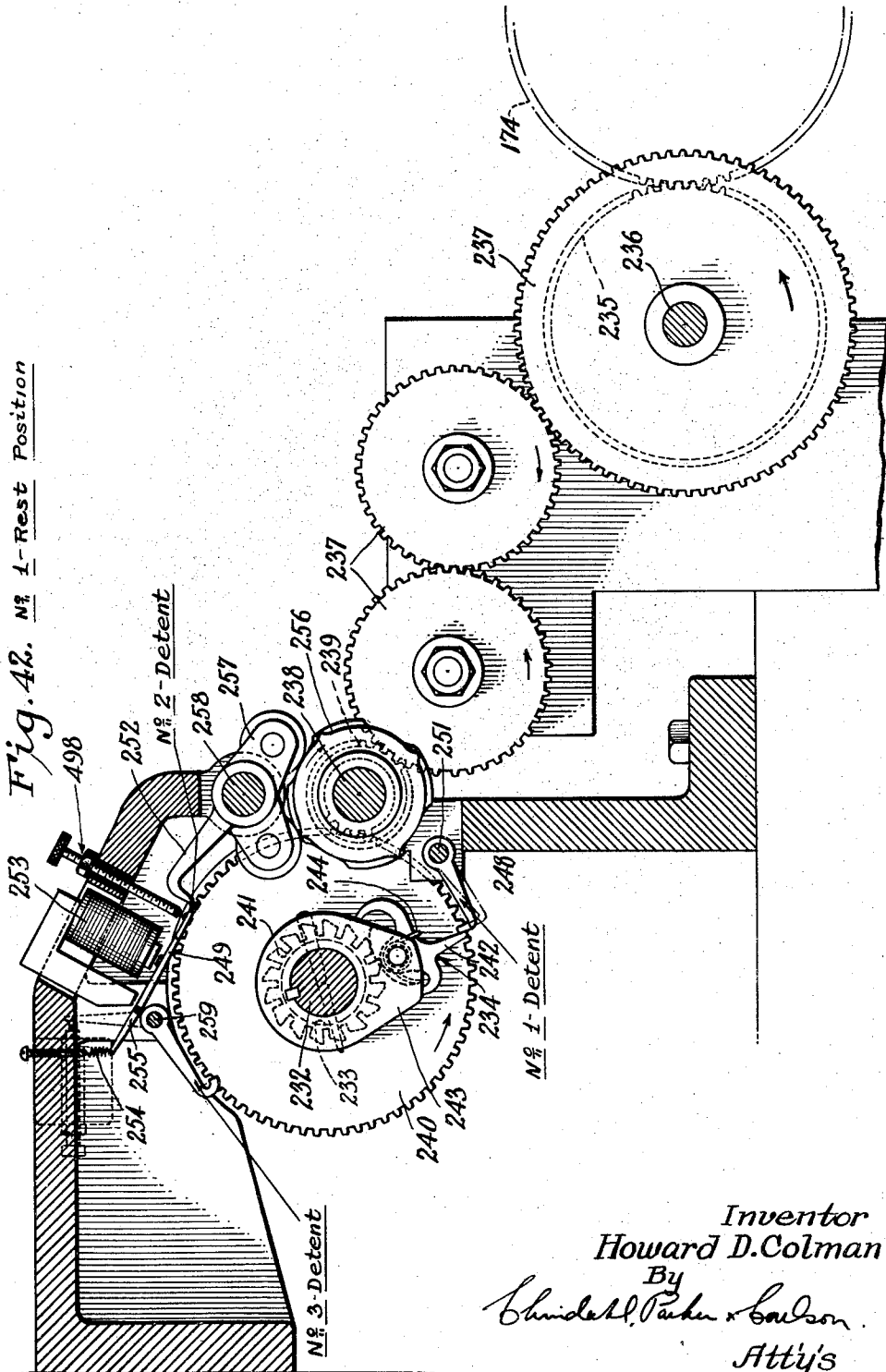
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52 Sheets-Sheet 29

Fig. 44. No. 3 - Rest Position

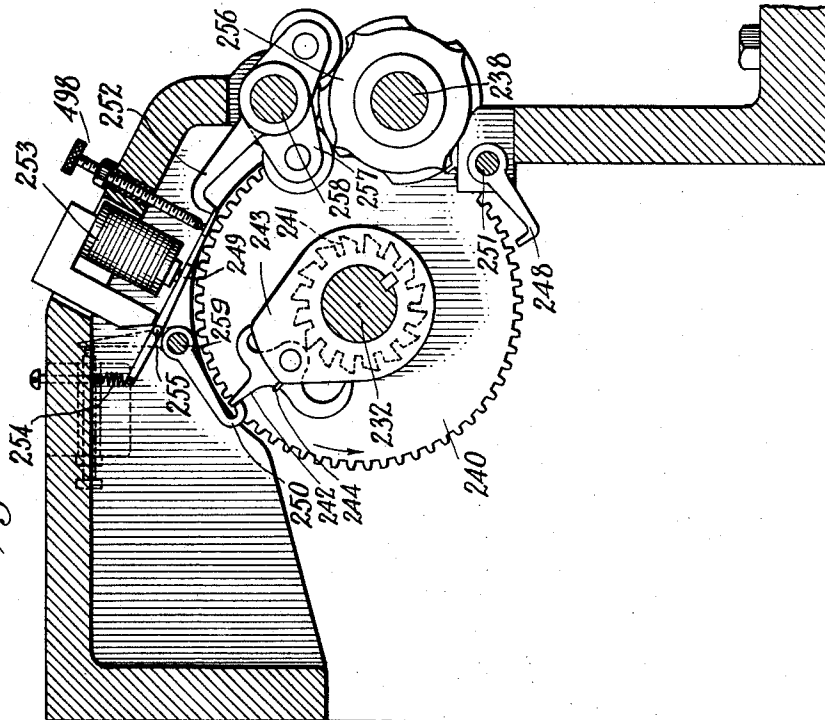
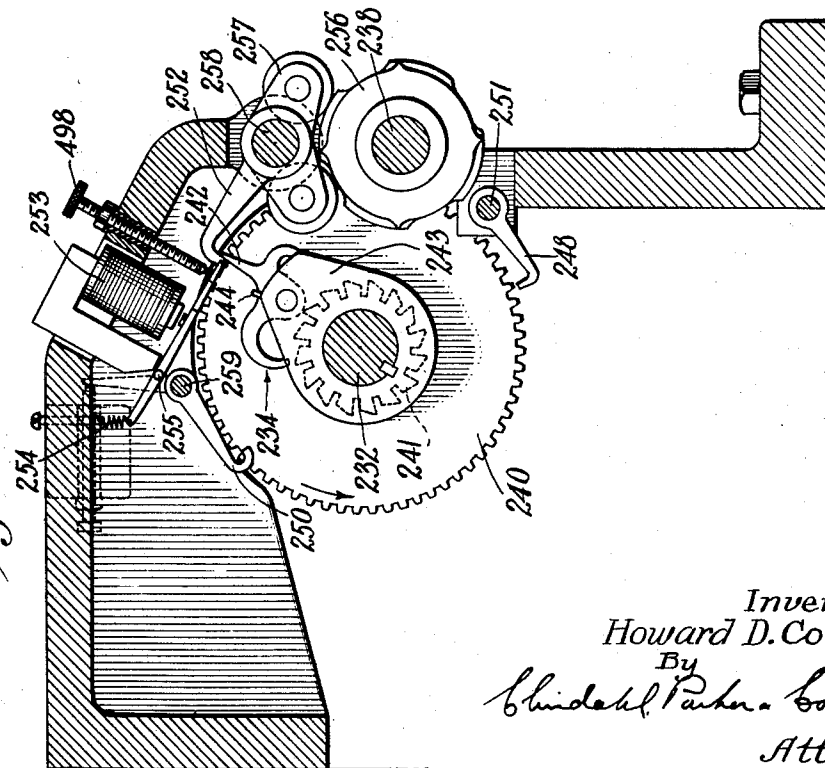


Fig. 43. No. 2 - Rest Position.



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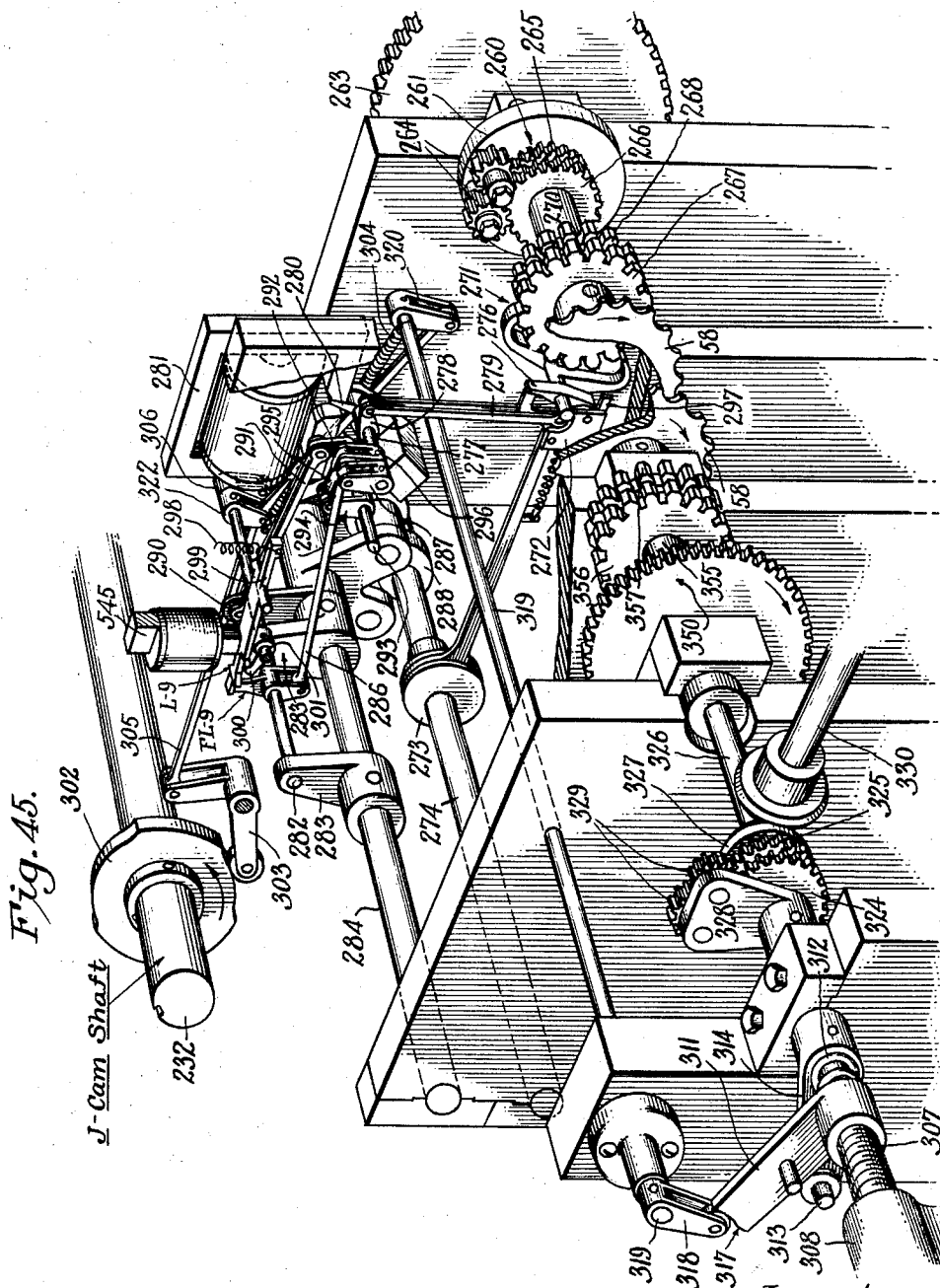
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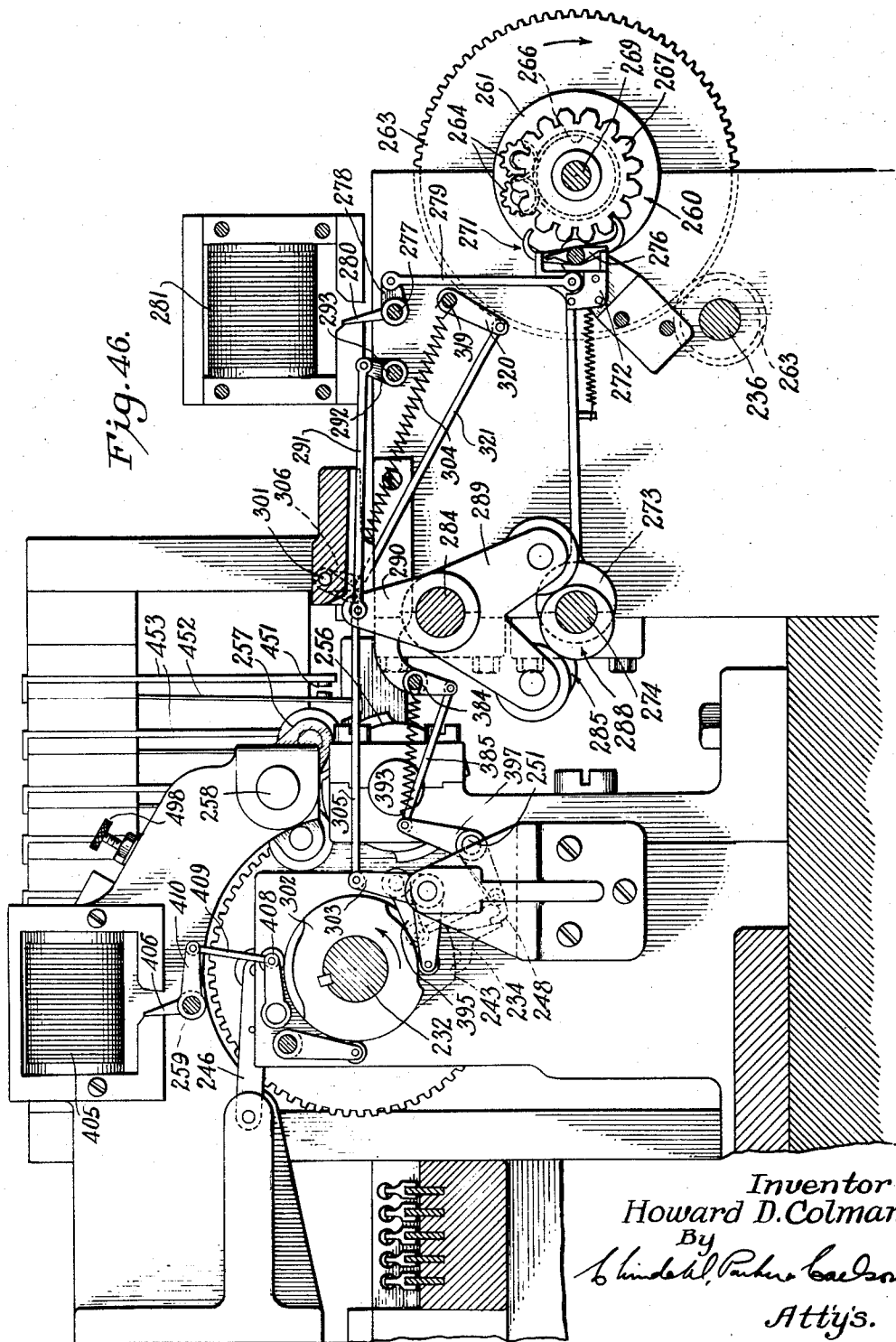
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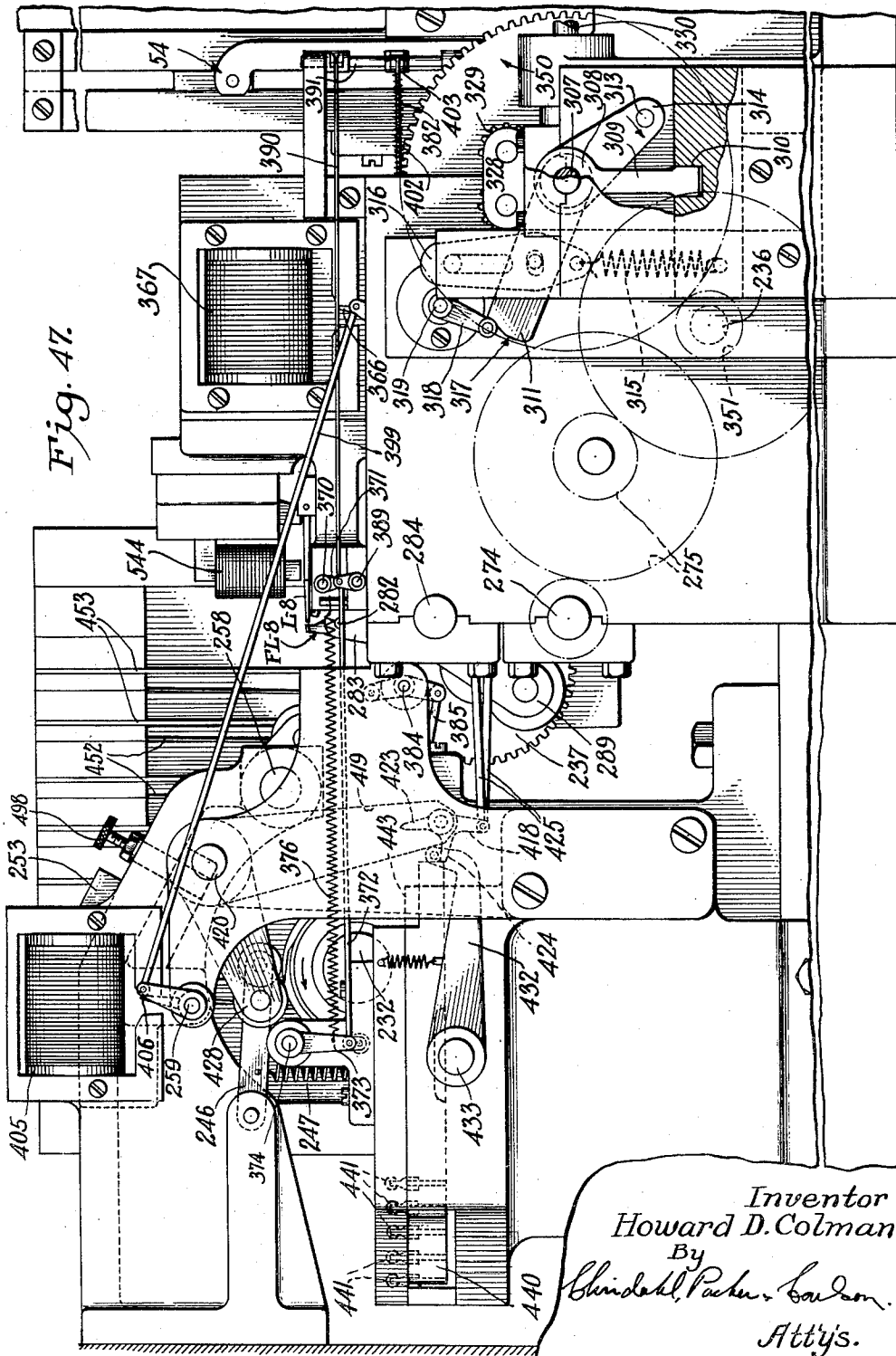
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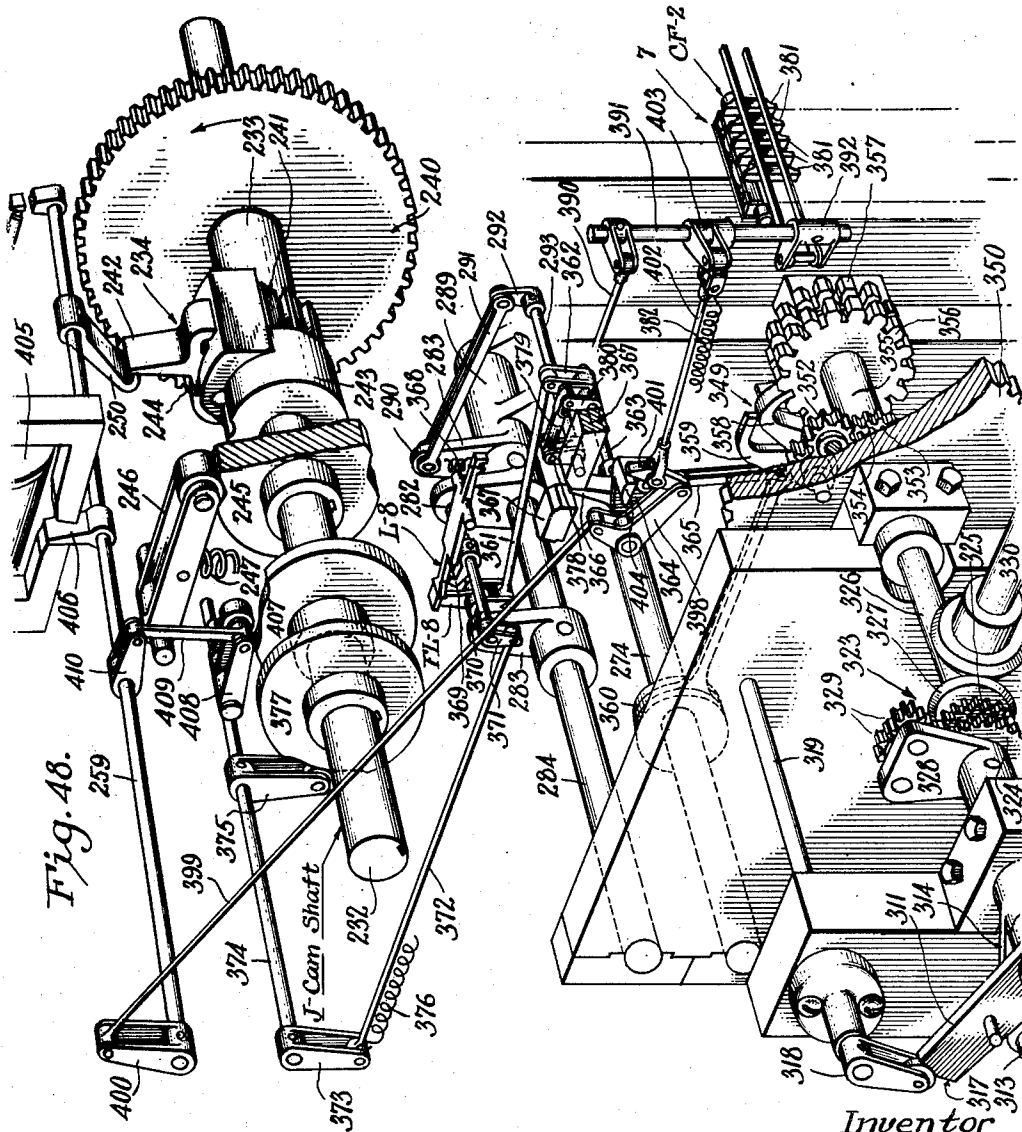
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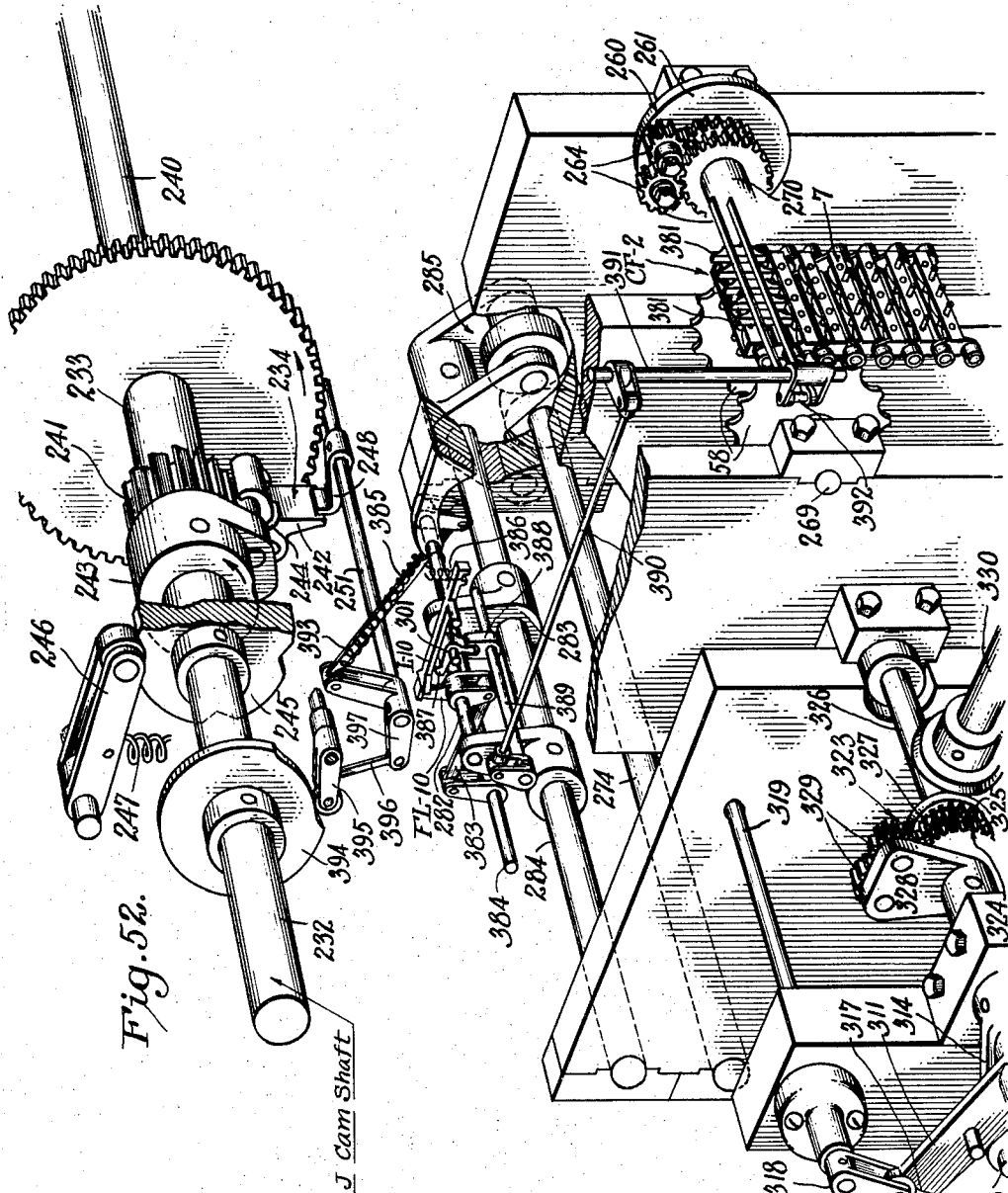
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Fig. 53.

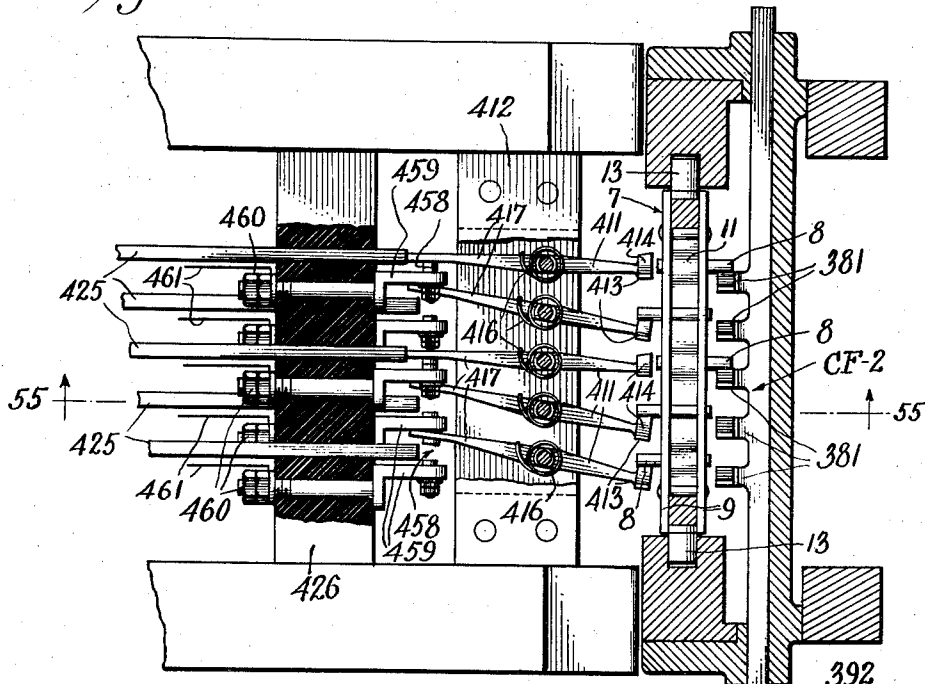


Fig. 54.

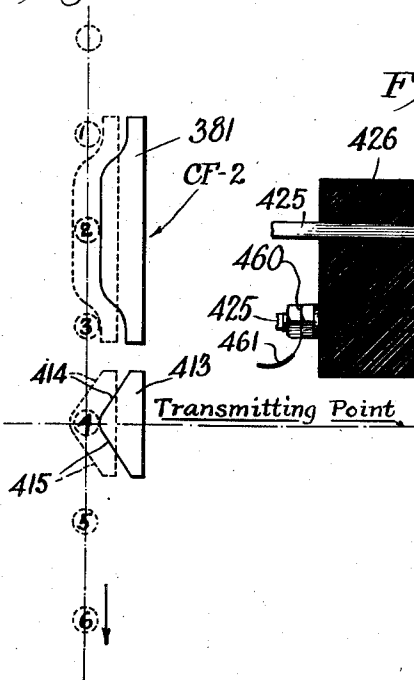
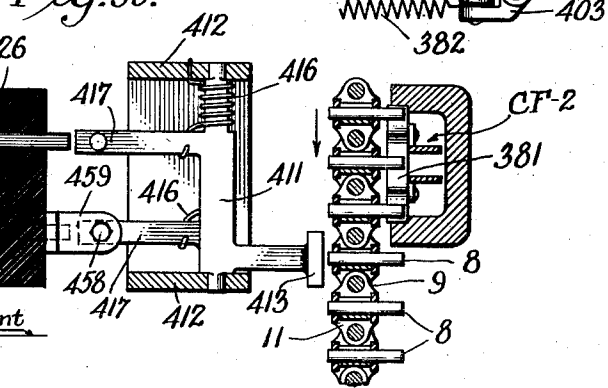


Fig. 55.



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52 Sheets-Sheet 37

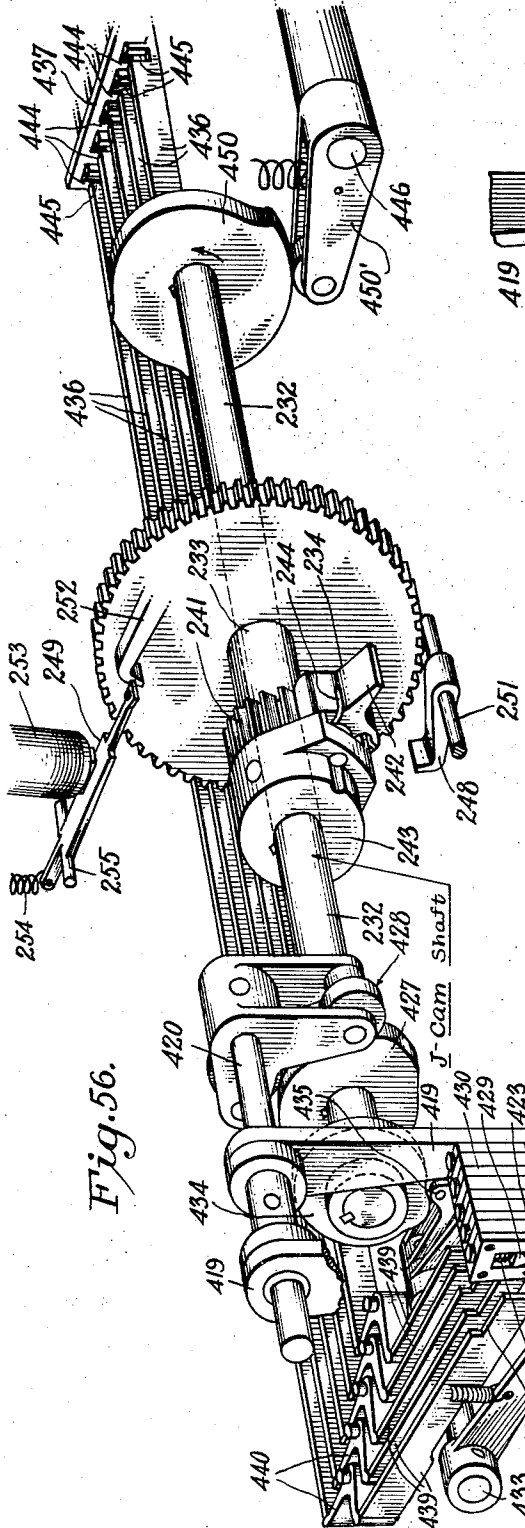


Fig. 56.

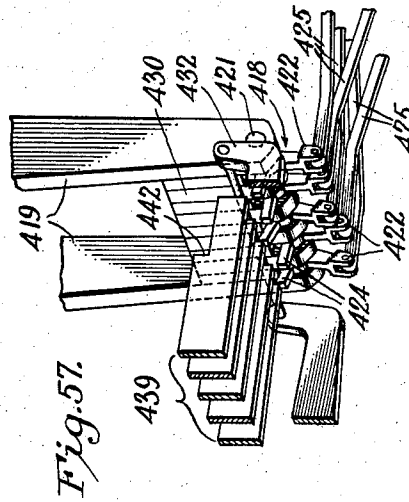
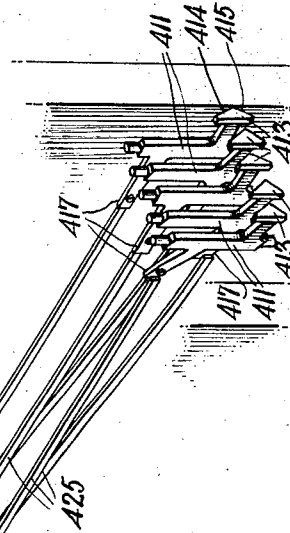


Fig. 57.



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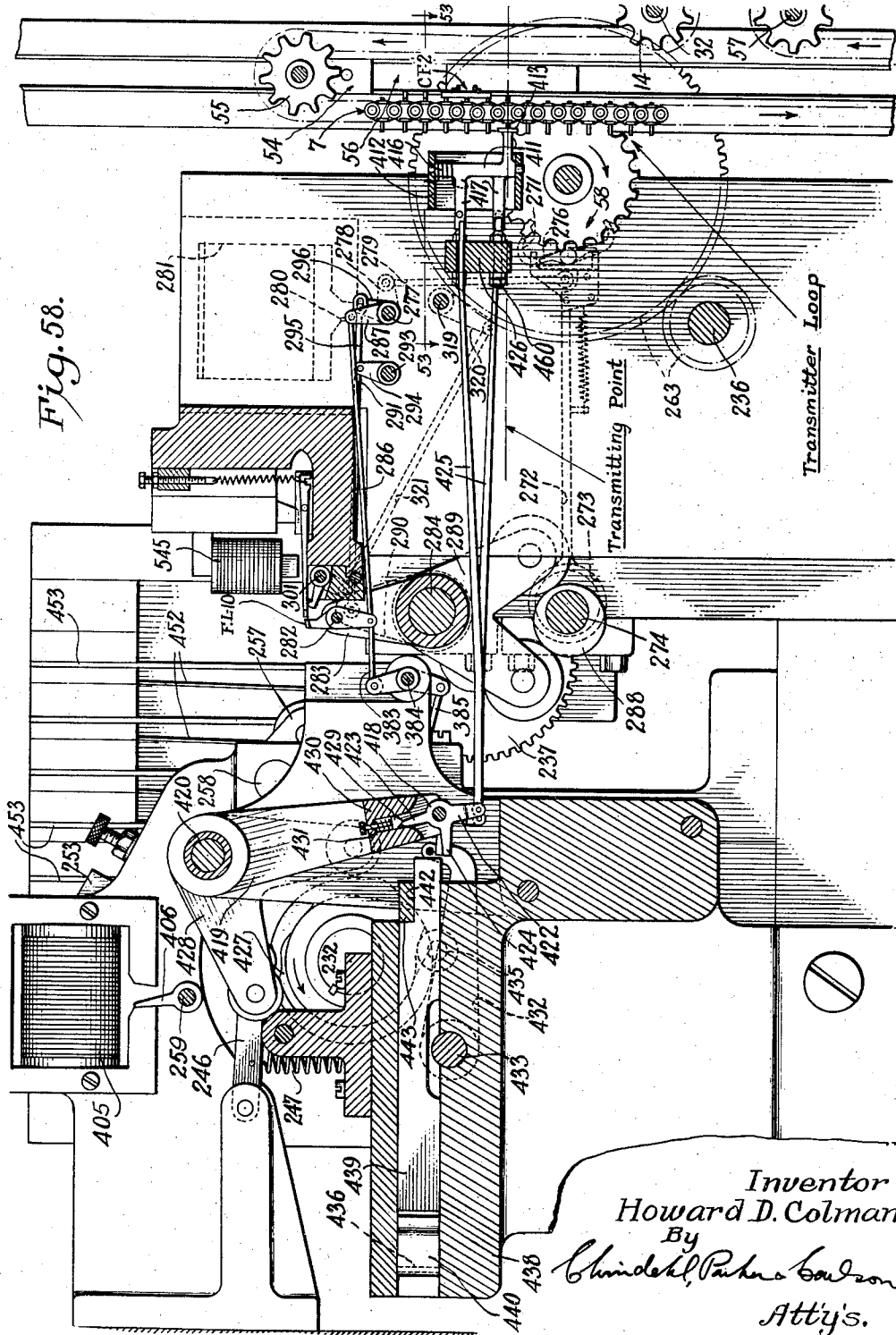
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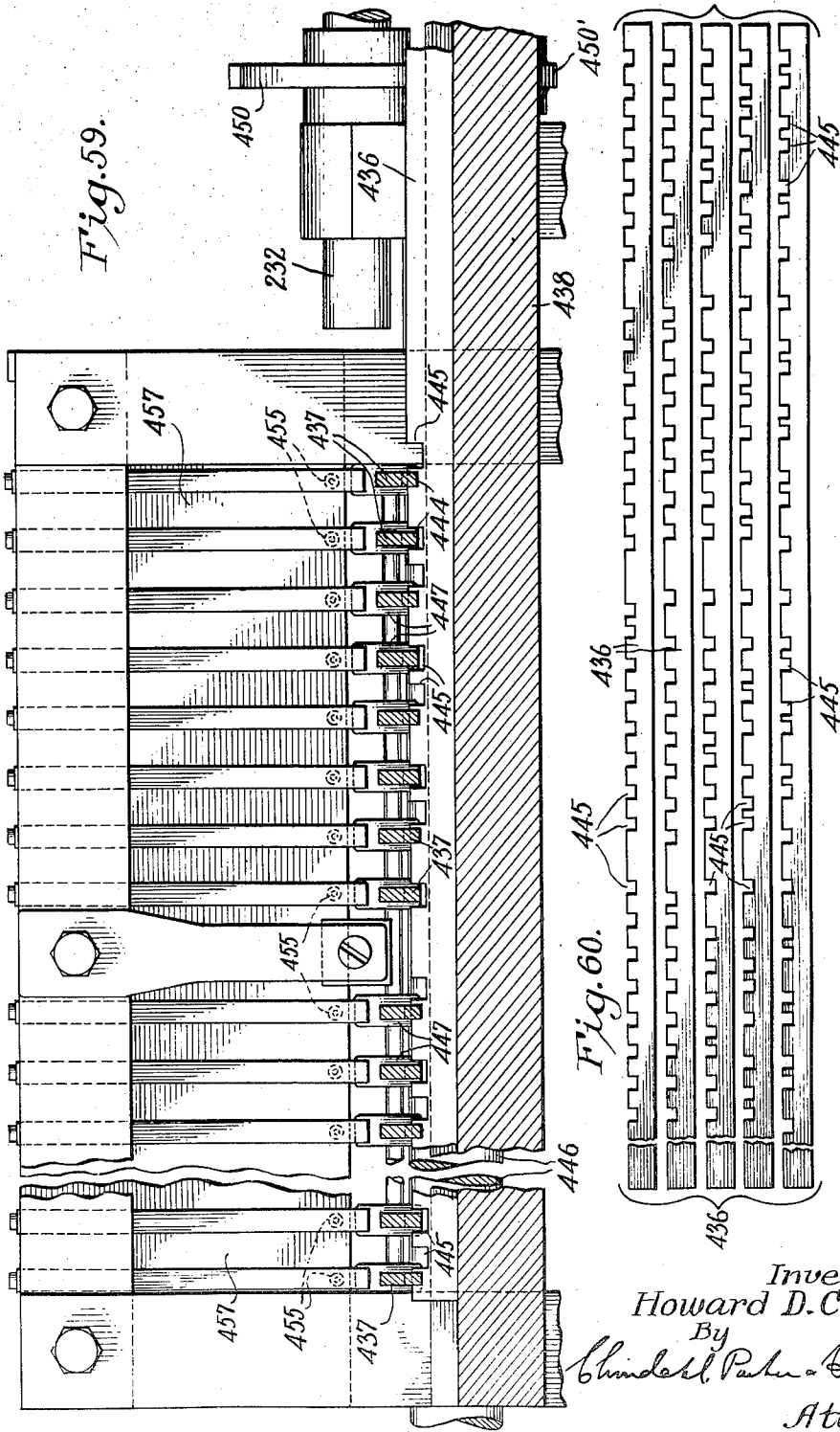
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Chas. L. Parker & Son.
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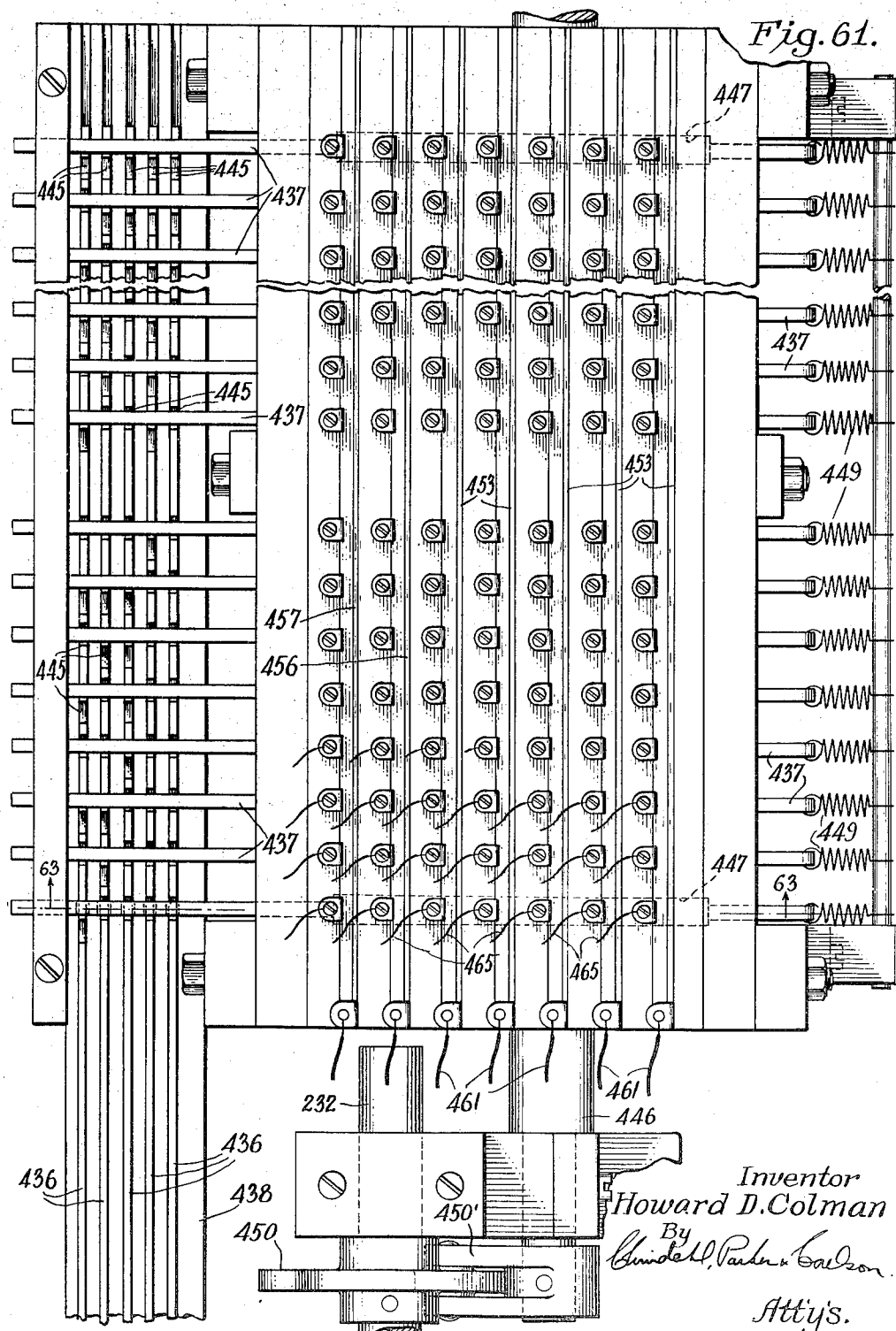
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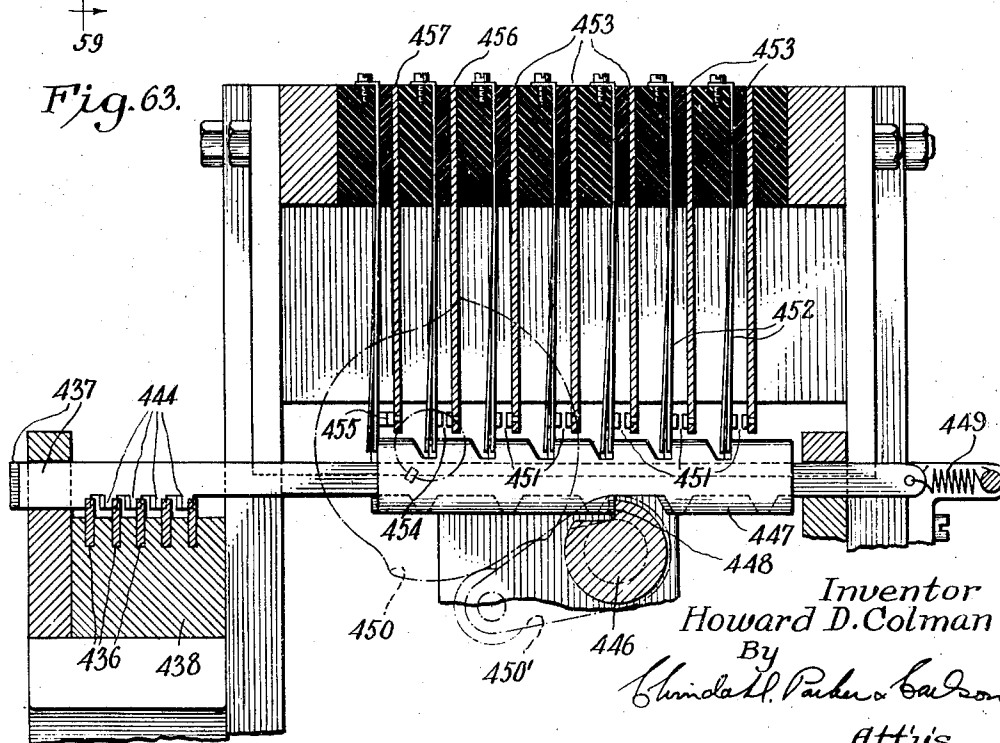
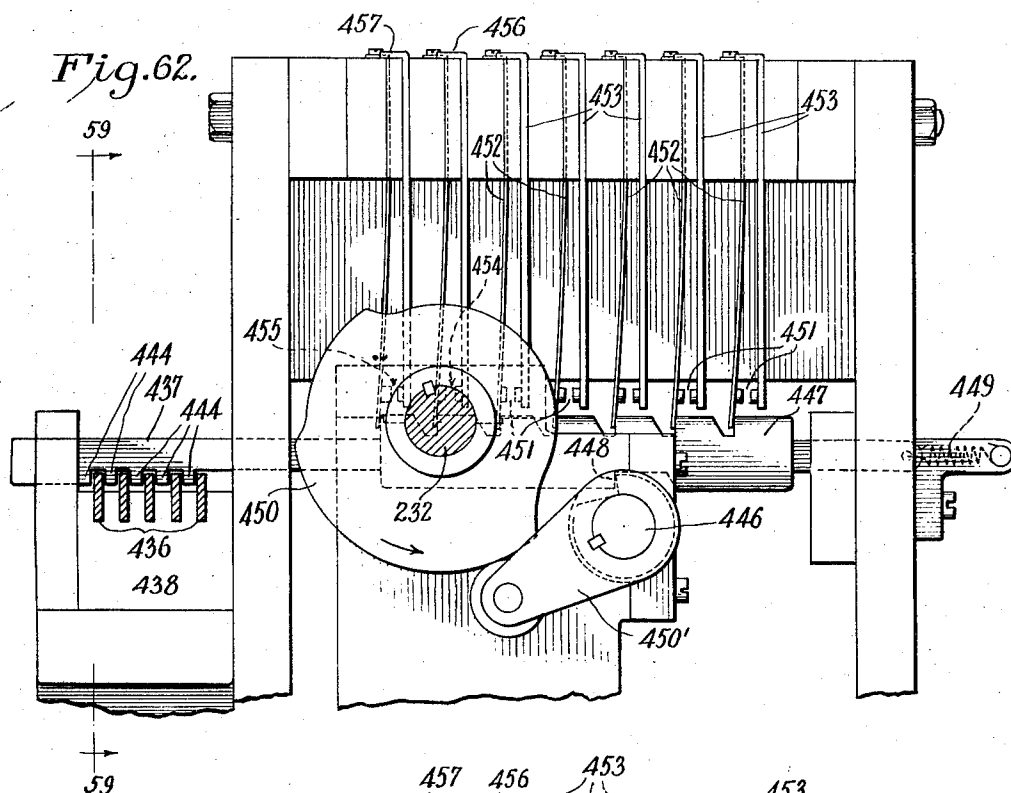
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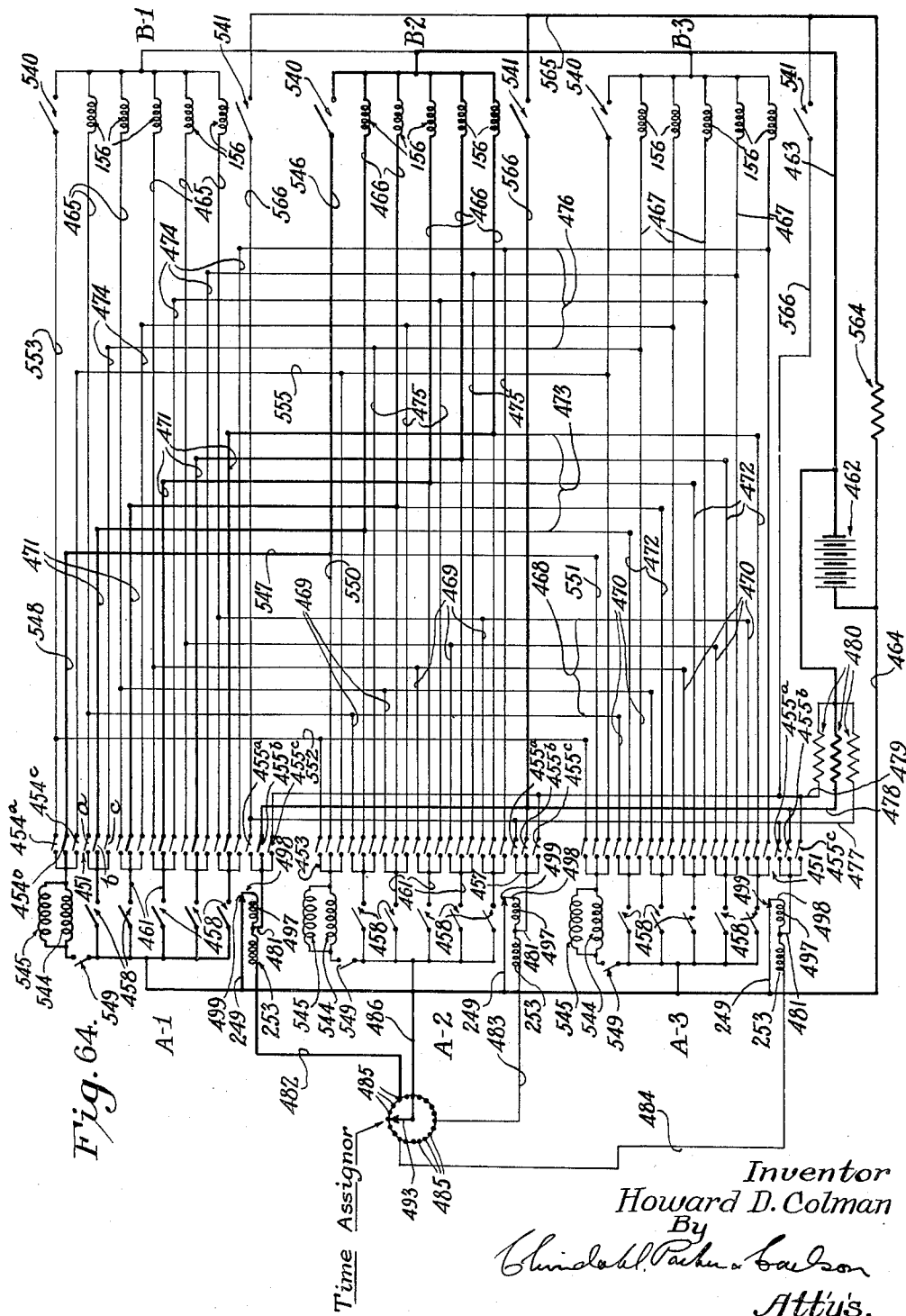
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52 Sheets-Sheet 42



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52 Sheets-Sheet 43

Fig. 65.

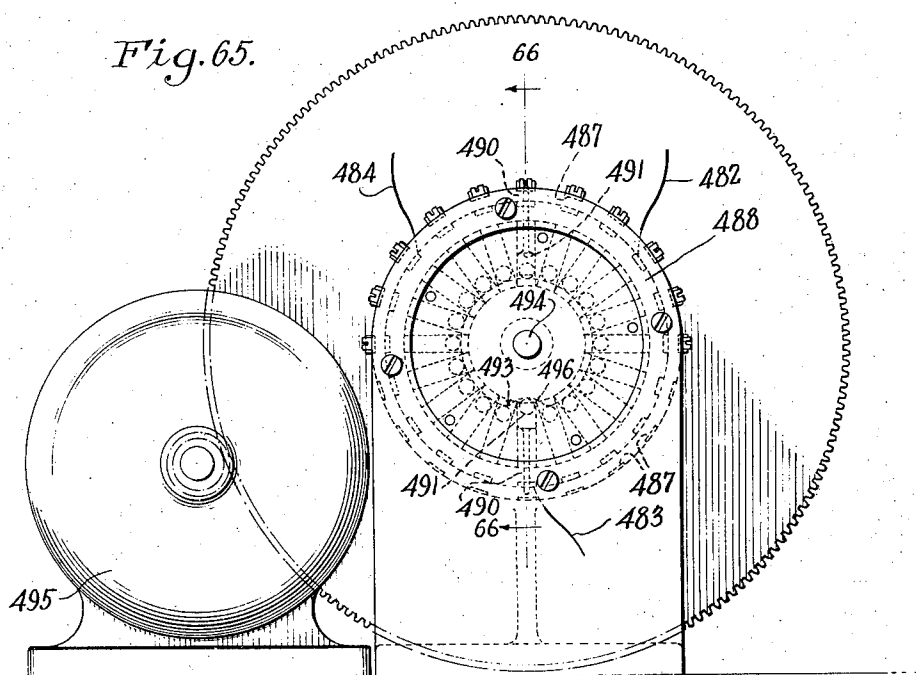
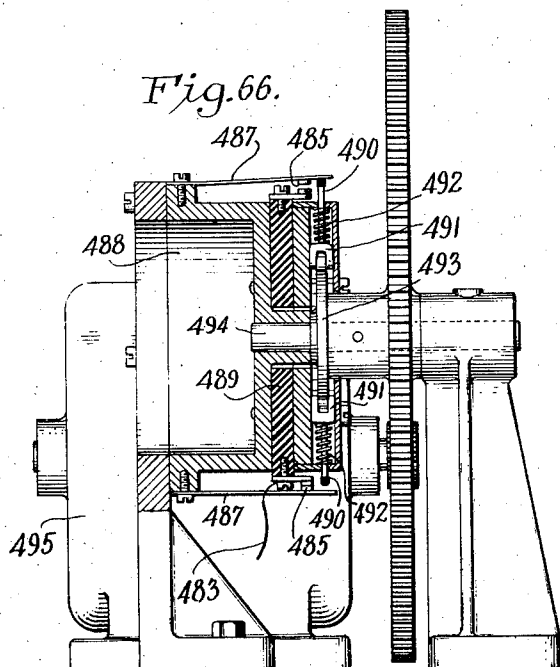


Fig. 66.



Inventor
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By
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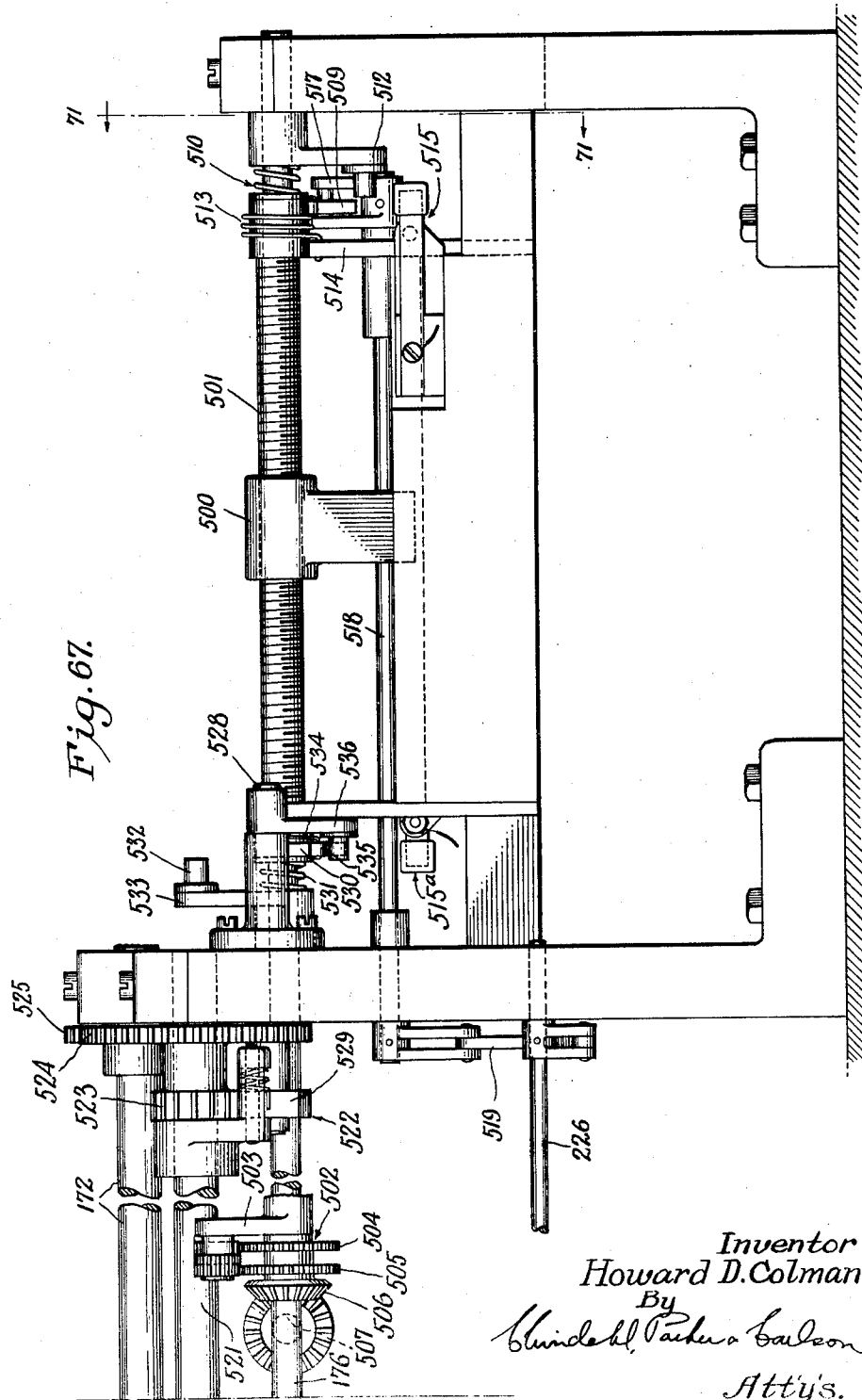
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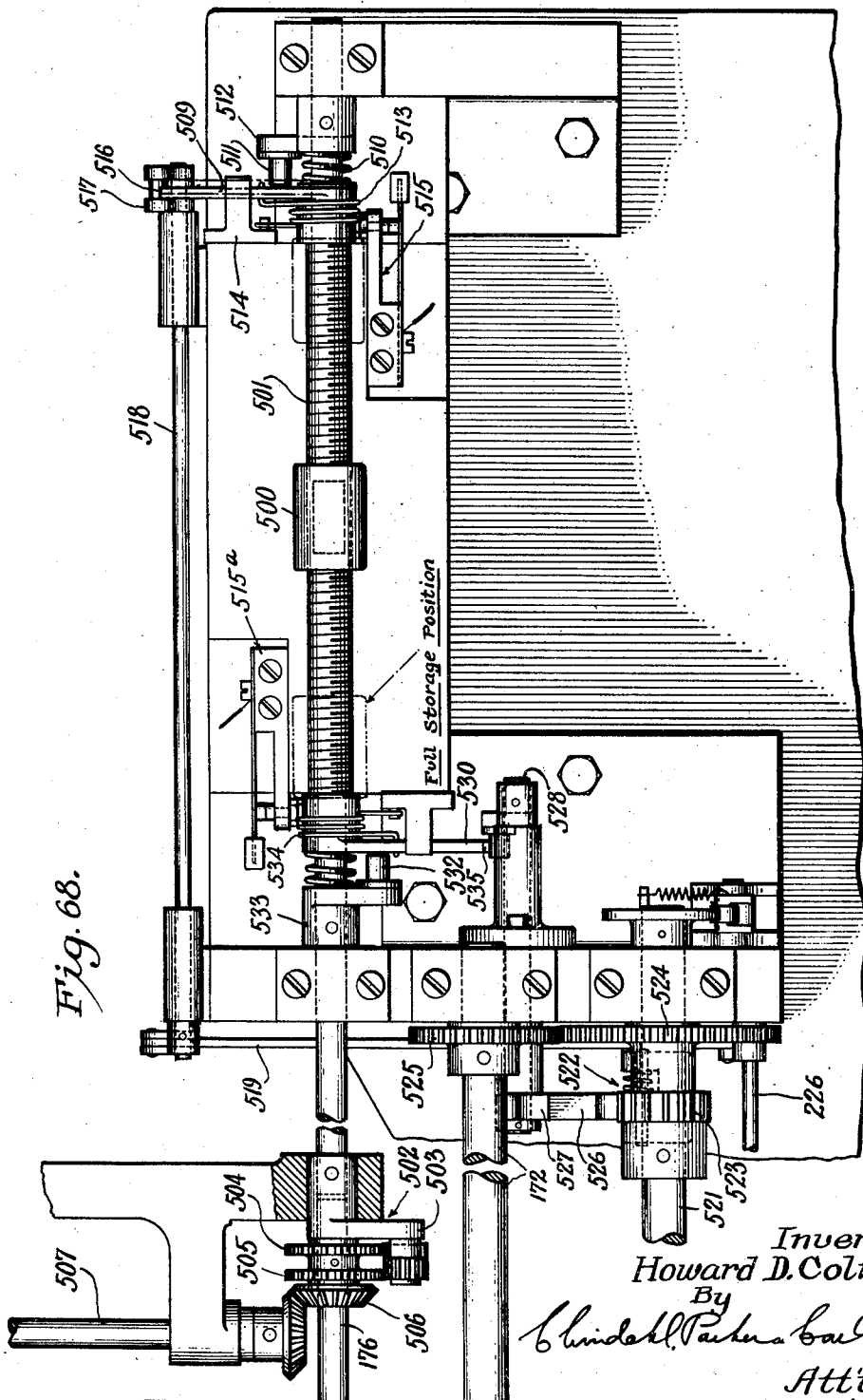
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SYSTEM OF COMMUNICATION

Filed Nov. 13, 1928

52 Sheets-Sheet 46

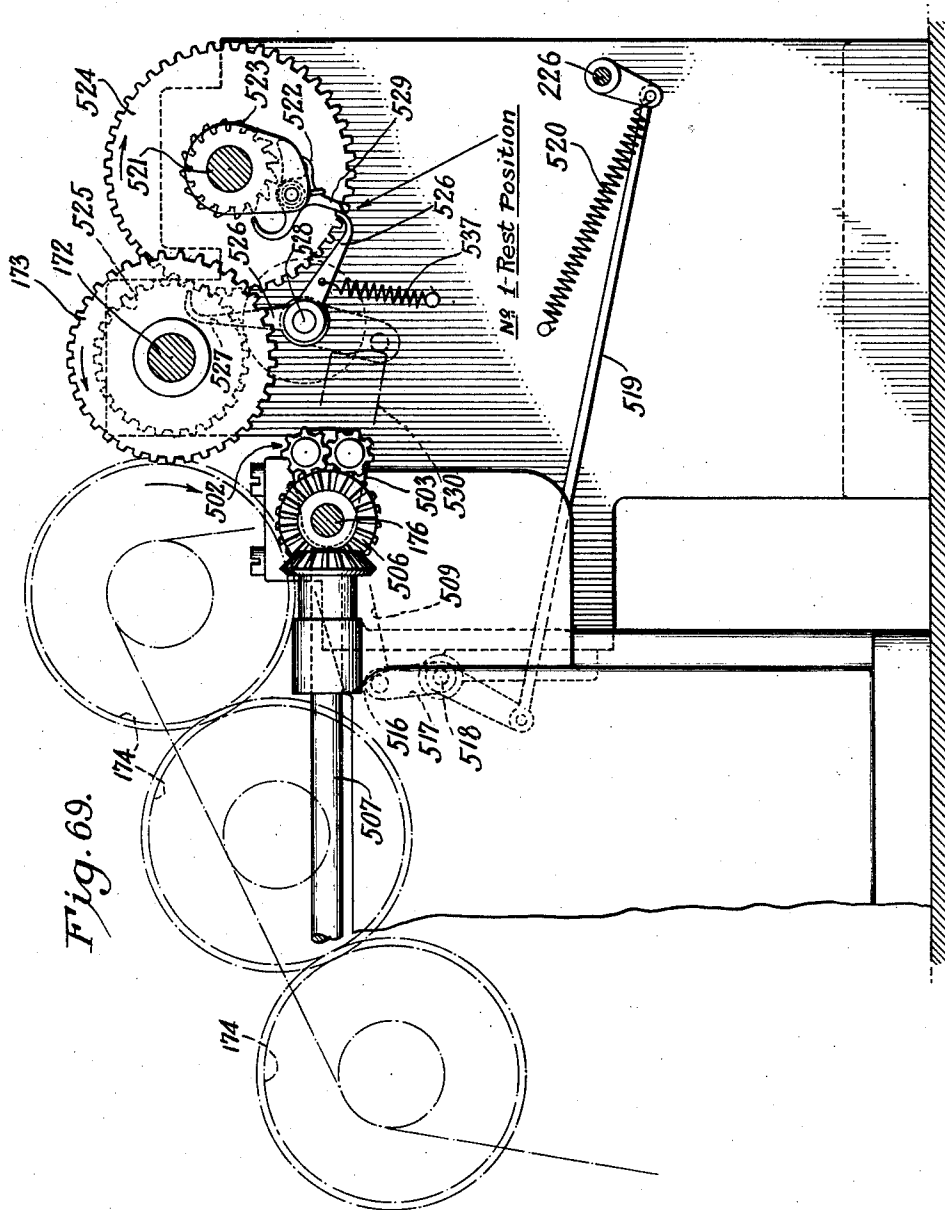


Fig. 69.

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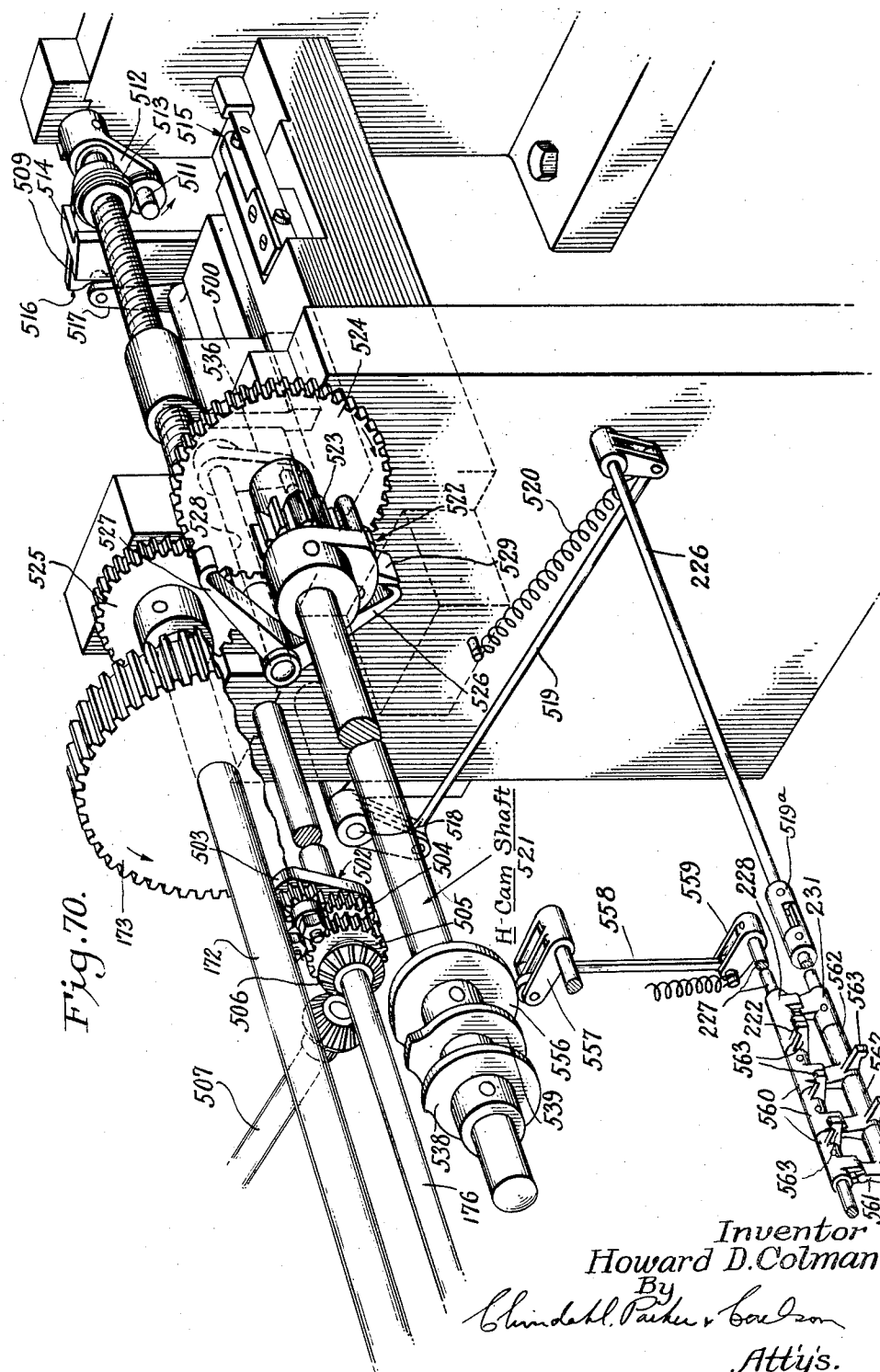
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52 Sheets-Sheet 47



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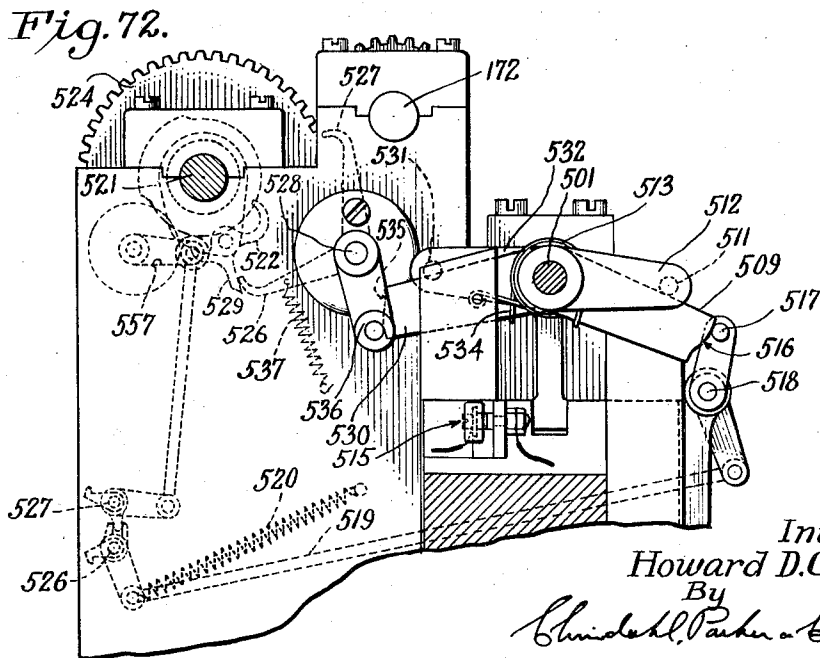
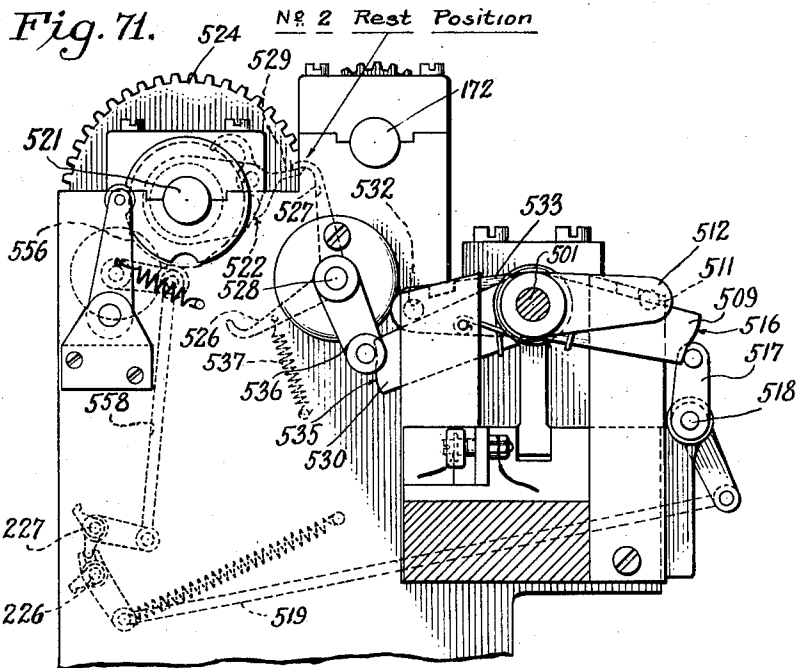
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SYSTEM OF COMMUNICATION

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52 Sheets-Sheet 49

Fig. 73.

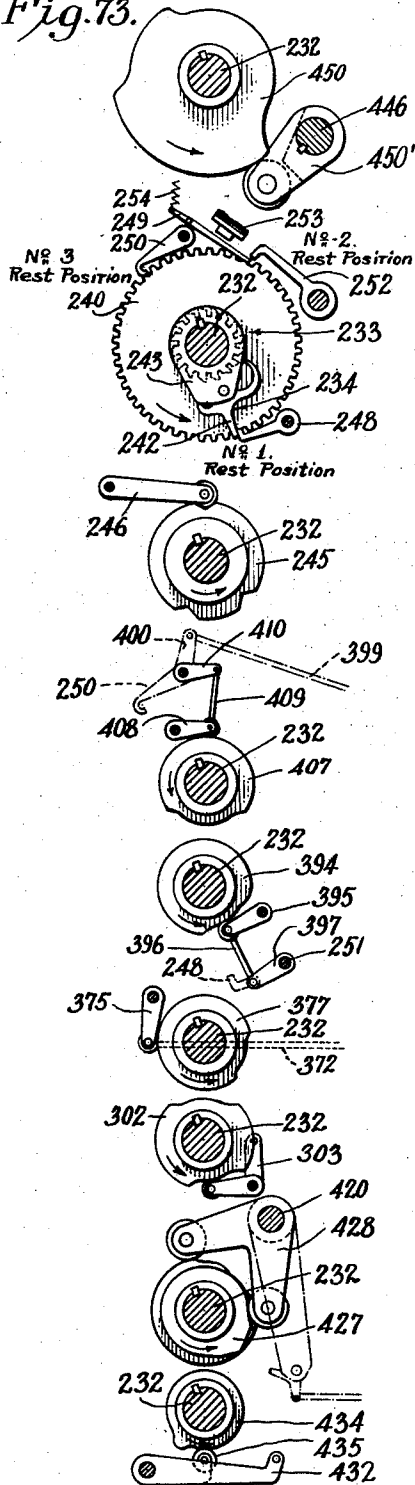
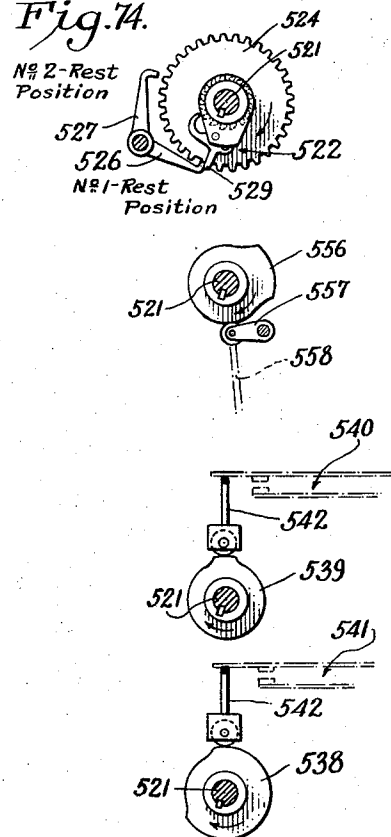


Fig. 74.



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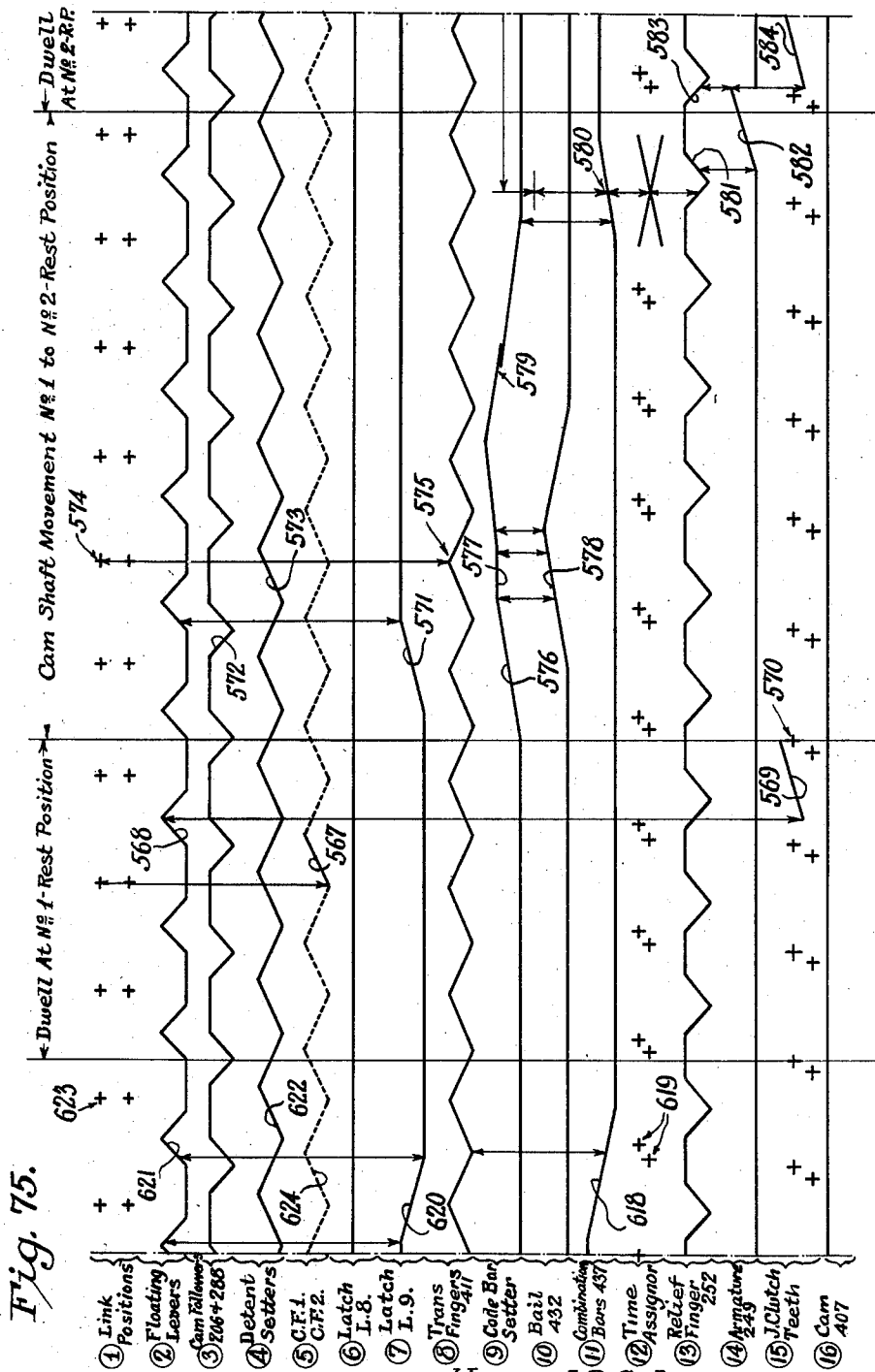
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52 Sheets-Sheet 50



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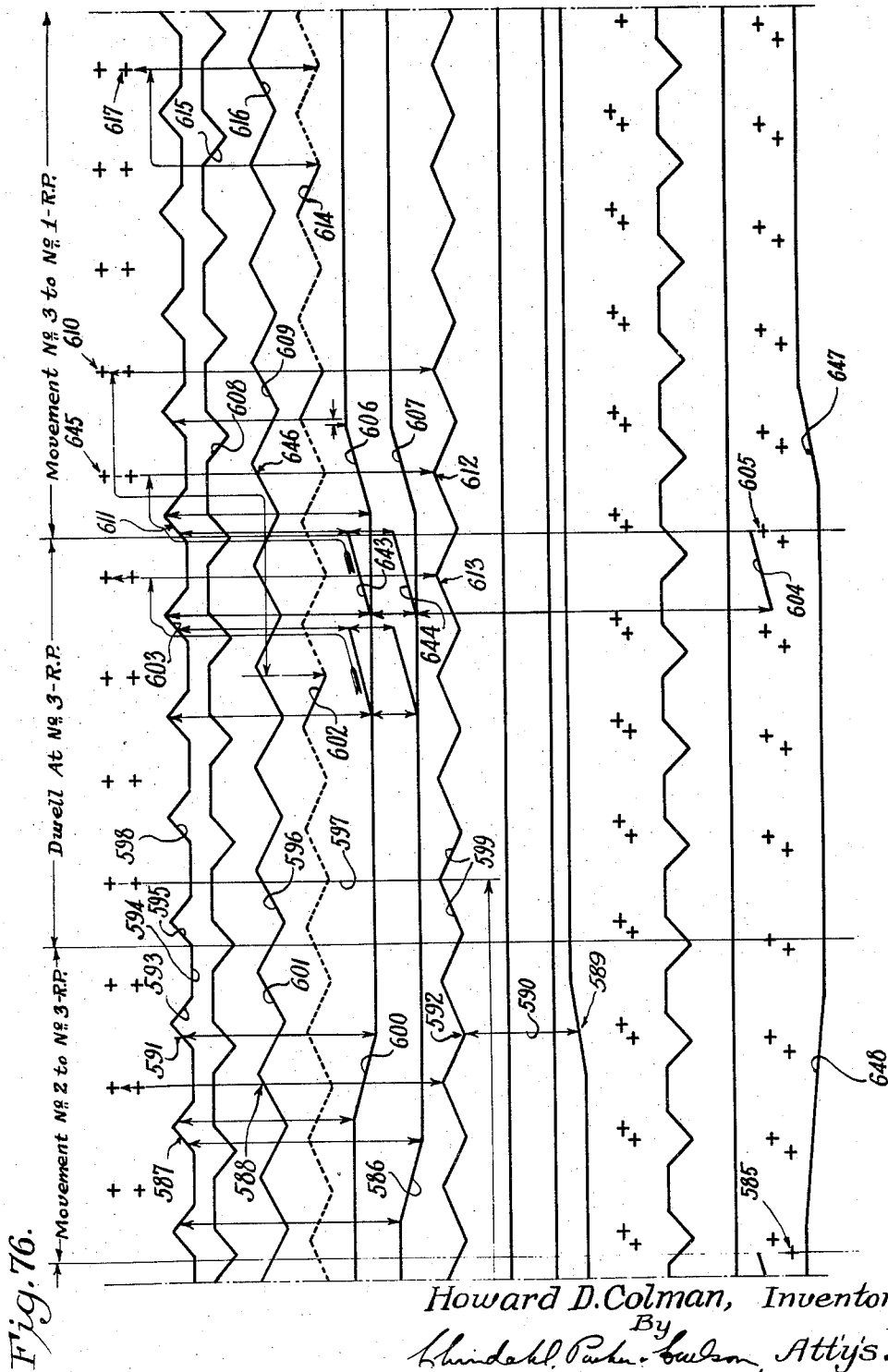
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SYSTEM OF COMMUNICATION

Filed Nov. 13, 1928

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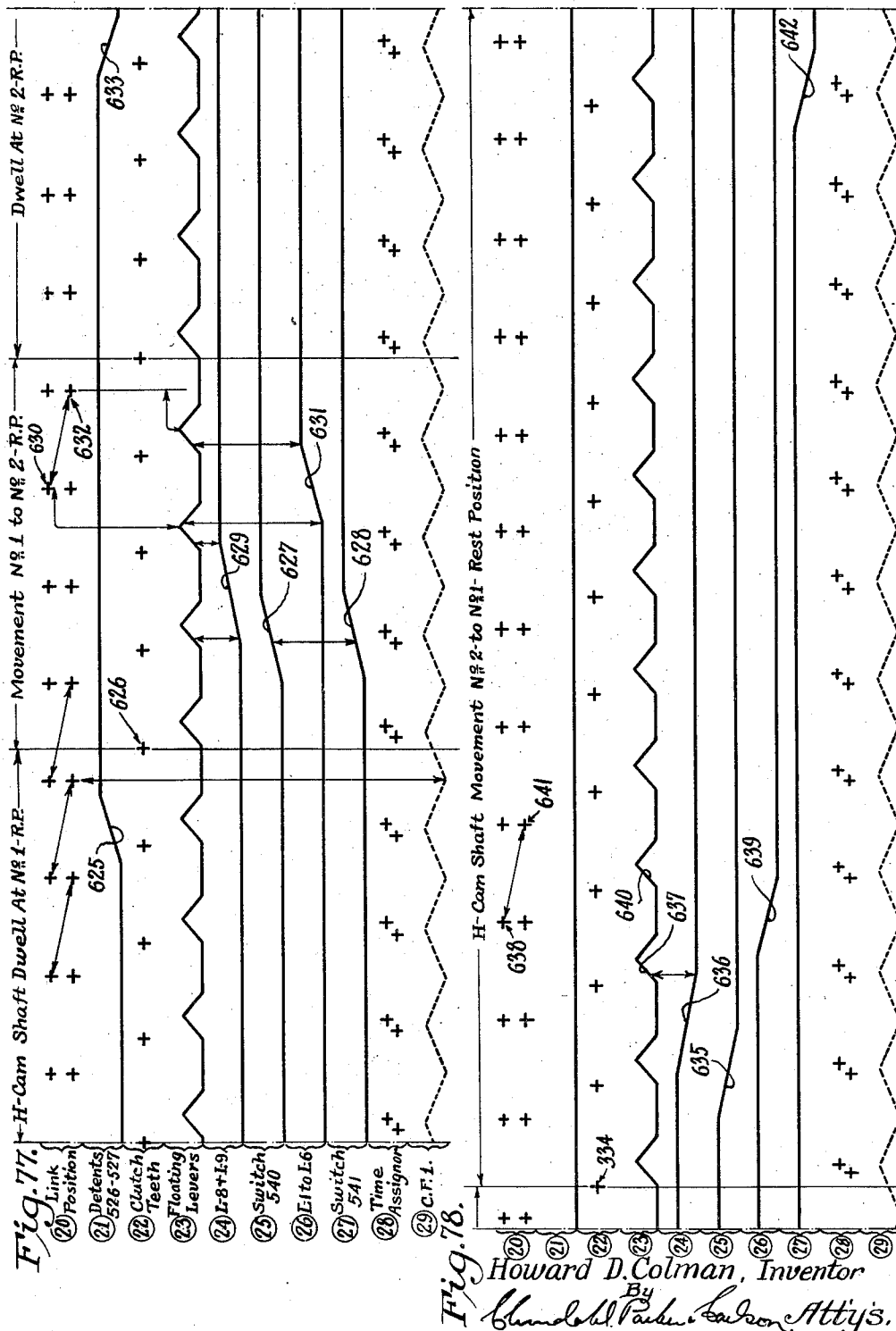
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SYSTEM OF COMMUNICATION

Filed Nov. 13, 1928

52 Sheets-Sheet 52



UNITED STATES PATENT OFFICE

2,380,894

SYSTEM OF COMMUNICATION

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Application November 13, 1928, Serial No. 319,047

464 Claims. (Cl. 178—3)

The invention pertains to a system of communication wherein message matter is transmitted electrically, and the primary object is to provide for a more expeditious and economical handling of message matter in transit than has heretofore been possible.

Prior systems of communication, generally speaking, may be said to be either of a single stage or of a multiple stage type. In the former, a through connection between the sending and receiving customers is established and maintained during communication, as for example in the case of the telephone. In the latter type a message is transferred from customer to customer in successive steps, as for instance in present telegraph practice in which a message received from a sending customer is successively delivered to a local exchange, transferred at the local exchange to the proper outgoing trunk, and transmitted electrically over the trunk to a distant exchange before reaching its ultimate destination. This system of relaying the message is advantageous as compared to the single stage type of communication in that it avoids tying up the trunk lines and other costly equipment except during actual transmission of the message. On the other hand, with the equipment now available, the relay or multiple stage system is slow and costly due to the fact that messages are handled at the exchange stations in printed form in order that their destinations may be easily read by attendants for dispatching purposes.

With the foregoing in view, the present invention aims to provide an improved method of and means for relaying message matter from one point to another by utilizing part of the message itself while in coded form for controlling selective transmission in one or more succeeding stages, to the end that a message may be transferred automatically from one point to another at higher speeds and at a lower cost than is possible with present day telegraph equipment.

The improved system thus generally characterized contemplates the transmission of message matter telegraphically in a plurality of steps or stages with provision at one or more relay points for receiving and temporarily storing the message in the form of mechanical signal combinations pending selective transmission to the next point. Each message as stored at any one relay point has embodied therein and forming a part of it a plurality of control signals governing the automatic transmission of the message in the succeeding steps of its journey to the ultimate destination. Certain of such control signals

may, in their codal form, designate respectively succeeding relay points through which the message is to pass, wherefore they constitute directing signals which are utilized individually at the successive relay points through the medium of automatic mechanism to select the succeeding path of transmission. Then the selected path becomes available as determined by a busy test mechanism, electrical transmission of the message is initiated automatically to the selected point. Other control signals are embodied in the message as stored for use in automatically interrupting the established connections so as to free the used transmission path after completing each stage of the transmission. According to the present invention, therefore, each message is rendered self-directing through each successive stage of its transmission by the provision of a signal-controlled relaying mechanism capable of responding automatically to control signals recorded in the form of mechanical combinations. With such a system of machine telegraphy the delays in transmission, equipment and maintenance charges, etc., incident to the frequent reduction of a message to printed form for control by a human agency is effectually minimized and a more rapid telegraph service may be rendered.

The automatic relaying of message matter according to my invention may be variously applied in the art. Thus it may be employed in a complete system of inter-city and intra-city communication between sending and receiving customers, in which case the sending customer transmits the message together with preconcerted control signals constituting a coded address, as determined by a known plan of routing, first to a local exchange where it is relayed automatically in one or more steps or stages under the direction of the control signals to the proper outgoing trunk. If the receiving customer is located in a distant city, as in inter-city communication, the message may be received at an exchange in said city, thereafter passing automatically through an appropriate number of stages and finally relayed to the receiving customer, as determined by the character of the several address or control signals. Where the sending and receiving customers are in the same city, the directing signals of the message would control its transmission in successive stages through the local exchange, finally arriving at the receiving customer's office or at an outlying station.

The invention, in another of its adaptations, may be utilized in automatically relaying message

matter through a telegraph exchange station for the purpose of minimizing the commonly recognized "office drag" incident in present systems of manual control to the transfer of a message to the proper outgoing trunk. At such exchange station the incoming message as received in printed form from a customer or an outlying office would be coded with the necessary directing or control signals incorporated therein for governing the operation of automatic relay mechanisms to transfer the message in coded form to the proper outgoing trunk.

In the present instance I have shown and will hereinafter describe the invention in detail as applied to a portion of an exchange station capable of utilization with either of the above mentioned adaptations of the invention. It is to be understood, however, that I do not intend to be limited by such disclosure but aim to cover all modifications and alternative adaptations falling within the spirit and scope of the invention as expressed in the appended claims.

Referring now to the drawings:

Figure 1 is a schematic view showing the arrangement of transmission paths and signal relay units in a telegraph exchange system embodying the features of the present invention.

Fig. 2 is a front elevational view of one of the relay units represented in Fig. 1.

Fig. 3 is an elevational view of a relay unit as viewed from the right hand side in Fig. 2.

Fig. 4 is a plan view.

Fig. 5 is a diagrammatic view of the signal storage medium employed between the recorder and transmitter of each relay unit.

Fig. 6 is a view of a length of chain constituting the signal storing medium, part of the links being shown in section.

Fig. 7 shows in perspective two different kinds of the links forming the chain.

Fig. 8 is a fragmentary elevational view of the lower part of the relay unit shown in Fig. 1.

Fig. 9 is a section taken on the line 9—9 of Fig. 8.

Figs. 10 and 11 are side and front elevational views of the device for connecting the adjacent loops of the storage chain.

Fig. 12 is a section taken along the line 12—12 of Fig. 8.

Fig. 13 is a section taken along the line 13—13 of Fig. 12.

Fig. 14 is a fragmentary elevational view of the lower portion of the relay unit as viewed from the left in Fig. 2.

Fig. 15 is a section taken along the line 15—15 of Fig. 8.

Fig. 16 is an end view of a clutch used in numerous instances in each relay unit.

Fig. 17 is a section on the line 17—17 of Fig. 16.

Fig. 18 is a fragmentary elevational view of the lower portion of the relay unit as viewed from the right in Fig. 2.

Figs. 19, 20, 21, 22 and 23 are sectional views taken respectively along the lines 19—19, 20—20, 21—21, 22—22 and 23—23 of Fig. 18.

Fig. 24 is a section along the line 24—24 of Fig. 21.

Fig. 25 is a section taken along the line 25—25 of Fig. 18.

Fig. 26 is a fragmentary perspective view of the recording mechanism of each relay unit.

Fig. 27 is a plan view of the recording mechanism.

Figs. 28 and 29 are elevational views of the re-

cording mechanism taken respectively from the right and left hand sides of Fig. 27.

Fig. 30 is a sectional view along the line 30—30 of Fig. 28.

Figs. 31, 32 and 33 are sectional views taken along the line 31—31 of Fig. 28 and illustrating different operating positions of the recording device.

Fig. 34 is an enlarged sectional view taken along the line 34—34 of Fig. 30.

Fig. 35 is a section taken along the line 35—35 of Fig. 34.

Fig. 36 is a diagrammatic view on an enlarged scale of one of the push rods and feeler shoes shown in Fig. 35.

Fig. 37 is a perspective view of the mechanism for controlling the chain advance on the recording side of each relay unit.

Fig. 38 is an enlarged sectional view showing the arrangement of the control magnets and latches shown in Fig. 30.

Fig. 39 is a section taken along the line 39—39 of Fig. 38.

Fig. 40 is a plan view showing on a larger scale the mechanism on the transmitting side of the relay unit which is shown at the left in Fig. 4.

Fig. 41 is an enlargement of the central portion of Fig. 40.

Figs. 42, 43 and 44 are sections taken along the line 42—42 of Fig. 40.

Fig. 45 is a perspective view of the mechanism for controlling the chain advance on the transmitting side of each relay unit.

Fig. 46 is a section taken along the line 46—46 of Fig. 40.

Fig. 47 is an elevational view of the mechanism shown in Fig. 40.

Fig. 48 is a perspective view showing the mechanism for controlling the message cycling mechanism.

Figs. 49 and 50 show in detail different positions of the parts shown in Fig. 48.

Fig. 51 is a fragmentary plan view of the parts shown in Fig. 50.

Fig. 52 is a perspective view of another part of the mechanism for controlling the message cycling mechanism.

Fig. 53 is an enlarged view taken along the line 53—53 of Fig. 58.

Fig. 54 is an enlarged elevational view of the chain feelers shown in Fig. 53.

Fig. 55 is a section taken along the line 55—55 of Fig. 53.

Fig. 56 is a perspective view of the mechanism for controlling the selector of each relay unit.

Fig. 57 is a perspective view of part of the mechanism shown in Fig. 56.

Fig. 58 is a section on the line 58—58 of Fig. 40.

Fig. 59 is a section taken on the line 59—59 of Fig. 62.

Fig. 60 is a fragmentary view of the code bars of the selector in each relay unit.

Fig. 61 is a fragmentary plan view of the code and combination bars of the selector.

Figs. 62 and 63 are sections taken along the line 62—62 of Fig. 40.

Fig. 64 is a wiring diagram showing the transmission and control circuits between two of the groups of relay units shown in Fig. 1.

Fig. 65 is a side elevational view of the time assignor.

Fig. 66 is a section taken along the line 66—66 of Fig. 65.

Fig. 67 is an elevational view of the loop indicator shown in Fig. 4.

Fig. 68 is a plan view of the loop indicator and may be taken together with Fig. 27 to show the relation of the loop indicator and recorder.

Fig. 69 is a section taken along the line 69—69 of Fig. 4.

Fig. 70 is a perspective view of the loop indicator and the mechanism controlled thereby.

Figs. 71 and 72 are sections taken along the line 71—71 of Fig. 67 and illustrating different positions of the loop indicator controls.

Fig. 73 is a schematic view of the J-cam shaft showing the relation of the cams thereon and the followers for such cams.

Fig. 74 is a schematic view showing the relation of the cams on the H-cam shaft.

Figs. 75 and 76 constitute a time chart of the message cycling mechanism.

Figs. 77 and 78 constitute a time chart of the full storage control mechanism.

The system in general

In accordance with the present invention message matter may be transferred automatically in one or more stages of transmission from one point in a telegraph system to a selected one of a plurality of other points through the medium of signal-controlled machines hereinafter termed "relay units" and each of which is adapted to receive and temporarily store message matter in the form of mechanical signal combinations pending the selection of a succeeding transmission path under the control of certain of the signals and the initiation of transmission automatically over such path. An arrangement for the selective transfer of messages in two successive stages wholly within a telegraph exchange station is shown diagrammatically in Fig. 1, there being a plurality of relay units A1 to A10 adapted for connection with similar units B1 to B9 through the medium of electrical transmission paths which are indicated diagrammatically by the lines 1. The units B in turn are arranged for connection with relay units C1 to C12 through the medium of transmission paths represented by lines 2.

In the use of such a system, an incoming message to be transferred, for example, to the relay unit C8 would first be recorded on the mechanical storage medium or control form of one of the units A as, for example A1, the successive characters of the message being represented preferably in the well known Baudot or five-unit code by individual signal combinations followed by a terminal or end-of-message control combination and preceded by one or more predetermined directing signal combinations collectively representing a predetermined destination, the number of such combinations depending on the number of stages of transmission necessary to bring the message to such destination. With the message signals thus mechanically stored, a selector mechanism associated with the transmitting unit A1 operates in response to one, preferably the first, of said directing signals to effect the selection of the path leading to the relay unit B2 whereupon this path is automatically tested. When found to be available, transmission of the stored combinations to the unit B2 is initiated automatically. After completion of the transmission, the operation of the transmitting unit A1 is interrupted under the control of the end-of-message combination which also causes the seized transmission path to be freed thereby completing the first stage of the transfer.

As received at the relay unit B2, the electrical signals are again converted into mechanical combinations and thus temporarily stored pending the

selection of the path leading to the unit C8. This is accomplished by the selector of the unit B2 acting in accordance with the character of another of the directing signals of the message.

When this path is not busy the transmitter of the relay unit B2 operates in the manner above described to send the individual message combinations electrically to the unit C8 where they are recorded mechanically. Thus, after the second stage of the transmission the message is recorded in the unit C8 in the same form as in the unit A1, except for two directing signals which preferably are discarded after being utilized in selecting the transmission paths in the two stages.

The arrangement of the transmission paths such as is shown in Fig. 1 may be utilized for instance within a telegraph exchange office for relaying the incoming messages to the outgoing trunk lines over which the different messages are to be dispatched, thereby avoiding reduction of the messages to printed form and manual handling thereof. Thus an incoming message might be recorded in any one of the units A while the units C would be associated with appropriate mechanism for converting the stored signal combinations into corresponding combinations of electrical signal units for transmission over the trunk lines.

The transmission paths in general

The trunking of the electrical transmission paths in any stage of transmission, that is between two successive sets of relay units is preferably such as to avoid what may be termed a "bottle neck effect," that is, an undue burden on certain of the relay units due to uneven distribution of the messages among the relay units at an intermediate relay point. In the present instance (Fig. 1), this condition is obviated by arranging a plurality of relay units A, B and C in groups D, E and F respectively and by assigning to each group D a predetermined one of the groups E, one unit of each group E being in turn adapted for transmission to any unit in a predetermined group F. Thus the individual units A1 to A3 are each adapted for connection by paths 1 with any one of the units B1 to B3, while the individual units B1 to B3 may transmit over paths 2 to any one of the units C in the different groups F. For example, a message in the unit A10 to be transmitted to the unit C1 must pass through the unit B1, whereas a message in the unit A1 intended to be transmitted to the same unit C1 must pass through the intermediate unit B1. As a result of such grouping, the messages recorded in the different units A to be relayed to a given unit C will not pass through the same unit B, but will be distributed to several of the latter units.

For the sake of simplicity, only a small number of relay units are shown in Fig. 1, but it will be understood that the number of groups of units at each relay point and the number of units in each group will be determined by the traffic conditions in the system to which the present invention is applied. Where, however, the directing signals are recorded in the Baudot or five-unit code and utilized one at a time in selecting succeeding transmission paths, as is contemplated in the present embodiment of the invention, it will be apparent that the number of relay units in each of the groups E and F must be confined to 32, which is the maximum number of different combinations available with five-unit signals each unit of which may have either of two differentiating mechanical or electrical characteristics. Since

the present system contemplates the utilization of one of the 32 available combinations for the purpose of indicating the end-of-message, the groups E and F are limited to 31 units each.

While the message may be sent electrically from one relay unit to another within the exchange station by any of the well known methods, this is preferably accomplished in the present system by what will hereinafter be called "simultaneous" transmission. That is to say, all of the units of a signal combination representing a message character or a directing signal are transmitted and received simultaneously. For this purpose each of the paths represented by the connecting lines between successive relay units in Fig. 1 actually comprises five separate circuits, one for each unit in the successive combinations. The arrangement of these circuits is shown in Fig. 64 and will be later described in detail. Such a method of transmission is feasible in the case of sending and receiving relay units located entirely within a single telegraph station or city where the distance between successive relay points is short and where the operations of the transmitter and receiver may be readily synchronized.

The multiplication of the speed of sending messages which results from the employment of simultaneous transmission as compared to the commonly used synchronous and start-stop methods is particularly advantageous because of the material reduction effected in the number of relay units which must be employed to handle a given traffic load. In addition, the transmitting and receiving equipment associated with the storage medium of the individual relay units is greatly simplified by the omission of sunflower switches or other apparatus for distributing the units of the individual signals as is required when the signal units representing a given message character are transmitted successively.

The relay units in general

The individual relay units for receiving, storing and transmitting message matter in the present system are intended to be of identical construction and each, as indicated by the legends in Figs. 2 and 5, comprises a signal-responsive recorder or receiver and a transmitter between which is a mechanism for storing received signals as mechanical combinations and conveying them to the transmitter. Associated with the transmitter is a mechanism by which selection of the succeeding transmission path, initiation of transmission and termination thereof, is effected automatically under the control of certain of the combinations incorporated in the stored message.

All of the relay units at any exchange station are intended to be driven from a single source of power and at synchronous speeds, as by means of individual synchronous electric motors 3 (Figs. 3 and 4).

Relay unit storage mechanism

In general.—The storage mechanism of any relay unit provides a travelling medium or control form such as a perforable strip of paper or the like or a flexible metal band upon which signal combinations are recorded and mechanically stored in variable quantities pending retransmission from such unit. To provide for a large available capacity in each unit (approximately 3,000 signal combinations or 500 average words), for a low maintenance cost, and for ease and reliability of operation in the automatic control of the transmitter and recorder of the relay unit, the storage medium herein employed com-

prises a plurality of individual signal carriers linked together to form an endless chain each link of which has a set of individually movable control elements which may be set in combinations representing different message characters or control signals. The recorder and transmitter of each relay unit are associated with the chain at spaced points indicated by the legends in Fig. 5 and hereinafter called respectively the recording point and the transmitting control point. That portion of the chain between the recorder control point of the relay unit and the transmitter control point constitutes a storage section of variable capacity, while another portion of the chain located between a blanker (Fig. 5) and the recorder constitutes a supply section from which blank links may be delivered according to the variable requirements of the recorder.

To provide for compactness in arrangement, the chain (see Fig. 5) in passing from the recording control point to the transmitter control point is arranged to form a series of loops 4 which vary in length as the quantity of message matter in the storage section increases or decreases. A corresponding arrangement of loops 5 is provided in the supply section, these loops varying in length to compensate for variations in the loops 4, a fixed over-all length of the loops in the storage and supply sections being thereby maintained.

To permit of movement of the chain past the recording and transmitting points at high speeds, relatively short sections of the chain immediately associated with the recorder and transmitter are arranged for advancing movement independent of the main body of the chain in the storage and supply sections. These sections comprise short loops of low inertia, hereinafter called the recorder loop 6 and the transmitter loop 7. Chain as needed is fed automatically into these loops from the supply and storage sections by a drive mechanism operable to move the main body of the chain so as to feed portions thereof in the loops 6 and 7 according to the individual requirements of the recorder and the transmitter.

Storage chain.—Referring to Figs. 6 and 7, the chain is composed of a series of pivotally connected parallel links each carrying a row of parallel pins 8 which may be shifted axially into either of two set positions. In the present instance, there are five pins in each row so that any one of 32 different combinations may be formed to represent individually message, directing, or end-of-message signals. Each link comprises two spaced parallel bars 9 connected by end plates 10 and having its pins slidable transversely of the direction of travel of the chain. A short strip 11 of resilient material is threaded around the pins and acts frictionally on opposite sides of the alternate pins to hold them in their set positions. The end plates of the adjacent links are pivotally connected by pintles 12, the ends of which carry studs 13 adapted to be engaged by pairs of sprockets or rollers for guiding or advancing purposes.

To form the storage loops 4, the chain between the two control points passes alternately around closely spaced sprockets 14 (Fig. 5) and movable rollers 15, a similar arrangement of sprockets 16 and rollers 17 being employed to form the supply loops 5. The loops of the storage and supply sections are arranged in longitudinally aligned pairs with their movable ends adjacent and connected by bodily movable cars 18.

All of the chain loops are vertically disposed

and supported by a framework (Figs. 2, 3 and 9) having a base 19 from which rises a pair of standards 20 joined at their upper ends by a cross bar 21. Two spaced members 22 (Figs. 9 and 25) depending from the bar 21 constitute journal mountings for five shafts 23, 24, 25, 26 and 27 on which are fast the upper drive sprockets 16 for the four supply loops 5. Shafts 28, 29, 30, 31 and 32 (Figs. 5 and 25) carrying the lower drive sprockets 14 are journaled in a pair of spaced members 33 (Fig. 9) on the base 19. In each instance the sprockets are arranged in pairs for engaging the studs 13 at opposite side edges of the chain.

Between the upper and lower members 22 and 33 extend five pairs of bars 34 (Figs. 9 and 15) separated by transverse spacer bars 35 and spaced laterally to form vertical ways for guiding the movable cars 18. Each car (Figs. 10 and 11) comprises two members 36 supporting the rollers 15 and 17 around which pass the adjacent ends of the upper and lower chain loops. Rigid with the respective members 36 are a rod 37 and a sleeve 38 telescoping therewith and within the sleeve is a spring 39 acting between one end of the sleeve and a shoulder on the rod to urge the members 36 together to compensate for stretching of and wear on different parts of the chain. The side edges of the members 36 are guided as shown in Fig. 15.

From the blanker the chain is led around rollers 40 to form a run 41 (Figs. 2 and 5) from which it is delivered to the upper loops 5. After passing through the supply section the blank chain is led by rollers 42 around the recorder to the loop 6. This loop has a substantially fixed over-all length and is mounted adjacent the first loop 4 of the storage section for bodily movement in a direction parallel to said first loop. To this end it passes around a car 43 comprising two pairs of spaced idlers 44 (Figs. 5, 8 and 30) rotatable on shafts 45 journaled respectively in pairs of upper and lower blocks 46 which are slidable in guide-ways 47. These blocks are connected through the medium of links 48 and in order to maintain the chain taut each of the upper blocks is made in two telescoping sections urged apart by a spring 49.

To form the loop 6, the chain passes from the adjacent roller 42 (Fig. 5) around a pair of sprockets on a drive shaft 50 (Fig. 30) and then successively around the lower and upper idlers 44 and finally around the sprocket on the terminal shaft 28 of the storage section. Thus an outwardly facing straight chain run 51 is formed in the recorder loop upon which the recorder operates to set the chain pins in accordance with the incoming signals. This run is guided in ways 52 (Fig. 34) and is therefore accurately positioned while being advanced past the recording point in the operation of the receiver.

Advancing movement of the recorder loop 6 independently of the main body of the chain is accomplished in the operation of the recorder by sprockets 53 (Figs. 5, 8 and 30) which engage the chain run 51 beyond the recording point and rotate in a direction to move the chain upwardly whenever signals are being received. If at this time the shafts 28 and 50 are not rotating, the car 43 will move upwardly. But if said shafts rotate in the direction indicated by the arrow in Fig. 30 and the sprockets 53 do not run, equal lengths of the chain will be fed into and drawn out of the recorder loop, and the car 43 will move downwardly. On the other hand, if the shafts

28 and 50, and also the sprockets 53 run at the same time, equal lengths of chain will be fed into and drawn out of the loop 6 while the run 51 is being advanced past the recording point, and the car 43 will be maintained in an idling position.

The transmitter loop 7 (Figs. 14 and 58) is located adjacent the last loop 4 in the storage section and is carried by a car 54 constructed the same as the car 43 for the recorder loop but arranged to move downwardly when the transmitter alone is operating. To form this loop, the chain is passed around the sprockets on the terminal drive shaft 32, then successively around idlers 55 carried at opposite ends of the car 54 to form a vertically guided outer run 56, and finally around a pair of sprockets on a driven shaft 57. Just beyond the transmitter control point, the chain run 56 is engaged by a pair of sprockets 58 which rotate during operation of the transmitter and move the loop 7 downwardly provided the shafts 32 and 57 are not rotating. If the latter shafts and the sprockets 58 operate simultaneously, the car 54 will remain in idling position while the chain is being advanced past the transmitter control point.

Chain blanker.—On passing from the transmitter loop 7, the chain is blanked, that is to say, all of the pins in each link are pushed to their extreme outward position relative to the closed loop formed by the chain, in order to prepare them for use again in the recorder. To this end, the chain is led from the sprockets on a shaft 57 successively around an idler 59, sprockets 60, and an idler 61. In passing around the sprockets 60, the chain is guided in stationary ways 62 (Fig. 12) receiving the chain studs 13. The sprockets 60 are carried by members 63 fast on a shaft 64. The members 63 support individually movable cross bars 65 cooperating with the pins of the individual chain links and having their ends guided in stationary cam grooves 66. During the advance of the bars 65 along with the links, they are progressively cammed outwardly in a direction axially of the pins so as to engage and shift the pins into blanked position.

Chain advance.—A rugged mechanism (Figs. 14 to 25) is provided for advancing the storage and supply sections or main body of the chain so as to feed blank chain into the recorder loop, or chain bearing message matter into the transmitter loop, according to the individual or the combined requirements of the recorder and transmitter. Generally stated, this mechanism comprises two independently operable clutch controlled drive trains, one for rotating the first shaft 28 in the storage section in a direction to draw chain from the recorder loop 6 and deliver the same to the storage section, the other train being operable to drive the last shaft 32 of the storage section in a direction to draw chain from the storage section and deliver the same to the transmitter loop 7. In addition a differential operating mechanism is provided to combine the drives from the two trains and rotate the intermediate shafts 29, 30 and 31 at such speeds and in such different speed ratios as to maintain equal the lengths of the storage and supply loops 4 and 5 under the three operating conditions above mentioned. The two drive trains are rendered operative automatically and selectively according to the positions of the transmitter and recorder loops 6 and 7 which, it will be remembered, are advanced by independent means in the operation of the transmitter and recorder respectively.

The two drive trains of any relay unit originate at a main drive shaft 67 (Fig. 19) which is driven at constant speed by the synchronous motor 3 (Fig. 4). Each of the drive trains is governed in its operation by a jaw clutch which is hereinafter called a J-clutch and which is employed in numerous parts of each relay unit. Digression will, therefore, be made at this point to describe the clutch in detail, the same description and numbering of the parts being applicable to all of the jaw clutches subsequently referred to.

Referring to Figs. 16 and 17, the driving member of the clutch is in the form of a shaft 68 carrying a wheel 69 having spaced peripheral teeth 70 each with a radially disposed leading surface 71 and an inclined trailing surface 72 terminating in a notch between successive teeth. The driven clutch member comprises a sleeve 73 rotatable on the shaft 68 and carrying a pin 74 on which a dog 75 is pivoted to swing into and out of engagement with the clutch teeth 70. The dog has a rigid arm 76 the tip of which extends in a substantially radial direction and is urged into the path of the teeth 70 by the use of a torsion spring 77. Engagement of the dog with the teeth 70 may be prevented by a detent 78 blocking the end of a finger 79 rigid with the dog, thereby holding the dog retracted. When the detent is withdrawn the spring 77 moves the tip of the dog into the path of the teeth, movement of the driven sleeve starting when the tip is picked up by the leading surface 71 of the next tooth 70. In the disengagement of the clutch by the detent 78, pivotal movement of the dog while the driven clutch member is coming to rest is limited by engagement of a tailpiece 80 on the dog with a surface 81 on the sleeve 73.

Referring again to the chain advancing means the individual drive train for the terminal shaft 32 which feeds chain from the storage section of the relay unit into the transmitter loop 7 includes a jaw clutch 82 (Figs. 14, 15 and 21) whose toothed driving member is fast upon a shaft 83 which is driven from the main drive shaft 67 through the medium of gears 84 (Fig. 19). The dog 75 carried by the driven member of the clutch 82 is controlled by a detent 85 adapted for movement into and out of the path of the dog finger. The detent is on a shaft 86 connected to an arm 87 and a rod 88 the upper end of which is positioned to be engaged by a lug 89 (Fig. 14) on the car 54 of the transmitter loop 7. As the car approaches its lowermost position as a result of the operation of the transmitter, that is, when the available message links in the loop 7 are approaching exhaustion, the lug 89 engages and depresses the rod 88 against the action of a spring 90. This trips the clutch 82 and allows its dog to engage its toothed driver thereby establishing a driving connection between the clutch members for at least one revolution of the clutch or until the detent 85 is allowed to move back into blocking position by upward movement of the car 54. To prevent engagement of the parts of the clutch 82 by reverse rotation of the driven member under the action of the clutch spring, a disk 91 geared to the driven clutch member (Fig. 14) is provided on a shaft 92 having notches 93 into which a roller 94 is pressed by the action of a spring 95. This counteracts and overcomes the action of the clutch spring.

Rotation of the driven member 73 of the clutch 82 operates through a pinion 96 (Fig. 21) rigid therewith and a gear 97 on the shaft 92 to drive

a pair of disks 98 (Fig. 20) carrying three circumferentially spaced pins 99, having rollers which are engageable respectively with six notches in a Geneva stop gear 100 which rotates with successive accelerated and retarded movements as the pins 99 revolve continuously. Through the medium of gears 101 and 102, a shaft 103 (Figs. 14 and 20) and gears 104 and 105, the member 100 imparts corresponding movements to the extended end of the shaft 32 which is the terminal drive shaft corresponding to the last loop of the storage section. Rotation of this shaft in the direction shown in Fig. 58 draws lengths of the chain out of the storage section and delivers the same into the transmitter loop 7. The sprocket shaft 57 for delivering the used chain to the blanker is driven from the shaft 32 by gears 106, 107, 108 and 109 (Figs. 14 and 25). The blanker shaft 64 is driven from the gear 101 (Fig. 14) through the medium of a shaft 110 and gears 111.

The means employed for driving the intermediate shafts 29, 30 and 31 at increasing speeds relative to the terminal shaft 32 includes three spur-gear differentials 112, 113 and 114 (Figs. 15 and 23) each of which has one terminal member driven from said terminal shaft 32 through the medium of a train of gears 115, 116, 117, 118 and 119 (Figs. 15 and 21) which rotate as indicated by the arrows in Fig. 21 when the clutch 82 is engaged in the downward movement of the transmitter loop 7. The speed ratio is such that the gears 116, 117 and 119 make 1.5, 1.0 and 0.5 revolutions respectively for each revolution of the shaft 32. As shown in Fig. 24, the gear 116 is rigid with a shaft 121 carrying the terminal member or gear 122 of the differential 112. The gears 117 and 119 are similarly mounted on shafts 121 rigid respectively with the terminal members or gears 123 (Fig. 9) and 124 (Fig. 18) of the differentials 113 and 114.

As is common in the construction of spur-gear differentials, the two terminal members of each are mounted in coaxial relation, the terminal gears 122, 123 and 124 in the present instance being fast upon shafts 121 (Fig. 23) while the other terminal gears 125, 126 and 127 of the three differentials 112, 113 and 114 are rigid with sleeves 128 through which the respective shafts 121 extend. The terminal gears of each differential mesh respectively with pinions 129 (Fig. 23) which in turn mesh with each other and are rotatably mounted on studs carried by intermediate members 130, 131 and 132 of the respective differentials 112, 113 and 114. The three shafts 31, 30 and 29 for advancing the intermediate loops of the storage section are driven from the intermediate members 132, 131 and 130 of the three differentials. To this end the intermediate member 130 (Fig. 24) is fast on a shaft 133 which through gears 134 drives the shaft 31 in the same direction as the shaft 32. Likewise the intermediate member 131 (Fig. 9) is fast on the extended end of the shaft 30 while the member 132 of the differential 114 (Fig. 25) is on a shaft 135 which drives the shaft 29 in the proper direction through the medium of gears 136.

The gearing arrangement and ratio in each of the three differentials is such that each of the intermediate members 130, 131 or 132 will rotate in the same direction and at one-half the speed of the cumulative rotative movements of its terminal members. Thus when the terminal members 125, 126 and 127 of the differentials are stationary and the terminal members 122, 123 and

124 are rotating as above explained in the ratio of 1.5, 1.0 and 0.5 relative to the speed of the terminal shaft 32 due to the engagement of the clutch 82 by individual operation of the transmitter, the shafts 31, 30 and 29 and the drive sprockets carried thereby will rotate in the ratio of 0.75, 0.50 and 0.25 relative to the speed of the shaft 32. As a result progressively increasing quantities of chain will be drawn from the first, second and third loops 4 of the storage section while an amount of chain equal to that utilized in the transmitter loop 7 will be drawn from the last storage loop 4 in the rotation of the terminal shaft 32. Thus all of the storage loops 4 will be shortened equal amounts in the individual operation of the drive chain whose clutch 82 is controlled by the movement of the transmitter loop 7.

The drive train for feeding blank chain into the recorder loop 6 and delivering the chain bearing message matter to the storage section is fed through an arrangement similar to that above described including a jaw clutch 137 (Figs. 15, 18 and 21) whose toothed driver is driven from the main drive shaft 67 and whose driven member operates a Geneva stop gearing 138 (Figs. 4 and 19), the notched member of which operates through a suitable gear train to rotate the terminal shaft 28 which advances the chain in the first loop 4 of the storage section at the same speed and in the same direction as the terminal sprocket shaft 32 operated by the transmitter drive train. The sprocket shaft 50 (Figs. 8, 18 and 30) for delivering blank chain to the receiver loop is driven from the shaft 28 through a train of gears 139 (Fig. 18).

The clutch 137 is governed by a detent 140 (Figs. 8, 18 and 21) movable into and out of the path of the dog 75 of the clutch. The detent is on a rock shaft 141 connected by an arm 142 and a link 143 to an arm 144, and the link has a lug 145 which is adapted to be engaged by a stud 146 on the receiver car 43 when the latter rises to a predetermined point in the operation of the recorder. This withdraws the detent 140 against the action of its spring and initiates the operation of the Geneva drive which continues for one or more revolutions of the clutch as determined by the position of the car 43.

To utilize the drive train last described as a means for driving the intermediate shafts 29, 30 and 31 at decreasing differential speeds when the recorder of the relay unit alone is operated, the shaft 28 is connected to a train of gears 147, 148, 149, 150 and 151 which rotate in directions indicated by the arrows in Fig. 22. The gears 148, 149, 150 and 151 are fast upon the sleeves 128 (Fig. 22) which carry the terminal members of the three differential gears 112, 113 and 114. The gearing ratio is such that the terminal members 127, 126 and 125 rotate at speeds of 1.5, 1.0 and 0.5 respectively relative to the speed of the shaft 28. Therefore, if the transmitter is idle, which causes the terminal differential members 122, 123 and 124 to remain stationary, the differentials will, when the drive clutch 137 is engaged, as an incident to the operation of the recorder, cause the shafts 29, 30 and 31 to rotate in the ratio of 0.75, 0.5 and 0.25 relative to the shaft 28. Under these conditions the chain drawn from the recorder loop 6 in the rotation of the shaft 28 will be distributed in progressively decreasing quantities to the four succeeding loops 4 in the storage section with the result that all of the loops in this section will be lengthened equal amounts.

The third operating condition which must be provided for in maintaining the storage loops 4 of constant lengths arises in the simultaneous operation of the transmitter and recorder of the relay unit. Since both of these devices are driven at the same speed, equal amounts of chain will, under this condition, be fed into and withdrawn from the storage section, thereby necessitating rotation of all of the shafts 28 to 32 at equal speeds. This is accomplished with the differential gear arrangement above described since the terminal members of each are driven in the same directions by their respective clutch control driving trains and at such speeds that their cumulative rotative movements are double the movements of either of the terminal shafts 28 and 32. Such rotative movements are combined by the differential gears and reduced thereby to the same speed as that of the shafts 28 and 32. Therefore, in the operation of the transmitter and recorder simultaneously the chain drive sprockets 14 will all rotate at the same speed with the result that the lengths of the loops 4 are not changed, the cars 18 remaining in fixed vertical position while the chain is run through the storage section.

Each of the drive shafts 23, 24, 25, 26 and 27 (Fig. 25) for the supply loops 5 are driven in the same direction and at the same speed as the corresponding lower shafts 28, 29, 30, 31 and 32. This is accomplished by five shafts 152 each connected through bevel gears at their upper and lower ends to the proper shafts. In the case of the shaft 27 an additional pair of gears 153 is interposed to obtain the proper direction of rotation.

Relay unit—recorder

In general.—In view of the simultaneous character of the transmission employed in the present embodiment of the invention, the receiver for recording the signals transmitted is made responsive to the several units of each signal simultaneously so as to record such units all at the same time on the storage medium. Such recodation is effected by five pin pushers arranged for actuation in unison from a constantly operating drive means and operable upon the pins in the successive links of the chain as the latter are moved at constant speed past the recording point in timed relation to the incoming signals.

The advance of the chain to present blank links successively to the recording point for operation by the pushers is herein accomplished through the medium of a suitable quick acting clutch arranged to drive the sprockets 44 for the recorder loop 6 of the storage chain from a drive means operating in synchronism with the drive means for the pin pushers. This clutch is controlled to start the chain advance by means responsive to the incoming signals; and the chain is advanced a distance equal to its pitch during each cycle of operation of the pin pushers. Accordingly the chain advance may be said to take place in successive link cycles, the chain being advanced in each cycle a distance equal to its pitch.

Means independent of control by the incoming signals is provided to govern the chain advance past the recording point for the purpose of incorporating with each message recorded thereon a predetermined number of signals represented by links of the chain having no pins pushed and constituting the end portion of the message, or under a certain condition for advancing blank links past the recording point independently of the recording operation.

Pin setting.—Referring now to Figs. 26, 27 and 30 to 33, the five pushers for recording the received signal combinations on the chain are in the form of rods 154 slidable in stationary guides 155 for movement in a direction axially of the pins in the chain at the recording point, and laterally spaced at their inner ends according to the spacing of the pins in each link of the chain. To permit of movement of the chain continuously, at a high rate of speed, during the setting of the pins thereon, said inner ends of the push rods have end faces elongated in the direction of travel of the pins (Fig. 30).

The push rods 154 are arranged for actuation by a series of five floating levers FL1 to FL5 (Fig. 26) and are moved selectively under the control of signal responsive means in the form of five latches L1 to L5, each controlled by an electromagnet 156. The levers are pivotally mounted between their ends on a rod 157 suspended by two arms 158 (Figs. 26 and 28) from a shaft 159 journaled in the framework and continuously rocked by cam means consisting of a pair of cams 160 fast on a driven shaft 161 and coacting with a pair of rollers 162 on a follower 163 pinned to the shaft 159. One end of each of the floating levers FL1 to FL5 is pivotally connected to one of the push rods and the other end of each lever is shaped to form a tip 164 (Fig. 31) for engagement with its corresponding latch when the latter is actuated under the control of its magnet 156. For the sake of compactness two of the magnets 156 are arranged above the push rods and three below, and the floating levers and their respective latches are correspondingly arranged. Thus as shown in Fig. 28, two of the levers (FL2 and FL4) have their tips above the carrier rod 157 and three of the levers (FL1, FL3 and FL5) have their tips below the rod, the adjacent levers having oppositely disposed tips and the outer ends of the adjacent push rods being bent upwardly and downwardly respectively for connection with their floating levers.

The latches L1 to L5 are pivoted between their ends on bracket arms 165 (Fig. 38) and are disposed approximately perpendicular to their corresponding floating levers, the outer ends or tips 166 of the latches being movable into and out of blocking relation to the tips 164 of the floating levers. The opposite or inner ends of the latches constitute the armatures of the several magnets 156, which are the receiving magnets responsive to the incoming signals. These magnets have U-shaped pole pieces 167 (Fig. 38) supported in blocks 168 of insulating material, one leg of each pole piece forming part of a metallic flux circuit including the latch armature.

Normally the latches are held out of blocking relation to their respective levers 158 and against suitable stops, by means of individual springs 169 connected thereto and anchored to tension adjusting screws 170 mounted in the supporting blocks 168. When the magnets are energized the latches engage and hold tips of the levers and thereby provide fulcrums on which the levers turn in the movement of the carrier rod in a direction toward the chain. This causes the opposite ends of the levers, and hence the corresponding push rods to move in a direction to push pins on the chain.

It will be observed that the pressure of the floating levers on the latches acts in a direction through their axes and therefore is sustained by the latch pivots. With this arrangement the magnets are used only for control purposes, and

only small movements of the latches are necessary. Therefore the magnets may be made small, extremely sensitive, and adapted to operate at high speed. When the magnets are not energized, the tips of the floating levers are permitted to move relative thereto and the push rods, due to their inertia, provide fulcrums about which the levers pivot in the forward or active stroke of the carrier rod, and the push rods therefore remain inactive.

The shaft 161 carrying the lever actuating cams 160 is arranged to be driven in timed relation to the advance of the storage chain, and for this purpose is connected by means of a gear train 171 (Fig. 27) with the main receiver drive shaft 172. The latter has a pinion 173 (Figs. 4 and 19) meshing with the terminal gear of a train 174 driven from the gear 84 on the main drive shaft 67 of the relay unit. The cam shaft 161 makes one complete revolution in the movement of each link of the chain past the receiver control point, and the cams 160 are shaped in the present instance to impart to the carrier rod 157 actuating and return movements in rapid succession, followed by a dwell period.

During said dwell period, the tips of the floating levers occupy their outer or inactive positions so that the control latches acting in response to the succeeding signal may have ample time to move into holding relation to their respective levers and thus govern the operation of the pin pushers in the subsequent actuation of the floating levers. Also it should be noted that after a latch has been engaged by its floating lever, it is frictionally held in such relation so that the succeeding signal may be received during the recording operation. This avoids the possibility of the latch being withdrawn, during the pushing stroke of its floating lever, by the succeeding received signal or as a result of vibration of the machine.

It will be seen that when no signal combination is being received, all of the floating levers operate idly, their free ends moving and their pivoted ends, together with the push rods connected thereto, remaining relatively stationary. Upon receipt of the first signal, those of the magnets 156 which are energized draw their latches into holding or blocking position, and in the next operation of the floating levers the corresponding push rods are actuated to record the signal by setting the appropriate pins in the links of the chain then opposite the rods.

It has been found that with the arrangement just described a continuous operating speed such as to record signals at the rate of 3600 per minute is practicable. This is due not only to the sensitive character of the signal-responsive control, but also to the nature of the cam means employed for driving the push rod actuators. Thus through the use of the double acting cam, the levers are positively actuated in both directions by small cams of low moment of inertia with relatively large roller followers which have large bearings and which rotate continuously in one direction.

Chain advance mechanism.—To avoid unnecessary wear on the chain and the advancing means therefor, it is desirable to start the same at the beginning of each message and to interrupt it at the end of the message, and since the chain advance must be controlled in timed relation to the power actuated recording means operating constantly at high speed, the starting and stopping of the chain is effected through the me-

dium of a quick engageable and disengageable clutch. In the present embodiment of the invention, the clutch employed for this purpose involves the use of a spur gear differential and is therefore hereinafter referred to by the term "spur gear differential clutch."

Referring now to Fig. 26, such a clutch, designated generally by the numeral 175, is adapted to drive a shaft 176 carrying the sprockets 53 meshing with the roller studs 13 at opposite edges of the chain in the recorder loop.

The clutch 175 comprises a disk 179 constituting the intermediate member of a spur gear differential, and rigid with a sleeve journaled in the framework having fast thereon a spur gear 177 driven constantly by a pinion 178 on the receiver drive shaft 172. Said disk has two pinions 180 (Figs. 26 and 27) meshing with each other and respectively meshing with two terminal gears 181 and 182. The gear 182 is rigidly connected with a notched disk 183 through the medium of a sleeve 184 mounted on the shaft 176, and the gear 181 is pinned to said shaft as is also a second notched disk 185 disposed adjacent the first disk. The notches in said disks are spaced according to the pitch of the chain, and the disks are adapted to be held against rotation selectively to cause the shaft 176 either to remain stationary or to be driven in the operation of the spur gear differential.

A means is provided for selectively locking the notched disks 183 and 185 against rotation, which comprises a U-shaped detent member 186 providing two laterally offset dogs respectively adapted to enter the notches in said disks. The detent is fast upon a rock shaft 187 mounted in fixed bearings and having rigid therewith two oppositely extending arms 188. A two-fingered member 189 is constantly reciprocated by means of an eccentric connection 190 (Figs. 26 and 31) with the constantly driven shaft 161. This member constitutes a setter for the detent 186, acting through the medium of the arms 188.

The fingers on the detent setter are spaced apart a distance somewhat greater than the combined length of the two arms 188, so that by shifting the vertical position of the detent setter relative to the arms (compare Figs. 31 to 33) the detent setter will, in its next reciprocation, toward the detent, engage one of the arms and rock the detent in a direction to withdraw the then engaged dog from its disk and to enter the other dog in engagement with the other disk. The arrangement is such that in the upper position (Figs. 32 and 33) of the detent setter its lower finger engages with the lower one of the arms 188 to cause the detent to hold the notched disk 183 and free the disk 185 so as to effect rotation of the sprockets 53 from the driving clutch member 179; and in the lower position of the detent setter (Fig. 31) its upper finger is adapted to engage the upper one of the two arms 188 to cause the other dog of the detent to hold the notched disk 185 against rotation (Fig. 26) and stop the drive. The active or setting movement of this detent setter by the eccentric 190 starts with the return movement of the floating levers, and continues during a part of their dwell, after which it is immediately returned.

The detent setter is shifted by the rocking of a shaft 191 (Figs. 26 and 31) having a crank arm 192 connected with the inner or free end of the detent setter by means of a double link 193. Said shaft is axially aligned with another rock shaft 194 with which it has an interfitting stud

and bore engagement as shown at 195 in Fig. 37, the two opposite ends of the rock shafts being journaled in the framework just above the push rods 154. The rock shaft 194 carries a feeler in the form of a depending bail 196 rigid therewith, and each of the push rods has a lug 197 thereon adapted to engage with this bail to actuate the rock shaft in one direction. The feeler is thus responsive to the recordation of each signal combination. The other rock shaft 191 also carries a depending member 198 in the path of a bar 199 arranged to be actuated by a floating lever FL6 under the control of a latch L6, in a manner similar to the other floating levers RL1 to FL5 and their latches L1 to L5, a spring 200 being provided tending to draw said latch L6 in a direction such as to block the free end of the floating lever FL6. Control of the chain advance by the latch L6 is independent of the operation of the push rods, for purposes which will later become apparent.

The bail 196 has a lug 201 rigid therewith overlapping a lug 202 formed on the member 198 rigid with the other rock shaft 191. These overlapping lugs constitute a one-way connection between the rock shafts, of a character such that when the rock shaft 194 is actuated by any one of the push rods 154, the other rock shaft 191 will be similarly actuated and the detent setter 189 shifted upwardly.

It will be apparent from the foregoing that the detent setter 189 may be shifted upwardly in any link cycle in the active stroke of the floating levers FL1 to FL6 respectively controlled by their latches L1 to L6, and since the eccentric 190 imparts a setting stroke to the detent setter just subsequent to such upward shifting movement, the chain may be started in any link cycle, actual movement taking place in the latter part of the setting stroke when the lower dog of the detent 186 stops the disk 183.

Thus, so long as the detent setter occupies its upper position during its setting stroke, the chain will continue to advance. In order that the chain may be stopped in any link cycle, the detent setter must not only be shifted to its lower position but must be permitted to remain there during the next setting stroke of the detent setter so that the dog will be actuated to release the disk 183 and stop the other disk 185. To this end the rock shaft 191 has a crank arm 203 rigid therewith and connected by means of a double link 204 with an arm 205 rigid with a cam follower 206 loose on the shaft 159 and having rollers acted upon by two cams 207 fast on the shaft 161. Said cams are adapted to impart to the follower 206 a cyclic operation similar to the floating lever operation, consisting of active and return strokes, followed by a dwell. The active stroke of the follower, in which the detent setter 189 is shifted downwardly, occurs in the latter part of the dwell of the floating levers, so as to lower the detent setter just in advance of its upward shift by the floating levers in their succeeding pin-setting operation. At the same time, the shaft 194 is rocked in a counter-clockwise direction by reason of the operative connection with the shaft 191 provided by the overlapping lugs 201 and 202 and operates through the medium of the bail 196 to restore the actuated push rods 154 to normal position. The link 204 has a pin-and-slot connection 208 with the crank arm 205 which renders the cams 207 inoperative to shift the detent setter upwardly, and therefore the detent setter is permitted to remain in its lower position dur-

ing its setting stroke unless shifted upwardly by one or more of the floating levers.

Immediately after the pin setting operation by one or more of the push rods 154 the floating levers FL1 to FL6, actuated by their cam device 160, make a quick return to their initial positions so as to provide the greatest possible time for the movement of the latches in response to the next signal. On the other hand the return of the rock shafts 191 and 194 is in the present instance delayed to allow time for the action of the detent setter 189. This is accomplished through the use of a two-position magnetic set device 209 (Fig. 29) operating to hold the detent setter in either of its shifted positions. This device acts to hold the detent setter in its upper position until positively returned by the cam device 207 near the end of the dwell period of the floating levers. This magnetic set device may consist of a continuously energized electromagnet 210 having spaced pole pieces 211 between which an arm 212 rigid with the rock shaft 191 oscillates.

In order that the detent setter 189 may be shifted downwardly while being withdrawn by the eccentric, without any harmful interference between the detent setter and the arm 188 of the detent, the upper finger of the setter is pivoted at 213 (Fig. 31) and urged downwardly against a suitable stop by a spring 214 permitting the finger to yield upwardly.

Chain feeler.—In view of the fact that the signal combination represented by a link having no pins pushed which is the same as a blank link, is employed in the present instance, to indicate the end of a message, means is provided in the case of each relay unit for automatically incorporating such blanks at the end of each message coming into storage. This means operates to continue the advance of the chain in the receiver loop 6 after the last signal representing the body of the message has been recorded, and in the present instance it comprises a signal-responsive device in the form of a feeler CF1 (Figs. 26, 30 and 34) located a short distance beyond the receiver control point and operating through the latch L6, floating lever FL6, and rock shaft 191 to control the detent setter 189.

The feeler CF1 comprises generally a series of five shoes 215 mounted on two bars 216 for reciprocation transversely of the chain on the inner side of the chain run 51 of the recorder loop. There is one shoe for each longitudinal row of pins in the chain, and as shown in Fig. 34 the shoes are spaced inwardly from the chain so as to engage with the advancing pins only when such pins are in pushed position. Each of the shoes is provided with a cam face consisting of a substantially straight intermediate surface 217 (Fig. 36) equal in length to the pitch of the chain and terminating in curved portions 218 which merge into end portions 219 offset with respect to the straight surface 217. Such end portions are spaced apart a distance equal to twice the pitch of the chain so that each shoe cannot be engaged by more than two of the chain pins at any one time. The relation of the shoe surfaces is shown diagrammatically in Fig. 36, wherein the positions of the pins of four successive links are indicated by the numerals 1 to 4, the path of movement of one longitudinal row of pins being indicated by a broken vertical line.

The feeler shoes are continuously urged into the path of movement of the chain pins by means of a spring 220, the movement being limited by a

stop 221. Considering the shape of the cam surface of the shoes as shown in Fig. 36, it will be evident that the position of the feeler is determined by the positions of the pins of the two successive links which may at any time be located between the Nos. 1 and 3 positions indicated. In other words, when message matter represented by a succession of links having one or more pins pushed are passing the feeler, the latter will be held outwardly in the position shown in full lines in Fig. 36. The feeler will remain in this position until two successive links following the message matter and having no pins pushed are advanced from the recording point into positions Nos. 2 and 3, whereupon it will move by the action of the spring 220 into its inward position in which the shoes are shown in broken lines in said figure.

The movement of the feeler from its outward to its inward position as permitted by the blank links at the end of the message is utilized to continue the chain advance in the receiver loop a distance sufficient in the present instance to insert three blank links at the end of each message. This is accomplished through the control of the latch L6 by the feeler, located so that the midpoint in the cam face of each of the shoes is spaced beyond the receiver control point a distance equivalent to two link cycles (Fig. 36).

The control of the latch L6 by the feeler is effected by an underlying control finger 222 (Figs. 37 and 39) connected to the feeler. To this end the feeler is connected to one arm of a bell crank 223 mounted to turn on a fixed vertical axis (Figs. 26, 27 and 34). The other arm of the bell crank is connected by a link 224 to a crank arm 225 of a rock shaft 226 suitably journaled in the framework and passing between the latches and parallel to the floating lever carrier rod 157. A second shaft 227 is mounted above and parallel to the shaft 226 and on this second shaft is a sleeve 228 (Fig. 39) carrying said control finger 222 which is located beneath the free end of the latch L6. Also carried by this sleeve is a notched arm 229 with which inter-engages an arm 230 on a sleeve 231 pinned to the shaft 226 connected to the feeler.

By this arrangement, the feeler, when held outwardly by pushed pins in the chain, operates to permit the latch L6 to be held by its spring in blocking relation to its floating lever FL6. The result is that the rock shaft 191 is operated independently of the shaft 194 after the incoming signals cease to effect the operation of the shaft 194. Accordingly the detent setter 189 continues to be shifted upwardly to continue the chain advance until the feeler is permitted to move inwardly. When this occurs, two blank links will have passed the recording point so as to occupy positions Nos. 2 and 3 (Fig. 36). Furthermore, a third blank link will have moved into position No. 3 by the time the chain drive is stopped by the operation of the detent setter 189 and clutch 175. Thus, the timing is such that the fourth succeeding blank link will be opposite the pusher rods in position No. 4 when the chain comes to rest and hence ready for the recordation of the first signal of the succeeding message.

Combined line-selector and transmitter

In general.—In the operation of effecting transmission of a message from a given point or station to one of a plurality of stations selectively, the combined line-selecting and trans-

mitting mechanism of each relay unit operates through a three-part message cycle to effect, first, selection of a path leading to the proper receiver, second, automatic initiation of transmission of the message when the selected path is available, and, third, freeing the transmission path.

The first part of each message cycle involves the presentation of the first directing signal of the message to be transmitted to the control point of the transmitter loop, whereupon a line-selector mechanism operates in accordance with the signal combination constituting such directing signal to select one of a group of transmission paths leading to a remote recorder. A busy test mechanism associated with the selector operates periodically to determine whether the selected path is available, and when available, to seize or appropriate such path while at the same time initiating the next step of the message cycle.

In the second part of the cycle, transmission of the message, including the unused directing signals, is effected by continuing the advance of the chain to move the successive signal combinations past the control point. In such movement, the signal combinations stored in codal form on the chain control transmitting contacts to effect electrical transfer of the message to the selected receiver.

The third part of the cycle is initiated by the presentation of the end-of-message signal to a feeler responsive thereto and operable to interrupt the advance of the chain and to free the transmission path.

The message cycling mechanism.—The three-part operation of transferring a message from one relay unit to another in the manner above set forth generally, is accomplished under the control of a cycling mechanism comprising a governor arranged to be driven at a predetermined speed through three successive steps corresponding to the three parts of the message cycle. In the present embodiment the governor is of the rotary type and is adapted to travel through one complete revolution for each message cycle. A shaft 232 carrying a series of control cams and hereinafter termed the J-cam shaft is provided for this purpose. This shaft (Figs. 40 and 58) is journaled horizontally in the frame parallel to the plane of the transmitter loop 7 and spaced a substantial distance therefrom to the left. A constant speed drive sleeve 233 (Fig. 48) is mounted loosely on the J-cam shaft 232 and is operable to drive said shaft through the medium of a positively acting clutch 234. The sleeve 233 has rigid therewith a gear 240 (Figs. 42 and 48) which is driven from the main drive shaft 67 of the relay unit through one of the gears 174 which meshes with a gear 235 fast on a shaft 236. The latter shaft is connected by a gear train 237 with a shaft 238 (Fig. 42) carrying a pinion 239 meshing with a gear 240.

The clutch 234 (Figs. 42, 43 and 52) for controlling the connection between the J-cam shaft and the constant speed drive sleeve 233 is, in the present embodiment, of the jaw type above described under the heading "Storage mechanism—chain advances." The toothed wheel or driving member 241 of this clutch is fast on the constant speed sleeve 233 which is driven at a speed such that a tooth of the wheel moves past a predetermined point once in each link cycle, i. e., in the passage of each link past the control point. The clutch dog 242 is mounted, through the medium of a member 243, upon the J-cam shaft, for pivotal movement into and out of engagement with

the toothed wheel, a spring 244 normally tending to cause such engagement. As in the case of other clutches of this type, a disk 245 mounted on the driven shaft has three angularly spaced notches into one of which a follower 246 is urged by a spring 247 so as to prevent reverse rotation of the cam shaft by the action of the clutch spring.

The control of the clutch to effect the three stepping movements of the shaft in the message cycle is accomplished by means of three detents 248, 249, and 250 (Fig. 42) spaced about the path of movement of the clutch dog. Each of these detents is adapted to engage the dog so as to withdraw the same against the action of its spring 247 and thereby stop the cam shaft. Provision is made for three dwell periods of variable lengths in each message cycle, the positions of the cam shaft during such periods being hereinafter referred to as No. 1, No. 2 and No. 3 rest positions.

Due to the variations in the traffic load which any relay unit is called upon to handle, a variable time interval necessarily occurs between the storage of successive messages, and in the case of the chain or tape type of storage medium such variation may require the insertion of variable lengths of blank storage medium between messages. The dwell of the governor in its No. 1 position allows for such variable spacing of the messages and is accomplished by the detent 248 (Fig. 52) termed the No. 1 detent fast on a rock shaft 251 and movable into and out of the path of the clutch dog 242. Upon the withdrawal of this detent the cam shaft is connected to the constantly operating drive sleeve 233 for movement through the first step of the message cycle during which the selection of the succeeding path of transmission is effected in accordance with the character of the individual units of the first directing combination.

In the present system any one of a plurality of relay units may be connected selectively for transmission to any one of a plurality of remote receivers. It will be apparent therefore that at the time any one transmitting relay unit desires connection with a particular receiving relay unit, the latter may be in use by a different transmitting relay unit, which renders the receiving unit unavailable for the reception of message matter from the first mentioned unit. It is to allow for such a "busy" condition that a dwell in the message cycle is provided following the selection of the proper remote receiver as above indicated.

This is accomplished through the combined action of a finger 252 (Figs. 43 and 44) and the detent 249 hereinafter termed the No. 2 detent, both of which are movable into and out of the path of the clutch dog. The No. 2 detent constitutes the armature of a magnet 253 hereinafter called the busy test magnet. This armature is acted upon by a spring 254 and is pivotally mounted at 255 so as to be disposed substantially tangential to and in the path of rotation of the clutch dog 242 and thus receive as an endwise thrust the force exerted by the clutch spring tending to cause engagement of the clutch. The finger 252 is constantly oscillated into and out of the path of the clutch dog in each link cycle by a double acting cam device consisting of two cams 256 on the shaft 238 and acting upon a double roller follower 257, the finger 252 and the follower being rigid with a shaft 258. The free end of the finger 252 is positioned slightly in advance of the detent armature 249 and in its movement into the path of the dog it cams the

dog backward so as to relieve the pressure thereof on the armature. When thus relieved the armature can be readily withdrawn against the action of its spring 254 upon the energization of the magnet.

The engagement of the clutch elements in starting the cam shaft from its No. 1 rest position (Fig. 42) is so timed that when the clutch dog approaches the No. 2 rest position of the cam shaft the relief finger 252 will be in its innermost or blocking position and therefore will, normally at least, withdraw the clutch dog and stop the cam shaft. Although the finger 252 is moved outwardly immediately following the withdrawal of the clutch dog, the detent armature 249 will, if its magnet is not energized, provide a stop for preventing the reengagement of the dog with the toothed wheel. Thus the cam shaft will be held in its No. 2 rest position (Fig. 43) by the combined action of the relief finger 252 and the armature, and will remain in such position until the selected receiver is available for the reception of the message, when the magnet will be energized by the busy test mechanism to be later described. Upon such energization the next withdrawal of the finger 252 will free the clutch dog for engagement with the constantly rotating toothed wheel 241 and thereby start the cam shaft upon the second step of its movement in proper timed relation to the power-actuated recorder of the relay unit to which the message is to be sent. Thus transmission of the message over the selected path is initiated in timed relation to the cyclic operation of the recorder.

The cam shaft is stopped in its No. 3 rest position (Fig. 44) where it is held during the transmission of the remaining portion of the message, and thus another dwell is provided in the movement of the cam shaft through its cycle to allow for the transmission of messages of varying lengths. Such stopping of the cam shaft is accomplished by the detent 250, called the No. 3 detent, which is fast on a rock shaft 259 (Fig. 48) and movable into and out of the path of the clutch dog 242 by a rocking of this shaft. Upon withdrawal of this detent the clutch dog is permitted to engage the toothed wheel 241 to start the cam shaft on its third and last step of its movement in the message cycle, during which transmission in the case of the instant message is terminated, and the transmission path is freed for use by other transmitting relay units, the message cycle being completed upon the arrival of the cam shaft at its No. 1 rest position. The next cycle is initiated immediately or is deferred by the stopping of the cam shaft in said position depending upon whether or not another message immediately follows.

Chain advance.—Initially the chain must be advanced a variable distance depending upon the position on the storage medium of the message to be transmitted, to present the first address signal to the control point for the purpose of selecting the proper transmission path; and finally the chain must be advanced past the control point to effect the transmission of the message. In one instance such initial chain advance is effected automatically by an auxiliary control means called the storage indicator, operatively associated with the storage mechanism. In another instance such advance is controlled by the cycling mechanism at the end of the preceding message cycle. In either event, such initial movement of the chain is utilized as the primary con-

trol means for starting the message cycle through the operation of the governor.

Power for driving the sprockets 58, to advance the chain in the transmitter loop 7, is derived from the constantly operating drive shaft 236 (Fig. 40) through the medium of a clutch 260 (Figs. 40, 45 and 46) of a character adapted to effect a rapid starting and stopping of the chain and herein of the spur gear differential type above described under the heading "Recorder—chain advance."

Of this clutch 260, the intermediate member is in the form of a disk 261 fast on a sleeve 262 journaled in the frame and driven from the shaft 236 by gears 263. The disk 261 carries two intermeshing pinions 264 respectively meshing with two terminal gears 265 and 266 of the clutch differential, and these gears are respectively rigid with two notched disks 267 and 268 through the medium of a shaft 269 and a sleeve 270. The shaft 269 carries the chain sprockets 58 and has a bearing in the sleeve 262. The disks are adapted to be locked selectively by a pivotal detent 271, the chain being advanced downwardly when the disk 268 is held stationary and being stopped when the other disk 267 is locked.

The clutch 260, which is of the spur gear differential type, has its detent 271 (Fig. 45) controlled by a detent setter 272 actuated by an eccentric 273 on a shaft 274 constantly driven from the main transmitter drive shaft 236 through a train of gears 275 (Figs. 40 and 47). The detent setter is vertically shifted with respect to the detent arms 276 by the rocking of a shaft 277 (Fig. 46) through the medium of a crank arm 278 and a link 279. Rigid with the rock shaft is an arm 280 constituting the armature of a two-position magnetic set device 281 adapted to hold the detent selectively in either of its two vertical positions during the actuation thereof by the eccentric 273.

Power means is provided for rocking the shaft 277 so as to position the detent setter 272. The shaft is rocked in a direction to lower the detent setter (Fig. 45) and thereby effect the advance of the chain, by means of a floating lever FL9 loose on a rod 282 which in turn is carried by a pair of arms 283 fast on a shaft 284. This latter shaft is journaled in the frame parallel to and just above the shaft 274, and its oscillation is effected by a double acting cam device 285 (Figs. 40 and 52) on the shaft 274. The movements imparted to the floating lever FL9 by the cam device 285 are identical with those of the levers FL1 to FL6 of the same and different relay units, and since all of the relay units are driven in synchronism, such movements of the floating lever FL9 occur simultaneously with the corresponding active and return strokes and dwells of the levers FL1 to FL6.

One end of the floating lever FL9 is connected by a link 286 (Fig. 45) to a crank arm 287 on the rock shaft 277, and said rock shaft is moved or is not moved in such oscillation of the floating lever depending upon whether or not the free end of the lever is permitted to move. When its end is free to move, the lever, due to the action of the magnetic set device plus the inertia of the parts, turns during its active or setting stroke on a fulcrum at the point of connection with the link 286, thus leaving the detent setter in its uppermost position corresponding to the idle position of the chain. On the other hand if the free end of the floating lever is blocked against movement on the active stroke, it becomes fulcrumed

at the free end, and the opposite end is positively actuated to rock the shaft 277 and thereby shift the detent setter to its lowermost position corresponding to the running position of the chain in which position it is held by the magnetic set device 281.

In order that the advance of the chain may be interrupted with any link thereof opposite the transmitter control point, a return cam 288 (Figs. 45 and 46) is provided which operates in a manner similar to the return cam 206, 207 of the recorder and previously described. The follower 289 of the cam has an arm 290 (Figs. 41, 45 and 58) connected by a link 291 to a crank arm 292 on shaft 293 which carries a second arm 294 connected to one end of a link 295. The other end of the link 295 has a pin-and-slot connection (best shown in Fig. 58) with an arm 296 fast on the rock shaft 277, this connection permitting of the required independent movement between the floating lever supporting rod and the return cam follower 289.

On the active stroke of the follower 289 which takes place during a portion of the idle stroke of the floating lever, the rock shaft 277 is oscillated to raise the detent setter 272 (see Fig. 46), thereby moving the arm 280 away from one of the poles of the set device 281 and against the other pole, in which position the detent-setter is held until the floating lever FL9 is again blocked on its active stroke. If the floating lever is not blocked in its next active stroke, the eccentric 273 will, on its next movement toward the detent, move the detent-setter against the lower arm 276 (Fig. 45) of the detent, the latter causing the disk 267 to be locked and the disk 268 to be freed, thereby interrupting the chain drive.

Because the detent setter 272 is moved upwardly during the idle stroke of the floating lever rod 282, the lower finger 297 of the setter is made yieldable to avoid injury in the case of interference.

For the purpose of blocking the floating lever FL9 in its control of the detent setter, a latch L9 is provided (Figs. 41 and 45). This latch is pivoted intermediate its ends on an axis lying within the path of movement of the lever on its active stroke. A spring 298 acting on a tailpiece 299 of the latch normally urges the free end of the latch into blocking relation to the lever. The position of the latch L9 is adapted to be controlled by a finger 300 underlying the latch and fast on a rock shaft 301.

One of two means for controlling the position of the latch L9 comprises a cam 302 (Fig. 45) fast on the J-cam shaft. A follower in the form of a bell crank 303 has one arm held by a spring 304 against the peripheral surface of the cam, and the other arm is connected by a link 305 to a crank arm 306 on the rock shaft 301 which carries the latch control finger 300. The cam is shaped so that in the approach of the J-cam shaft to its No. 1 rest position the shaft 301 carrying the latch control finger is rocked in a direction to permit the latch to move into blocking position with respect to the floating lever, and unless the latch is otherwise prevented from entering by means to be presently described, the detent setter will be shifted downwardly and thus start the advance of the chain.

In the movement of the J-cam shaft from its No. 1 to its No. 2 rest position, said cam 302 withdraws the latch L9 to stop the chain advance pending the selection of the succeeding path of transmission. The chain advance is again started

in the movement of the J-cam shaft to its No. 3 rest position, this being accomplished by the entry of the latch into blocking position as permitted by the cam 302. In the movement of the cam shaft through the latter part of the message cycle, that is from its No. 3 to its No. 1 position, the cam operates to withdraw the latch from blocking position to stop the chain.

Storage indicator.—In the present system the supply of message matter may at times become completely exhausted from the storage medium due to the fact that the receiver at any relay unit being operated intermittently may fail to supply message matter in quantities sufficient to meet the full operating capacity of the transmitter. It is, therefore, desirable that when such a condition occurs the transmitter be stopped to avoid running the storage chain continuously. Moreover when message matter again comes into storage it is necessary to start the chain so as to run out the blank links preceding such message matter, and thereby advance such message to the point of control in the case of the transmitter loop. Such stopping and starting of the chain is controlled by the storage indicator, which operates to control the latch L9 and constitutes the other means above referred to for controlling this latch.

The storage indicator is therefore a presence-of-message detector serving to indicate whether or not a message or any part thereof as represented by non-blank chain links is in storage; and it constitutes an auxiliary control means for initiating the advance of the chain whereby the latter becomes a primary control means for the cycling mechanism.

To accomplish this result, the indicator is controlled both from the receiver and from the transmitter, being differentially driven from such mechanisms. Generally stated, it herein includes a part arranged to move in one direction when message matter is being recorded, thereby counting and adding the signals coming into storage; to move in the opposite direction when message matter is being transmitted, thereby counting and subtracting the signals going out of storage; and remaining stationary when both the receiver and transmitter are operating at the same speed.

Referring now to Fig. 4 of the drawings, the storage indicator is located at the left hand end of the relay unit. It comprises a threaded shaft 307 (partially shown to the extreme left in Fig. 45) rotated in one direction by a connection with the recorder and in the opposite direction by a connection with the transmitter. On the shaft is mounted an internally threaded member 308 having a depending portion 309 (Fig. 47) slidable in a stationary guide 310.

The member 308 hereinafter termed the storage indicator traveller is moved toward the left in Fig. 45 by the receiver drive alone, and is moved to the right by the transmitter drive alone. When no message matter is in storage, that is when all of the links of the chain between the receiver and the transmitter of the relay unit are blank, the storage indicator traveller is in what may be termed zero position (Fig. 4), at the extreme right of the shaft as viewed in Fig. 45.

When message matter is received into storage the traveller moves away from its zero position. In moving into zero position it engages an arm 311 loose on the shaft 307 and moves the same axially against the action of a spring 312 into the path of a pin 313 on a second arm 314. The

latter is fast on the shaft 307 so as to rotate therewith, and its pin in striking the arm 311 moves it upwardly against the action of a spring 315 (Fig. 47) operating through a vertically guided plate 316 pivotally connected with the arm 311. The arrangement is such that the pin of the arm 314 just clears the loose arm 311 when the latter is held away by the action of the spring 312, but in one revolution of the shaft the traveller is adapted to move a sufficient distance to move the loose arm against its spring well into the path of rotation of the pin on the rigid arm 314.

In this connection, in one revolution of the indicator shaft the traveller moves through a distance equivalent to forty link cycles, in which forty successive links are presented to the point of control. Accordingly while the traveller moves only a very short distance in each link cycle, during forty link cycles or in one complete revolution of the shaft, the traveller moves a substantial distance amply sufficient to effect the desired overlapping of the loose arm with the pin on the rigid arm. When the loose arm is thus moved by the engagement of the pin therewith, a cam surface 317 thereon moves the roller on a follower arm 318 fast on one end of a rock shaft 319. Said rock shaft 319 has as its other end a crank arm 320 connected by means of a link 321 with a crank arm 322 fast on the rock shaft 301 which carries the latch control finger 300.

It will be apparent that although the traveller moves only a very short distance axially for each signal passing out of storage, it renders effective the rotating arm 314 so that in the running out of the last signal combination in storage said arm moves the loose arm 311 through a substantial distance, sufficient to withdraw the latch control finger 300 and thus stop the chain. Thus the chain remains stationary until another message comes into storage through the receiver, whereupon the receiver drive for the storage indicator operates to rotate the indicator shaft in the opposite direction.

In the movement of the shaft corresponding to the passage of the first signal combination into storage, the arm 311 is permitted to move under the action of its spring 315 into the position shown in Fig. 45, and thus the latch control finger to be lowered by the spring 304. At this time the J-cam shaft will be in its No. 1 rest position so that the cam 302 thereon will permit the latch L9 to move into blocking relation to the floating lever FL9 to start the chain advance.

It will be observed that the storage indicator is thus sufficiently sensitive to respond to the passage of the last signal combination out of storage and to the arrival of the first combination of the next message to be received. Yet its traveller has only a relatively short range of axial movement which corresponds to the 3000 link capacity of the storage section of each relay unit.

The means for driving the storage indicator shaft differentially from the receiver and the transmitter of the relay unit comprises a spur gear differential 323 (Figs. 4 and 45) the two terminal gears 324 and 325 of which are respectively rigid with a shaft 326, driven from the transmitter, and a bevel gear 327 loose on said shaft and driven from the receiver, said shaft 326 being suitably journaled in the frame in axial alignment with the storage indicator shaft. The intermediate member of the differential is in the form of a bracket arm 328 fast on the indicator shaft 307. Said bracket arm carries a pair of intermeshing pinions 329 meshing respectively

with the terminal gears 324 and 325 of the differential.

Referring first to the driving connection between the spur gear differential 323 and the receiver, the bevel gear 327 meshes with a similar gear on a horizontally disposed shaft 330 and the latter in turn is connected by bevel gearing 331 (Figs. 4, 27 and 37) to a shaft 332 axially aligned with the chain drive sprocket shaft 176 of the receiver loop. The shaft 332 must be driven from the receiver only when message matter is being recorded on the chain in the receiver loop and to this end a spur gear differential clutch 333 is provided, the direction of drive being such as to cause movement of the storage indicator traveller away from zero position.

The intermediate or drive member of this clutch is in the form of a spur gear 334 constantly driven through the medium of a pinion 335 (Fig. 27) fast on the constantly driven shaft 172 of the relay unit (Fig. 27). Mounted on this gear are a pair of intermeshing pinions 336 (Fig. 37), meshing respectively with two terminal gears 337 and 338, the former rigid with the shaft 332 and the latter rigid with a sleeve 339 on the shaft, the two terminal gears being in turn respectively rigid with notched disks 340 and 341 arranged to be locked selectively by a detent 342 having associated therewith a detent setter 343 adapted to be oscillated by the constantly driven shaft 161 through the medium of an eccentric 348.

The detent setter 343 is arranged to be operated under the control of the pin pushers 154 of the recorder, and to this end is connected by means of link 344 to a crank arm 345 on the rock shaft 194. An arm 346 rigid with the rock shaft 194 constitutes the armature of a two-position magnetic set device 347 which operates to hold the detent setter yieldably in either of its two vertical positions. The detent setter 343 may be shifted upwardly by the pin pushers 154 and downwardly by the action of the return cam 207, but by reason of the one way connection 195 (Fig. 37), the detent setter cannot be shifted by rocking of the shaft 191 under the control of the latch L6. In this way, the storage indicator is driven from the recorder so as to count only the signals going into storage which represent the directing and body portion of the message.

Referring to Figs. 48 and 45, the shaft 326 of the spur gear differential 323 is driven through the medium of a spur gear differential clutch 349 whose intermediate member is in the form of a spur gear 350 constantly driven by a pinion 351 (Fig. 40) on the drive shaft 236. The spur gear 350 carries two intermeshing pinions 352 (Fig. 48) which mesh respectively with the terminal gears 353 and 354 connected respectively through the shaft 326 and a sleeve 355 thereon to two notched disks 356 and 357, and the two disks are adapted to be locked selectively by a detent 358 controlled by a detent setter 359 actuated by an eccentric 360 on the shaft 274.

A floating lever type of actuator is provided for shifting the detent setter downward to cause the clutch 349 to drive the shaft 326. This actuator comprises a floating lever FL8 (Figs. 48 and 49) mounted on the constantly oscillating rod 282 which carries the floating lever FL9. One end of this floating lever is connected through the medium of a link 361 and a crank arm 362 to a rock shaft 363 (Figs. 41 and 48) on which is fast a second crank member 364 from which the detent setter 359 is suspended by a link 365. An arm 366 rigid with the crank member 364 forms the arma-

ture of a two-position magnetic set device 367 for holding the detent setter in either of its vertical positions corresponding to the running and idle positions of the shaft 326.

To block the free end of the floating lever FL8 and thus cause the detent setter to be shifted downwardly on the active stroke of the lever, a latch L8 (Fig. 48) is employed. This latch is of the same construction as, and is mounted in a manner similar to the latch L9, being normally urged into blocking relation to the floating lever by a spring 368. Also the entry of the latch into blocking position is controlled in a manner similar to the latch L9 by a finger 369 fast on a rock shaft 370.

The rock shaft 370 carries a crank arm 371 connected by a link 372 and a crank arm 373 to a rock shaft 374 carrying a follower 375 urged by a spring 376 against a cam 377 on the J-cam shaft. This cam is positioned to rock the shaft 374 so as to lower the latch control finger 369 and permit the entry of the latch L8 under the action of its spring 368 into blocking position during the movement of the J-cam shaft from its No. 2 to its No. 3 rest position.

For reasons which will later appear, such entry of the latch L8 takes place one link cycle later than the entry of the latch L9 as above described in the same movement of the cam shaft, the transmitter drive for the storage indicator being thereby started one link cycle later than the drive for the chain in the transmitter loop. Also in the movement of the J-cam shaft from the No. 3 rest position, the cam 377 operates to withdraw the latch L8 at the same time that the cam 302 withdraws the latch L9, the shaft 326 and the chain drive sprockets being thereby stopped simultaneously.

The detent setter 359 is returned to its uppermost position against the action of the magnetic set device by movement of the rock shaft 293 which as above described is constantly oscillated by the cam device 288. Such returning of the detent setter occurs during the inactive movement of the floating lever FL8, and to this end the rock shaft 293 carries a crank arm 378 connected by a link 379 having a pin-and-slot connection (Fig. 48) with a crank arm 380 fast on the rock shaft 363. The slot in the link is provided to permit the detent setter to be shifted downwardly by the floating lever FL8 independently of the cam actuated return means for the detent setter.

Chain feeler.—Inasmuch as the present system contemplates the transmission of a message in successive stages with storage thereof at one or more intermediate points pending automatic selection of the succeeding transmission path, the message itself is utilized to initiate and terminate the message cycle above referred to. Accordingly a device is provided located in advance of the transmitter control point, which operates in the advance of the chain to detect in one instance the presence on the storage medium of signal combinations representing the address and body of the message approaching the control point, and in another instance one or more signal combinations representing the end of that message. Such device in the present embodiment operates to feel for pushed pins in the chain in advance of the control point, and is operated in advance of their presentation to the control point. It is moved in one direction when the message is approaching the control point to initiate a message cycle by releasing the No. 1 detent of the message

cycling mechanism and in another direction when the end of the message is approaching such point to terminate the message cycle by releasing the No. 3 detent of said mechanism.

Referring now to Figs. 40, 48 and 51 to 54, the feeler device CF2 is substantially identical in structure to the chain feeler CF1 employed in connection with the recorder, and is located within the transmitter loop for association with chain pins on the inner side of that portion of the transmitter loop which is guided for vertical movement. As in the case of said feeler CF1, each shoe 381 is adapted for cooperation with the pushed pins of not more than two successive links of the chain. Such relation is shown diagrammatically in Fig. 54, wherein the positions of the pins of four successive links are indicated by the numerals 1 to 4, the path of movement of one longitudinal row of pins being indicated by a broken vertical line.

The feeler shoes are continuously urged into the path of movement of the chain pins by means of a spring 382, and upon the advance beyond the No. 1 position of a link having one or more pushed pins thereon, the feeler will be cammed by such pins in their movement, into its outward position (Figs. 53 and 54).

The movement of the feeler from its inward to its outward position, due to the approach toward the control point of the first directing signal combination of a message, is utilized to withdraw the No. 1 detent of the message cycling mechanism so as to start the J-cam shaft on the first step of its movement and thereby initiate the message cycle. This is accomplished by power means of the floating lever type, controlled by the feeler, and comprising a lever FL10 (Fig. 52) pivoted between its ends, on the constantly oscillating rod 282 between the floating levers FL8 and FL9. One end of said lever is pivotally connected by a link 383 to a crank on a rock shaft 384, the latter being operatively connected by means including a link 385 to the rock shaft 251 which carries the No. 1 detent. The free end of the floating lever is arranged to be controlled by a latch L10 constructed and mounted similar to the latches L8 and L9 previously described, and normally urged into blocking position by a spring 386. To withdraw the latch from blocking position a control finger 387 has a tailpiece interengaging with an arm 388 on a rock shaft 389 connected by means including a link 390 to a vertical rock shaft 391. The latter is mounted adjacent one edge of the transmitter loop and is connected by means of a crank 392 with the feeler CF2 so as to rock in the reciprocation thereof.

It will be seen that when the pins of the link representing the first directing signal combination of the message move into engagement with the feeler shoes, the outward movement thereof will cause the control finger 387 to be lowered, thereby allowing the latch L10 to move into position to hold the floating lever FL10. Then on the next advancing stroke of the floating lever the shaft 251 will be rocked against the action of a spring 393 to withdraw the No. 1 detent, thereby allowing the J-clutch dog 242 to engage with the constantly rotating toothed wheel 241 so as to start the cam shaft on its movement from its No. 1 to its No. 2 position in the first step of the message cycle.

In order to avoid unnecessary movement of the No. 1 detent and the parts associated therewith by the floating lever, a cam 394 (Fig. 52) is provided on the J-cam shaft operating on a pivoted

follower 395 which is connected to the shaft 251 by a link 396 and bell crank 397 to one arm of which the link 385 is connected. The cam is shaped so as to permit the entry of the No. 1 detent into the path of the J-clutch dog only during a small angular movement of the J-cam shaft in approaching and leaving the No. 1 rest position.

As the end of a message being transmitted approaches the control point in the transmitter loop, the chain feeler CF2 is permitted to move under the action of its spring from its outward to its inward position as above set forth; and this movement is utilized to initiate the third and final step of the message cycle by the withdrawal of the No. 3 detent from blocking relation to the clutch dog 242.

In the present instance such withdrawal of the detent is accomplished by means controlled by the feeler CF2 and deriving power from the crank member 364, which as above set forth is continuously operated by the combined action of the cam device 288 and the floating lever FL8 when the latter is blocked by the latch L8, as is the case when the J-cam shaft is in its No. 3 or running position. This means (Figs. 48 to 51) comprises a bell crank 398 loose on the rock shaft 363 and having one arm connected by means of a link 399 and a crank 400 to the rock shaft 259 on which the No. 3 detent 250 is fast. On the other arm of said bell crank 398 is pivotally mounted a pawl 401 which is connected by means of a link 402 and a universal coupling 403 to the feeler rock shaft 391.

When the feeler is in its outward position the pawl 401 occupies a position out of the path of movement of a lug 404 (Fig. 49) on the oscillating crank member 364; and when the feeler, in response to an end-of-message signal, moves into its inward position, said pawl 401 moves into the path of the lug 404 (Fig. 50). Accordingly on the next stroke of the member 364, due to the blocking of the lever FL8, the bell crank 398 is rocked and with it the rock shaft 259, the latter in a direction to withdraw the No. 3 detent. For a reason which will later appear, the detent is temporarily held in such withdrawn position by the action of a two-position magnetic set device 405 (Fig. 48) acting on an arm 406 fast on the rock shaft 259.

To restore the detent into its blocking position relative to the clutch dog 242, a cam 407 is provided on the J-cam shaft, which acts through a follower 408 connected by a link 409 and a crank 410 to the rock shaft 259. Said cam is shaped to rock the shaft 259 against the action of the magnetic set device 405, in a direction to move the detent into blocking position shortly after the cam shaft leaves its No. 3 rest position, and then to free the cam follower to permit withdrawal of the detent before the cam shaft again arrives at its No. 3 rest position.

Line selector.—It is the function of this mechanism to select the paths over which the successive messages coming into storage in any relay unit are to be transmitted, the selection in any case being determined by the directing portion of the message and preferably upon the presentation of the first directing signal combination to the control point of the transmitter loop.

In the present embodiment, the line-selector is actuated by the cycling mechanism in the movement of the J-cam shaft from its No. 1 to its No. 2 rest position during the initial part of which the chain is stopped as above described with the

first directing signal opposite the control point of the transmitter loop. In this position the pins of the first link set the elements of a selective feeler in a combination corresponding to the directing signal and control the setting of the elements of a transfer device, which in turn governs the operation of a code bar selecting unit by which the transmission path leading to a particular one of a plurality of remote receivers is selected.

Referring to Figs. 41, 53 to 55 and 58, the selective feeler is located externally of the transmitter loop 7 and comprises five individually movable elements 411, hereinafter called transfinders, there being one for each row of pins in the chain. Said transfinders comprise L-shaped portions pivotally mounted between vertically spaced plates 412 so as to swing on closely spaced vertical axes. Each transfinder carries a shoe 413 with oppositely inclined leading and trailing cam surfaces 414 and 415 intersecting at the control point (Fig. 54). A spring 416 normally urges each finger in a direction to position its shoe in the path of movement of its corresponding row of chain pins.

When a pushed pin in this row approaches the control point, it engages with the leading surface 414 of the shoe, thereby camming the shoe out of the path of movement of the pin into the full line position shown in Fig. 54. Thus the transfinders are selectively operated in accordance with the setting of the pins in the chain as shown, for example, in Fig. 53 wherein the chain pins bear a signal combination in which two of the five pins are pushed. The pushed pins, it will be observed, do not engage their respective shoes and, therefore, the corresponding transfinders remain unmoved. Such selective setting of the transfinders is utilized for control purposes through the medium of tailpieces 417 rigid with the L-shaped portions of the transfinders 411 and disposed opposite the shoes 413. The tailpieces are arranged in staggered relation to provide for a large range of movement notwithstanding the closely spaced relation of the transfinder axes.

The device for transferring the signal combination to the line-selecting unit is mounted for bodily movement toward and from the transfinder tailpieces, and has five individually movable elements 418 (Figs. 56 and 58) adapted to be set in accordance with the setting of the transfinders in a combination corresponding to the directing signal opposite the control point. These elements are operable to retain such combination during the operation of the selector mechanism, and in the present instance they are in the form of five dogs pivotally mounted on a carrier consisting of a pair of arms 419 fast on a rock shaft 420 and connected at their free ends by a rod 421 upon which the dogs are pivoted.

Each element has three radial arms 422, 423 and 424. The arms 422 are each pivotally connected to one end of a rod 425, the other end of which is slidable in a guide 426 (Fig. 58) for movement in a plane including an axis of one transfinder. As shown in Fig. 56, the ends of the rods adjacent the transfinders are arranged in staggered relation corresponding to the relation of the transfinder tailpieces 417. Thus, as shown in Fig. 53, the tailpieces when in non-shifted positions provide abutments for positively limiting the movements of the corresponding slide rods of the transfer device when the latter is moved toward the transfinders, the pressure of such en-

gagement being thus sustained by the pivotal supports for the transfingers.

Oscillation of the carrier to move the rods 425 toward and from the transfingers is effected by means of a double cam 427 fast on the J-cam shaft and acting through a double roller follower 428 on the rock shaft 420. Said cam 427 is shaped so that at a predetermined time in the movement of the J-cam shaft from its No. 1 to its No. 2 rest position, the carrier is moved in a direction to slide the rods 425 toward the transfinger tailpieces and the rods which correspond to the transfingers which have not been shifted are blocked thereby, while the other rods corresponding to the unpushed pins of the directing signal are permitted to move beyond the ends of the corresponding tailpieces.

Thus in the feeling stroke of the carrier, a movement of each rod corresponding to a pushed pin in the link bearing the directing signal is interrupted by its abutting engagement with the transfinger tailpiece, and as the carrier continues in such movement the corresponding dog is shifted out of normal position. Therefore, at the end of the feeling stroke, the dogs are set selectively in accordance with the combination set up on said link.

Each of the dogs 418 is held either in its normal or in its shifted position by means of a detent 429 (Fig. 58) mounted in a yoke 430 and urged by a spring 431 into engagement with the arm 423 of the dog at one side or the other of a centered position. The yokes 430 are mounted between the arms of the carrier, with spaced members therebetween.

During a short dwell in the feeling stroke of the transfer device by its swinging carrier, occurring during the early part of the message cycle, those dogs 418 which, in the preceding message cycle, were shifted out of their normal positions are returned or reset through the operation of a bail 432 (Figs. 56 to 58). Said bail is carried by a rock shaft 433 and overlies the arms 424 of the dogs. It is actuated by a cam 434 on the J-cam shaft operating through a spring pressed follower 435 so as to rock the shaft 433 in a direction to move the bail downwardly into engagement with the arms 424 of the previously shifted dogs. The latter are thus moved against the action of their yieldable detents 429 into normal position, as indicated by the position of the end dog shown in Fig. 56. When the dogs have thus been reset, the bail is immediately returned to its upper or inactive position (Fig. 58).

The selector unit, through the medium of which the succeeding transmission path is selected, comprises a series of five code bars 436 with which are associated a group of combination bars 437, one corresponding to each of a plurality of remote receivers, to any one of which the message may be transmitted. Said code bars are adapted to be set upon the return stroke of the dogs 418 in accordance with the combination which has been transferred thereto, and upon such setting of the code bars one of said combination bars is caused to move for the purpose of operating a switch means for partially establishing transmitting circuits leading to the selected remote receiver.

The code bars 436 (Figs. 40, 56 and 61) are, in the present instance, arranged in closely spaced parallel relation for endwise movement so as to be capable of occupying either of two different positions. Herein they are arranged to slide in guides 438 (Fig. 40) in a direction parallel with the axis of the J-cam shaft. Selective movement is im-

parted to the code bars in accordance with the combination recorded on the transfer dogs 418 through the medium of five extension bars 439 guided for individual endwise movement perpendicular to the code bars 436, bell cranks 440 being interposed between the several extension bars of the respective code bars, so that movement of the extension bars is transmitted to the code bars proper. The ends of the extension bars are positioned adjacent the transfer dogs 418 and together with the code bars proper are normally urged toward said dogs by individual springs 441 (Fig. 40) this movement being limited by shoulders 442 (Fig. 58) on the extension bars adapted to engage with a stop member 443.

As shown in Figs. 56 to 58, the ends of the extension bars 439 are positioned with respect to the arms 424 of the transfer dogs 418 so that when one or more of the dogs have been shifted under the control of the pushed pins of the directing signal, said arms 424 of the shifted dogs will, upon the return stroke of their carrier, engage and move the extension bars and thereby shift the code bars into their second position. On the other hand, the arms 424 of the transfer dogs which have not been shifted, as determined by the non-pushed pins of the directing signal will in such movement clear and pass the ends of their extension bars and the corresponding code bars will remain unmoved. The return movement of the shifted code bars takes place in the initial part of the next feeling stroke of the swinging carrier 419 which occurs in the succeeding message cycle.

It will be understood that since there are five code bars each capable of occupying either of two positions, they may be set in 31 different combinations by moving one or more of them out of normal position.

The combination bars, of which there are, in the present instance, 31 are mounted for endwise movement above and transversely of the code bars, and each is provided along its lower edge with wards 444 (Fig. 62) adapted to cooperate with notches 445 (Fig. 60) formed in the upper edges of the code bars. There are 31 notches in each of the code bars, arranged as shown in Fig. 60, so that in the shifting of any one or more of the code bars to form one of 31 possible combinations, certain of the notches of the code bars form a transverse groove in which all of the wards of one of the combination bars may move.

Movement of the combination bar thus selected by the setting of the code bars occurs in two steps in the same direction under the control of the message cycling mechanism. The first step serves to establish a testing circuit for the purpose of determining whether or not the receiver to which the message is to be transmitted is available, and the second step serves to establish circuits for the actual transmission of the message when the receiver becomes available, the establishment of the transmission circuits being delayed to enable the used directing signal combination to be discarded as will later be set forth more fully.

The two-step movement of the combination bars referred to is controlled by means of a fluted rock shaft 446 (Figs. 62 and 63) extending transversely of the combination bars and cooperating therewith. Rigid with the individual combination bars are notched bars 447 of insulating material and each having a shoulder 448 in its lower edge normally urged by an individual spring 449 against a shoulder on the fluted shaft 446. The selected combination bar is permitted to move in

its transverse groove formed in the code bars by a rocking of the shaft 446 through the action of a cam 450 on the J-cam shaft and a spring pressed follower 450' rigid with the rock shaft 446.

When the J-cam shaft is in its No. 1 rest position, the cam 450 operates through the follower and fluted shaft to hold the combination bars with their wards 444 disposed centrally between the code bars (Fig. 62), and the cam is shaped to permit the first step of movement of the combination bar into the position shown in Fig. 63 upon the movement of the J-cam shaft from its No. 1 to its No. 2 rest position, such movement being timed with respect to the setting of the code bars so as to follow immediately thereafter.

Rocking of the shaft 446 to permit the second step of movement of the selected combination bar occurs during the initiation of transmission of the message cycle, that is say in the movement of the J-cam shaft from its No. 2 to its No. 3 rest position. The timing is such that this movement of the combination bar follows the movement of the first used directing signal past the transmitter control point, and precedes the presentation of the next signal to the control point. As the J-cam shaft approaches the No. 1 rest position, the cam 450 rocks the fluted shaft 446 reversely to restore the selected combination bar to its normal position whereupon all of the switches controlled by said bar are opened.

The movement of the combination bar selected under the control of the directing signal is utilized to establish a path for the transmission of the message to a particular remote receiver by partially completing electric circuits leading thereto, whereas actual transmission of the message over the path thus selected is controlled in the movement past the transmitter control point of the non-blank links which represent the message and any unused directing signals. In view of the simultaneous character of the transmission herein employed, each transmission path consists of five separate circuits, one for each unit of the signal combination, and each circuit therefore is provided with one control switch by which the partial completion of the circuit is established and one switch for controlling transmission thereafter.

Referring to Figs. 61 to 63, the switching means employed in selectively establishing connections with remote receivers may comprise 31 sets of five switches 451, one set for each combination bar, not all of the combination bars being herein shown. Each of such selector switches comprises a yieldable arm 452 tending to move into engagement with a stationary contact on a plate 543. Each plate constitutes a common terminal for the corresponding switches 451 of the 31 different sets respectively controlled by the combination bars 437. Normally however, that is when the combination bars 437 are in retracted position (Fig. 62), the yieldable contact arms of each set of switches 451 are held out of engagement with their respective stationary contact plates 543 by engagement with shoulders on the insulated bar 447 of the corresponding combination bar, and the arrangement is such that in the second step of the movement of any one combination bar under the control of the J-cam shaft as above described, the several switches 451 will be closed.

In this same movement of each combination bar, another similarly constructed switch 454 is closed, this switch forming a part of a mechanism to be later described under the heading

"Loop indicator—full storage control." In addition another and similar switch 455 is provided for operation by each combination bar, this switch forming part of the circuit testing mechanism which determines whether the selected transmission path is available. The switches 454 and 455, actuated by the different combination bars, have common terminal plates 456 and 457 respectively. In the case of the switch 455 the contact members are spaced somewhat more closely together than in the case of the other switches so as to be closed in the first step of movement of the combination bar for a reason which will hereinafter more fully appear.

Transmitter.—The switches for effecting transmission of the message under the control of the chain are operated selectively by means of the transfinders 411 which, it will be remembered, are also utilized to control the operation of the selector mechanism. Thus, referring to Figs. 53 and 54, these switches are designated generally by the numeral 458, the movable contact of each switch being carried by the tailpiece of one of the transfinders so that the tailpiece 417 constitutes the grounded contact arm. The stationary contact of each transmission switch is carried by a bracket arm 459 mounted in the insulating block 426, the several brackets providing terminals 460 which are connected respectively by conductors 461 to the switch terminal plates 453 (Figs. 53 and 61).

The five transmission switches tend to assume a closed position under the action of the springs 416 of the transfinders, and when the shoe of the transfinder corresponding to the non-pushed pins are cammed outwardly by the latter, the corresponding switches are opened. Conversely, when a pushed pin passes the control point, the switch 458 controlled by the corresponding transfinder remains closed. By this arrangement electric impulses are sent over the selected transmission path only under the control of the pushed pins, it being remembered that at the receiver the setting of pins in the chain is controlled by the energization of magnets 156. Moreover, it should be noted that the transfinder shoes are so shaped that the engagement of successive non-pushed pins therewith prevents the tailpieces from moving far enough to close the corresponding transmission switches, thus preventing the sending of impulses between successive non-pushed pins.

Cam relationships.—In Fig. 73, a J-cam shaft is shown schematically in its No. 1 rest position, the various cams thereon being illustrated in the positions which they occupy relative to each other. Each of the cams is shown in elevation so that the contour thereof becomes more readily apparent, as does also the location of their respective followers.

Transmission circuits in detail

The circuits diagrammed in Fig. 64 illustrate the manner in which each group of selector switches 451 closed in the operation of the line-selector of any relay unit, and the transmitting switches 458, may be utilized in the selective establishment of and the transmission of message matter over the circuits constituting a simultaneous transmission path between one relay unit A (Figs. 1 and 64) and one of the units B with which it is associated.

For simplicity of illustration, only three sets of simultaneous transmission paths are shown in Fig. 64, by which the transmitters of the relay units A1, A2 and A3 may send signal impulses to

any one of the receivers of three relay units B1, B2 and B3, it being understood that when five-unit directing signals are employed for purposes of selection, 31 different combinations (not including the blank) are available for use so that the number of combination bars and the circuits established in the movement thereof may be increased to include the transfer of a message from any one of a group of transmitting relay units to any one of 31 receiving relay units.

Each of the five circuits, constituting any one transmission path, includes in series relation a source of electrical current such as a battery 462, the winding of one magnet 156 at one of the receiving relay units, one of the five selector switches 451 which are arranged for actuation by a predetermined combination bar of the line-selector associated with the transmitting relay unit, and one of the transmitting switches 458.

In the present instance, the battery is common to all of the individual transmission circuits between the relay units A and B. Thus one terminal of the battery is connected by a conductor 463 to one side of all the receiving magnets 156 of the relay units B, and the other battery terminal is connected by a ground conductor 464 to the grounded contacts of the transmitting switches 458 for all of the relay units A. As above set forth, the other contacts of the five transmitting switches at each transmitter are connected respectively by conductors 461 to the five plates 453 (Fig. 61) each of which is common to one terminal contact of one selector switch 451 in each of the 31 sets of such switches which sets are actuated selectively by movement of the different combination bars 437.

Each combination bar is thus adapted to operate five selector switches 451, one in each of five groups of such switches at each relay unit. Each group therefore contains one switch for each combination bar and where 31 combination bars are employed, each group would contain 31 selector switches. In the present instance only three of these switches are shown in each group in Fig. 64, since this diagram is only intended to show the circuits for three transmitting and receiving relay units. For convenience in identification of the different selector switches 451 in each of the groups, those switches at the relay units A1, A2 and A3 which are controlled by corresponding combination bars to establish paths leading to the relay unit B1 are designated by the letter *a* while the switches 451 closed by other combination bars to establish circuits through the relay units B2 and B3 are indicated by the letters *b* and *c* respectively.

The movable contacts of the five selector switches *a* in the case of the unit A1, are connected by insulated conductors 465 (Figs. 61 and 64) to the respective magnets 156 of the unit B1. In like manner, selector switches *b* and *c* of the relay units A2 and A3 are directly connected to the magnets of the units B2 and B3 by conductors 466 and 467 respectively.

To minimize wiring costs in the selective establishment of a transmission path between the units A2 and A3 and the unit B1, five cross conductors 468 are connected respectively to the conductors 465 of the unit A1, and each cross conductor is connected by conductors 469 to a selector switch *a* at the unit A2 and by conductors 470 to the selector switch *a* at the unit A3. In a similar manner the five switches *b* at the units A1 and A3 are connected respectively

by conductors 471 and 472 to five cross conductors 473 which are connected respectively to the conductors 466 leading to the unit B2. Likewise the selector switches *c* at the units A1 and A2 are connected respectively by conductors 474 and 475 to cross conductors 476, the latter being connected to conductors 467 leading to the unit B3.

With the arrangement just described, nine transmission paths, of five circuits or channels each, are formed, there being a group of three paths leading from the transmitter of each relay unit A1, A2 and A3 to the receivers of the units B1, B2 and B3 respectively. All three paths in each group are controlled by five transmitting switches 458 while the selection of individual paths leading to the units B1, B2 and B3 is controlled respectively by the switches *a*, *b* and *c*. Thus, by closure at any of the relay units A of a predetermined set of five selector switches *a*, *b* or *c* by movement of the corresponding combination bar of the selector mechanism at such unit, five parallel transmission circuits will be partially established through the magnets 156 at the corresponding receiving relay unit. For example, to send a message to the relay unit B2 from the unit A1, the path shown in heavy outline in Figs. 1 and 64 would be seized by closure of the five selector switches *b* at the unit A1, each of the five circuits in such path including the conductors 471, 473 and 466 (Fig. 64). Actual transmission of the message could then be effected by the selective operation of the transmitting switches 458 of the unit A1 in the movement of the storage chain past the transmitter control point thereof.

A similar arrangement of simultaneous transmission circuits is contemplated between one group of relay units B and a group of units C (Fig. 1) except that each group of circuits is available for use by one only of the transmitting relay units B. The circuits would however be arranged in exactly the same manner as between the units A and B when the units B1, B4 and B7 are considered as the group of transmitting units and the units C1 to C4 are taken as the receiving units. In other words, any one of the units B1, B4 and B7 may select and transmit message matter to any one of the units C1 to C4.

Testing circuits

These circuits are provided for the purpose of ascertaining whether the transmission path selected in the operation of the line-selector of any relay unit where a message is awaiting transmission is "busy," or whether it is available for use in transmitting the stored message to its next destination or storage point. In other words these circuits operate to determine whether or not the receiver of any one of the relay units B selected by one of the relay units A is connected to and being used by any other one of the relay units A.

The condition of availability of a selected receiving relay unit is, in the present instance, evidenced by the energization to a certain degree of the busy test magnet 253 of the transmission relay unit which made the selection. Such energization, it will be remembered, controls the release of the J-cam shaft of the transmitting relay unit for movement to its No. 3 position in the second step of the message cycle during which actual transmission of the message matter is initiated.

Referring now to Fig. 64, there are a plurality

of circuits for separately testing the transmission paths leading from a transmitting relay unit to the different receiving relay units with which the transmitting unit is associated, the individual testing circuits being rendered operative for testing purposes in the operation of the selector of the transmitting relay unit. To this end, the circuits at each of the relay units A1, A2 and A3 for testing the condition of the relay units B1, B2 and B3 respectively are arranged in parallel relation and include the busy test switches 455^a, 455^b and 455^c respectively, which, it will be remembered, are closed in the initial step of movement of the corresponding combination bars 437 of each relay unit. Said switches of each relay unit A are connected by separate conductors 477, 478 and 479 respectively to one terminal of the battery 462, each through a separate ballast resistance 480 which may be adjusted as desired.

All of the busy test switches 455^a, 455^b and 455^c, etc. at any one of a group of transmitting relay units A have a common terminal plate 457 which is connected by a conductor 481 to one terminal end of the winding 253 of the busy test magnet at such unit. The other winding terminal of the busy test magnets of the relay units A are connected respectively by conductors 482, 483 and 484 to different contacts forming part of a constantly operating switch mechanism hereinafter called the "time assignor" and shown diagrammatically in Fig. 64 and in detail in Figs. 65 and 66.

The time assignor functions to allot definite time intervals to the busy test circuits of the different transmitting relay units which are capable of transmitting to a particular remote receiver so as to prevent attempted seizure of the same transmission path simultaneously by two or more line selectors whose busy test contact switches may be closed simultaneously. There is thus a time assignor common to all of the busy test circuits of the relay units which may be adapted to transmit to a particular remote unit.

Each time assignor comprises a series of circumferentially spaced switches 485 (there being twenty such switches shown in Fig. 65). One contact of each of these switches is common to a conductor 486 leading to the battery 462 through the conductor 464. Herein the common contacts are yieldably supported on the ends of spring arms 487 secured in spaced relation about the periphery of a drum 488. The other or stationary contacts of the several switches are mounted on the periphery of a disk 489 of insulating material, adjacent the yieldable contacts, and the free ends of the contact arms 487 are disposed opposite the outer ends of individual pins 490 radially disposed and having followers 491 pressed by individual springs 492 into engagement with the peripheral surface of a cam 493. The latter is fast on a shaft 494 continuously driven at a predetermined constant speed as by means of a small synchronous motor 495 geared to the shaft. In its rotation the cam operates upon the pin followers successively.

As shown in Fig. 65, the cam 493 has a relatively short depression 496 such that normally all of the pins except one are held outwardly against the action of their springs and their corresponding contacts are broken. Accordingly the switches are successively closed in the rotation of the cam and they remain closed for one link cycle.

The closing operation is timed so as to occur in each instance at a predetermined time in any

link cycle. Herein, it is made to occur at the time that the busy test switches 485 may be closed by the combination bars for the several units of the group with which the time assignor is associated. This insures that in the case of any one unit whose busy test circuit is closed by the movement of the combination bar, the closure of the corresponding time assignor switch will occur at such time as to allow for the release of the J-cam shaft at the proper point in the link cycle through the operation of the relief finger 252 and busy test armature 249.

From the foregoing it will be observed that the busy test circuits for any transmitting relay unit are arranged in parallel relation between the battery terminals, and that each includes in series relation the busy test magnet of one relay unit, a busy test switch 455, a time assignor contact switch 485, and a resistance element 480. The busy test switches 455^a, 455^b and 455^c correspond to the respective relay units B1, B2 and B3 or the transmission paths leading thereto, and are arranged in parallel between the battery and the magnet 253 of a particular transmitting relay unit.

Each circuit through one of the busy test magnets is therefore under the joint control of its time assignor switch and one of the busy test switches 455^a, 455^b and 455^c, the latter being operated selectively as above described by the different combination bars of the relay unit. Thus to establish a circuit through a busy test magnet, the corresponding time assignor switch and also one of the switches 455 in series therewith must both be in closed positions simultaneously.

It will also be observed that the testing circuits for the different transmitting relay units A for testing any one receiving relay unit B include a common resistance element 480 and parallel branch portions having interposed therein the switches 455, the busy test magnets of different relay units A, and different contact switches of the time assignor. Because of the inclusion of different time assignor switches in the different branches, the time assignor effectually prevents more than one transmitting relay unit at a time from testing and therefore attempting to seize a path leading to the same receiving unit.

In addition to the control by the combined closure of a busy test switch and time assignor switch, the effective energization of the busy test magnet in any of the testing circuits is governed by the condition of testing circuits of the associated relay units in order that two transmitting units cannot, at the same time, seize transmission paths leading to the same receiving relay unit. To this end, means is associated with each busy test magnet for preventing effective energization of more than one of the magnets in the group of parallel testing circuits controlling the seizure of a transmission path leading to any one relay unit.

This means comprises generally a branch conductor rendered operative upon the energization to a predetermined degree of its associated busy test magnet and operable to close a circuit to an additional low resistance winding on that magnet, thereby maintaining, so long as the seized path is in use, a locking circuit of such low resistance as to prevent effective energization of any other busy test magnet in parallel therewith. As shown in Fig. 64 the branch conductor for each testing circuit includes for this pur-

pose, an auxiliary winding 497 concentric with the winding of the busy test magnet and having a resistance approximately one-tenth as high as that of the high resistance winding 253. The low resistance winding is connected at one end to the conductor 481 and at the other end to a binding post 498 (Fig. 42) cooperating with the armature 249 of the busy test magnet to form a switch 499. The armature closes this switch 499 upon the effectual energization of the high resistance winding 235 in the seizure of the selected transmission path, the switch being held closed by the flow of current through the winding 497. A holding circuit is thus established which continues to draw current from the battery until broken by opening of the busy test switch 455 in the approach of the J-cam shaft to its No. 1 rest position, as above set forth.

The battery potential, the tension of the individual springs 254 controlling the busy test magnet armatures for any group of relay units, and the resistance of the ballast element 480 and the relative resistances in the high and low resistance windings 253 and 497 of the associated busy test circuits are so coordinated that when the locking circuit around any busy test magnet is closed, the auxiliary winding 497 therein will, due to its low resistance, prevent the busy test winding in the testing circuit of any other relay unit from being energized to the degree required for movement of its armature against the spring acting thereon.

In the present instance, the resistance of the ballast element 480 is such that the voltage between the conductor 464 and one of the conductors 477, 478 or 479 is approximately one-sixth as great when one of the low resistance windings 497 is energized as when one of the high resistance windings 253 is energized. Therefore, when the locking circuit of any relay unit A is closed, the potential across any high resistance winding 253 in parallel therewith is so low that the current which flows through said winding when the circuit therethrough is closed will be insufficient to cause movement of the busy test armature.

Thus, after a transmission path leading to a predetermined receiving relay unit has been seized by the effectual energization of the busy test magnet of any one transmitting relay unit, no other relay unit, whose busy test switch and time assignor switch may be closed simultaneously, can seize this transmission path.

The transmission path thus seized is held during complete transmission of the message. It is broken to free the relay unit receiving the message, in the movement of the J-cam shaft of the transmitting relay unit from its No. 3 to its No. 1 rest position, preferably just before the J-cam shaft reaches its No. 1 position. At this time, the selected combination bar is restored to normal position as above described, and in its movement to such position, after opening the transmission circuits, opens the busy test switch, maintaining the locking circuit. Thus the transmission path is freed for seizure by any other selector which may have selected the same path.

Opening of the busy test switch to free the transmission path is delayed a sufficient length of time following the transmission of the last intelligence signal of a message in order to allow for the automatic incorporation in the message as recorded at the receiving relay unit, of the three blank chain links representing the end-of-message control combinations. Such timing is for

the purpose of preventing immediate seizure of the same receiving unit by another transmitting relay unit before these control combinations have been inserted.

The loop indicator

Operatively associated with the recorder of each relay unit (Fig. 4) is a device herein termed the loop indicator, provided for purposes of controlling the operation of the recorder of any relay unit, under two different conditions and for controlling the operation of the remote transmitter under one of those conditions.

One of these conditions is due to the continuous character of the storage medium employed and arises when the loops in the storage section of the relay unit are reduced to minimum length and there is still some message matter in storage to be transmitted. To allow continued operation of the transmitter in this event, means must be provided for supplying blank chain from the receiver loop to compensate for the non-blank or message chain running out of the storage section into the transmitter loop. The blank chain thus supplied serves to bridge over the fixed gap between the receiver and the transmitter of the relay unit.

The other condition which will be hereinafter called the "full-storage" condition, may be encountered during the transmission of a message when the available storage capacity of the receiving relay unit is being reached, that is, when the loops in the storage section of the relay unit are approaching maximum length. To avoid damage to the receiving relay unit under such condition, operation of its receiver must be interrupted, and to avoid loss of any of the signal combinations during such interruption, transmission to this receiver from the remote relay unit must be interrupted in timed relation to the stopping of the receiver.

In accomplishing the foregoing results, the loop indicator serves to register at all times the amount of storage medium or length of chain in both the storage and supply sections of each relay unit regardless of the character of the combinations recorded in the storage section. The construction is generally similar to that of the storage indicator above described. It includes a traveler 500 differentially driven from the transmitter and receiver of the relay unit with which it is associated so as to move in one direction or the other depending on whether chain is being advanced through the transmitter or the receiver of this unit, and to remain stationary when chain is being fed into and drawn from the storage section simultaneously and at the same speeds.

In Figs. 67 to 72, which show the loop indicator and the mechanisms by which the full storage stop and bridging over functions are performed, the traveler 500 is carried on the threaded portion of an elongated shaft 501 journaled in the frame structure in alinement with the driven shaft 176 for the receiver chain loop 6. The traveler is held against rotation so as to move along the shaft 501 in one direction or the other depending on the direction of rotation of the shaft.

The differential drive for the shaft 501 is effected by a spur gear differential 502 (Figs. 68 to 70) whose intermediate or driven member 503 is rigid with the extended end of the shaft 501. One terminal gear 504 of this differential is pinned to the shaft 176 which, it will be remembered, is the shaft driven to advance the re-

ceiver chain loop 6. Rigid with the other terminal gear 505 is a bevel gear 506 meshing with a similar gear on a shaft 507 (Figs. 4, 40 and 68) connected by bevel gears 508 to the shaft 269 which, as above described and shown in Fig. 40 carries the chain drive sprockets 58 by which the advance of the transmitter chain loop of the relay unit is effected through the medium of the clutch 260.

The terminal gears 504 and 505 of the differential are arranged to be rotated in opposite directions in the operation of the transmitter and receiver, respectively, and the threading of the shaft 501 is such that when the transmitter drive alone is operating, the shaft will rotate in a direction to move the traveller 500 to the right, as viewed in Fig. 68, the limit of travel in this direction being hereinafter termed the "zero" position of the loop indicator which corresponds to the minimum length of loops in the storage section or maximum length of the supply loops.

On the other hand, when the shaft 501 is driven from the receiver alone, the traveller moves to the left, its limit of movement in this direction being termed the "full-storage" position corresponding to the maximum length of the loops in the storage section. When both the transmitter and receiver chain drives are operating, the shaft is at rest, it being remembered that the chain is advanced past the receiving and transmitting control points at equal speeds.

Bridging over control.—In its bridging over function, the loop indicator controls only the operation of the relay unit with which it is associated and in the following description thereof it will be assumed that a portion of a message still awaits transmission from one such unit when the minimum length of the loops in the storage section is reached and that no further message matter is received into storage during the operation.

As above set forth, the operation of the transmitter alone causes the traveller 500 to move toward its zero position, and as the loops in the storage section reach their minimum lengths, the traveller likewise moves into such zero position. Such movement of the indicator traveller toward its zero position is utilized in the control of the spur gear differential clutch 175 governing the advance of the chain in the receiver loop, so as to start the chain and thus supply blank chain to the storage section of the relay unit, notwithstanding the fact that the receiver push rods, normally controlling the chain advance are inactive at this time.

The control of the clutch 175 to start the chain advance is effected through the medium of the latch L6 at the receiver which has previously been described, by allowing said latch to move into blocking position with respect to its floating lever FL6; and conversely the control of the clutch to stop the supply of blank chain after the message matter in storage has been transmitted, is accomplished by withdrawing the latch L6, such withdrawal being effected in the movement of the indicator traveller away from its zero position.

To this end an arm 509 loose on the indicator shaft 501 is urged by the traveller in approaching its zero position against the action of a spring 510 into the path of an actuating stud 511. The latter is mounted on an arm 512 fast on the shaft 501 and upon engagement with the arm 509 moves it in a clockwise direction as viewed in Fig. 71 since at this time the shaft

501 is driven only from the transmitter. Normally, the arm 509 is held in the position shown in Fig. 71 by a torsional spring 513, the arm being limited in its upward movement by a stop 514.

Upon the engagement of the arm 509 by the stud 511, the arm is moved into the position shown in Fig. 72, during which movement a cam surface 516 on the end of the arm acts on a follower 517 and rocks a shaft 518, which through the medium of a connection including a link 519 (Fig. 70) and a one-way coupling 519^a rocks the shaft 226 and through the knuckle connection 229 rocks the sleeve 228 in a direction to lower the latch control finger 222 (Figs. 39, 70 and 72) against the action of a spring 520. Thus the latch L6 is permitted to block the constantly operating floating lever FL6 so that the latter shifts the detent setter 189 for the clutch 175 in a direction to start the chain in the receiver loop.

It will be understood that as soon as the chain in the receiver loop starts, the arm 509 on the loop indicator shaft, due to the fact that the transmitter loop is also advancing, comes to rest in the position shown in Fig. 72, one-fortieth of a revolution in advance of that shown in Fig. 71, where its cam surface remains active to hold the control finger for the latch L6 in lowered position. Thus while the chain in the storage section is being withdrawn for the purpose of transmission, blank chain is supplied to the storage section at the same rate, the chain loops remaining at their minimum lengths.

When the chain in the transmitter loop stops, the indicator shaft, due to the drive from the receiver alone, causes the shaft 501 to move reversely, thus retracting the stud 511 and allowing the spring 513 to move the arm 509 back to normal position. The spring 520 is thus permitted to raise the control finger 222 and thus withdraw the latch L6 so as to stop the chain in the receiver loop.

If for any reason the bridging over control at any relay unit should fail to effect the advance of the chain at the recorder, the continued advance of the chain at the transmitter might result in serious damage to the mechanism due to the fact that the loops in the storage section are at this time at minimum length. Provision for such a contingency has therefore been made by arranging a switch 515, adapted to control the motor circuit with its movable contact arm in the path of movement of the arm 509. It will be apparent that if the advance of the chain at the recorder does not take place the shaft 501 will continue to be driven from the transmitter, thereby causing the arm 509 to open the switch 515 and stop the motor drive for the relay unit as a whole.

Full storage control.—The loop indicator, in so far as its full storage function is concerned, controls a transmitting relay unit and a receiving relay unit associated through the medium of a seized transmission path. Therefore, for the sake of clearness in the description of the full storage function of the loop indicator, let it be assumed that a normal connection has been established between the transmitter of the relay unit A1 and the receiver of a relay unit B2, as shown in heavy outline in Fig. 64; and that the full-storage condition arises when a maximum of 3000 chain links are present in the storage section of the unit B2.

In the full storage control of the relay units A1

and B2, the movements of the loop indicator traveller 500 at the relay unit B2, into and out of its full-storage position, are utilized respectively to discontinue and restart both the chain advance and the storage indicator drives at the transmitter and the receiver of these units.

The transmitter operation at the unit A1 is governed through the medium of the chain and storage indicator drive clutches 260 and 355 of that transmitter, which clutches, it will be remembered, are controlled respectively through the medium of the latches L9 and L8; while the operation of the receiver at the unit B2 is governed by the chain and storage indicator drive clutches 175 and 333, the chain clutch 175 being controlled either by the latches L1 to L5 or by the latch L6, and the clutch 333 being controlled only by the latches L1 to L5.

To effect proper timing of these functions, the clutches are operated under the control of an actuator driven at a predetermined speed. In the present embodiment, this actuator comprises a cam shaft 521, hereinafter termed the H-cam shaft (Figs. 69, 70, 71 and 72) arranged to be driven through the medium of a J-clutch 522 whose toothed member 523 is rigid with a spur gear 524 meshing with a pinion 525 on the main receiver drive shaft 172.

This J-clutch is adapted to be controlled by two rigidly connected detents 526 and 527 fast on a rock shaft 528 which is journaled in the frame parallel to the loop indicator shaft 501. Said detents are spaced apart about the cam shaft and are movable into and out of the path of the J-clutch dog 529, it being apparent that when one of the detents is moved out of the path of the dog to release the shaft the other detent moves into the path of the dog to stop the shaft after a predetermined range of movement.

The position of the detents is determined by the position of the loop indicator traveller 500 so as to effect a two-step movement of the cam shaft in each of its revolutions. Thus when a condition of full-storage is approaching, the traveller, advancing toward its full-storage-stop position, moves a loose arm 530 axially on the shaft 501 against the action of a spring 531, into the path of a stud 532 on a rigid arm 533, the latter moving in a counterclockwise direction as viewed in Figs. 71 and 72, when chain is being advanced through the receiver loop. Normally the loose arm 530 is held in the position shown in Fig. 72 by a spring 534, in which position a cam surface 535 on the end of the arm presses a follower 536 on the rock shaft 528 against the action of a spring 537 so as to position the end of the detent 526 in the path of the clutch dog 529, which is the No. 1 rest position of the cam shaft (Figs. 69 to 70).

As the 3000th link passes the recording point into the storage section, the stud 532 engages the arm 530 and moves the same from its normal position (Fig. 72) to the position shown in Fig. 71. This allows the spring 537 to withdraw the detent 526 (Fig. 69), thus releasing the clutch dog 529 so as to start the H-cam shaft from its No. 1 rest position. The cam shaft is stopped in its No. 2 rest position by the action of the detent 527, as shown in Fig. 71.

When the 3000th link passes out of the storage section, due to the operation of the transmitter alone, the loop indicator shaft 501 and therefore the arm 533 rotates reversely, which allows the spring 534 to move the arm 530 in a direction to cam the follower outwardly (Fig.

72). Thus the detent 527 is withdrawn and the cam shaft started for movement to its No. 1 rest position (Fig. 69), where it is stopped by the detent 526.

The control of the transmitter at the relay unit A1 to stop transmission to the relay unit B2 is accomplished as the H-cam shaft at the latter unit moves from its No. 1 to its No. 2 rest position. In such movement, two cams 538 and 539 (Figs. 28, 29, 30 and 74) permit the closing of two switches 540 and 541, these switches being normally held open by two pins 542 provided with insulating caps and constituting followers which are pressed against the cams by springs 543.

Closure of the switch 540 is utilized through appropriate electrical connections with the transmitting relay unit A1 to interrupt the chain advance in the transmitter loop thereof and also the drive of the associated storage indicator. To this end, two magnets 544 and 545 (Figs. 40, 45, 47 and 49) are positioned respectively above the latches L8 and L9 of the relay unit A1, which latches constitute magnet armatures. Upon energization of the magnets, the latches are withdrawn from blocking position with respect to the floating levers FL8 and FL9 which, it will be remembered, respectively control the detent setters for the chain-advance and storage indicator drive clutches 260 and 355. After such withdrawal the detent setter return cam 288 shifts the detent setters into positions for disengaging the clutches 260 and 355, the chain advance and storage indicator drives being interrupted simultaneously.

The magnets 544 and 545 at the transmitter of the unit A1, and the switch 540 of the receiver at the unit B2 are connected in series relation by the closure of the contact switch 454^b when the transmission path between the units A1 and B2 is established in the movement of the corresponding combination bar 537 which selects the unit B2 under the control of the line selector at the relay unit A1. The circuit thus established through these magnets and the switch 540 is shown in heavy outline in Fig. 64, and extends through the battery 462, the conductor 463, the switch 540 at the unit B2, conductors 546, 547 and 548, switch 454^b of the unit A1, the magnets 544 and 545 and normally closed switch 549 of the conductor 464.

The corresponding switches 454^b of the units A2 and A3 are connected to the conductor 547 by conductors 550 and 551. Through the medium of a cross conductor 552, connected to the switches 454^a of the relay units A1, A2 and A3 and also connected by a conductor 553 with the switch 540 of the relay unit B1, closure of the latter switch may be effective to control transmission from any of the units A. Similarly the closure of the switch 540 at the unit B3 may, through the medium of a conductor 554 and a cross conductor 555 connected to the switches 454^c of the units A, control transmission of any of the units A.

Shortly after the energization of the magnets controlling the latches L8 and L9 at the relay unit A1, the latches L1 to L6 in the recorder of the unit B2 are operated to control the clutches 175 and 333 for the purpose of stopping the chain advance and the storage indicator drives at the recorder, it being remembered that the latter drive is in the present instance responsive to the pin pusher movements. This is accomplished by another cam 556 (Figs. 28,

29 and 70) on the H-cam shaft as the latter moves toward its No. 2 rest position, said cam acting through the medium of a spring-pressed follower 557 connected by means of a link 558 and a crank arm 559 to the shaft 227. Pinned on said shaft are three sleeves 560 (Fig. 39) connected by knuckle joints 561 to three sleeves 562 loose on the adjacent shaft 226. Each of the sleeves carries a latch control finger 563, which in the aforesaid operation of the cam operate to withdraw the latches L1 to L6.

The chain for the recorder of the receiving relay unit B2, as well as the drive for the storage indicator thereof, are thus stopped with the withdrawal of the latches L1 to L6 controlling the clutches 175 and 333. The timing is such with respect to the stopping of the transmitter at the unit A1, as above described, as to insure that the transmission of the signal combination being sent when a full-storage condition arises will be completed, and that a blank link will be positioned opposite the recording control point of the unit B2 for the next signal combination to be sent from the unit A1 when the full-storage condition is cleared and transmission resumed.

To this end, the cams 538 and 556 are adapted to perform their respective functions in a definite timed relation with respect to each other, the switch 540 in the present embodiment being closed to withdraw latches L8 and L9 at the unit A1 one cycle earlier than the withdrawal mechanically of the latches L1 to L6 at the unit B2.

The switch 541 operated in the movement of the H-cam shaft of the receiving relay unit from its No. 1 to its No. 2 rest position, is interposed in parallel with the busy test locking circuit which seized the transmission path leading to the receiving unit where the full storage condition arose. This circuit (Fig. 64) extends from one battery terminal through a resistance element 564, a conductor 565 common to the receiving relay unit switches 541 of the respective units B1, B2 and B3. Said switches are also connected by conductors 566 to the respective cross conductors 477, 478 and 479 of the circuits for testing the units B1, B2 and B3.

Thus by closure of any switch 541 of a receiving relay unit, for example B2, under a condition of full storage, a circuit including the resistance element 564 is established which is in parallel with the holding coil 497 at a transmitting relay unit, for example A1, which coil acts to prevent seizure of said receiving unit by one of the transmitting units A2 or A3. The resistance 564 must be of high enough value that it will not reduce the current in said holding coil 497 to a point where the busy test armature 499 attracted by this coil would be released. On the other hand, the resistance must be low enough as to prevent effective energization of the high resistance windings 253 of transmitting units A2 or A3, even though the circuit through the holding coil 497 of the unit A1 has been released by termination of the message cycle at A1 and the consequent opening of its switch 455b.

In other words, so long as the condition of full-storage exists at any receiving relay unit, the transmission path leading thereto cannot be seized by any other transmitting unit which may have selected the receiving relay unit, even though the first transmitting unit has opened

its selector switches, thereby deenergizing its busy test locking circuit.

It will be remembered that while the full-storage condition continues the loop indicator traveller remains in its full-storage position. Accordingly the H-cam shaft remains in its No. 2 rest position, and the cams 538 and 539 thereon continue to allow the switches 540 and 541 to remain closed. Also the latches L1 and L6 at the unit B2 are held by the cam 546 in withdrawn position. When, however, the full-storage condition in the case of the unit B2 is cleared by the operation of the transmitter thereof, the H-cam shaft moves from its No. 2 rest position to its No. 1 rest position as above described.

In such movement of the cam shaft, the switch 540 is opened by its cam 538, and at the same time the cam 556 permits the latch control fingers 563 to be operated to release the latches L1 to L6. Thus the latches L8 and L9 of the transmitting relay unit A1 are again permitted to effect the driving of the chain and the storage indicator drive local thereto, while the latches L1 to L6 of the receiver are permitted to start the chain and storage indicator drive at the receiving unit B2, it being understood that the opening of the switch 540 causes deenergization of the latch control magnets 544 and 545. The switch 541 is opened just prior to the arrival of the H-cam shaft in its No. 1 position.

To prevent damage to the machine in case of a failure of the full storage stop control to interrupt the advance of the chain into the storage section when the loops thereof reach their normal maximum lengths, a safety switch 515a similar to the switch 515 at the opposite end of the loop indicator is provided. This switch 515a is also adapted to control the motor circuit and has its movable contact arm disposed in the path of movement of the arm 530 so that the switch will be opened in the continued rotation of the arm beyond its normal full storage position. It will be understood that such movement of the arm 530 will occur in the event that the recorder continues to operate after the loops in the storage section reach their normal maximum lengths.

Time charts

As an aid to a thorough understanding of the many functional and timed relationships between the various parts of the same and different relay units in the present system, the motions of several important parts of each of the relay units are diagrammed in Figs. 75 to 78. Figs. 75 and 76 when placed in end to end relation constitute a chart showing the operation of the various instrumentalities which come into play at associated transmitting and receiving relay units during the execution of a message cycle by the cycling mechanism of the transmitting unit. Since all of the relay units are of similar construction and driven in synchronism, it will be seen that the chart thus formed is applicable to the associated relay units in any of the successive stages of the message transmission.

In the chart formed by Figs. 75 and 76, the transverse rows of crosses or lines represent actual or theoretical movements of the control or operating parts indicated by the headings at the left of the chart. The vertical division lines common to all of these headings define the three-step movement and the intermediate dwell periods of the J-cam shaft in making one revolu-

tion, these movements and periods being indicated by the legends along the top of the chart. The dwell periods are, for the sake of compactness, shown on the chart as being of fixed length, but actually their lengths vary depending on the spacing and lengths of the successive messages and on the time required in testing the selected transmission path. The inclined lines indicate the times required to effect actual movements of the different parts but are not intended to represent the extent of such movements. Under certain of the headings, the theoretical or possible movements are represented by dotted lines and the actual effective movements by full lines. The vertical lines with arrowheads call attention to significant timed relation between the motions indicated under two or more different headings.

Referring now to the individual headings of the chart, the crosses in the upper and lower rows under heading No. 1 define between them successive link cycles in the operation of one transmitter and its associated receiver respectively, one link cycle being the time required to effect the movement of the storage chain in the receiver and transmitter loops 6 and 7 a distance equal to its pitch, that is the distance between the pins of two successive links. Each individual cross indicates a possible rest position of the pins in one link of the chain when brought to rest by the disengagement of the chain drive clutch. These rest positions correspond to the transmitting and receiving control points of the relay units so that when the chain is at rest, the pins of one link will be located opposite one of said control points.

Heading No. 2 shows the active and return movements and the intermediate dwells of the floating levers FL1 to FL6, FL8, FL9 and FL10 of each relay unit, these movements being represented respectively by upwardly inclined, downwardly inclined and horizontal lines. In each instance, the free ends of the levers pass or engage the tips of their control latches after approximately one-third of the time allowed for their active strokes has elapsed.

All of the devices which are actuated directly or indirectly by any of the nine floating levers have the same timing as the active strokes of the floating levers and therefore the movements of such devices are not indicated on the time chart.

Under heading No. 3 the dwells and the successive active and idle movements of the cam followers 206 and 288 for the detent setters 343, 359, 189 and 272 for the storage indicator and chain drive clutches 333, 349, 175 and 260 are represented respectively in each link cycle by horizontal, downwardly inclined and upwardly inclined lines. The active or resetting movements of the followers take place during the dwell periods of the floating levers.

Heading No. 4 shows the continuous motions of the detent setters 189, 343, 272 and 359 by their respective eccentric drives to cause engagement or disengagement of their clutches depending upon the vertical positions of the detent setters. The strokes of these motions which actuate the clutch detents are represented by the upwardly inclined lines under different headings, the clutches becoming engaged or disengaged to start or stop the chain or storage indicator drives after approximately two-thirds of the time provided for their active stroke has elapsed.

Under heading No. 5 the theoretical outward and inward strokes of the feelers CF1 and CF2

are represented by successive upwardly and downwardly inclined dotted lines, the actual movements being indicated in full lines.

The movements of the control latches L8 and L9 are represented under headings Nos. 6 and 7.

Heading No. 8 shows the movements of the transingers 411 by the cam action of successive non-pushed pins in the chain links as they pass the transmitter control point. The pins engage the leading and trailing surfaces of the transingers along the upwardly and downwardly inclined lines respectively, passing the transmitter control point and the center of the transingers at the upper point of intersection of these lines each of which, it will be noted, corresponds to a rest position of the storage chain, heading 1.

Headings Nos. 9, 10 and 11 represent respectively the motions of the transfer device code bar setter 419, the ball 432 and the combination bars 437.

Under heading 12 the lower and upper crosses represent respectively the earliest and latest possible times in the successive link cycles at which the time assignor switch contacts for any transmitting relay unit may be closed or opened, the time tolerance being the distance between the adjacent crosses. In one instance, the actual movements of the cam 493 (Fig. 65), to open or close the time assignor switch of a relay unit are represented by crossed lines. Each time assignor switch when closed remains closed for one link cycle. Comparison of the headings 11 and 12 will show that the closure of the time assignor switch of any unit takes place simultaneously with the closure of the busy test switch 455 by the selected combination bar.

The successive dwells and the outward and inward movements of the relief finger 252 are represented by the horizontal, downwardly inclined and upwardly inclined lines respectively under heading 13. The outward stroke occurs simultaneously with the closure of the busy test and time assignor switches. The finger passes out of blocking relation to the dog of the J-clutch after having traversed approximately one-half of its outward stroke.

The movements of the busy test armature 249 are represented under heading 14.

The full lines under heading No. 15 represent the inward movements of the J-clutch dog controlling the J-cam shaft into engagement with the teeth of the driving clutch wheel. The crosses in the upper row under this heading represent times in the successive link cycles when a tooth on the driving wheel of the clutch 234 passes the engaging finger of the clutch dog 242 when the J-cam shaft is in its No. 1 and No. 3 rest positions, that is to say, the times when the clutch dog could be engaged and picked up by the driving wheel to start the cam shaft following the withdrawal of the No. 1 and No. 3 detents. The crosses of the lower row represent the possible times when the teeth of the driving clutch member may engage the J-clutch dog when the latter is freed from its No. 2 rest position.

Heading No. 16 shows the movements of the cam 407 for resetting the No. 3 detent.

Figs. 77 and 78, when placed end-to-end constitute a chart showing the timed relation in which the parts of two interconnected relay units, operate during a full storage stop cycle, that is one revolution of the H-cam shaft of the receiving relay unit. The vertical lines divide the chart into columns which represent the dwells and cam shaft movements as indicated by the sig-

nals along the top of the chart. The horizontal rows of lines and crosses represent motions of the various parts under the headings listed at the left of Fig. 77, which correspond to the numbers at the left of Fig. 78. The lines with arrowheads call attention to significant relations of two or more parts.

Headings 20, 22, 23, 28 and 29 are the same as headings 1, 15, 2, 12 and 5 respectively of the message cycle time chart shown in Figs. 75 and 76. The movements of the H-cam shaft clutch control detents 526 and 527 by the loop indicator are represented under heading 21. Headings 24, 25, 26 and 27 show respectively the movements of the latches L8 and L9, the contact switch 540, the latches L1 to L6, and the switch 541 in the full storage cycle.

Operation

The operation of the mechanisms above described will now be set forth in connection with the selective transfer of a message in two stages from one point, for example, the relay unit A1, to another, as the relay unit C8, through an intermediate point. The course for such message according to the present trunking arrangement is shown in heavy outline in Fig. 1 and extends through the intermediate relay unit B2.

In following the course of the message through these units, it should be remembered that all of the units A, B and C are driven in exact synchronism and that certain parts of each unit operate constantly including the driving member of the clutches 234 and 522 for the J and H-cam shafts, the driving shafts 172 and 236 for the receiver and transmitter, drive clutches 333 and 349 for the storage indicator, clutches 175 and 260 for the recorder and transmitter chain drivers, the receiver floating levers FL1 to FL6 and the transmitter floating levers FL8 to FL9, and the drivers for the clutches 127 and 82 which feed chain automatically from the supply and storage sections of the storage mechanism into the recorder and transmitter loops 6 and 7 respectively, according to the operating requirements of the recorders and transmitters of the different units.

In the following discussion, reference will be made to the two time charts to show the exact timing of the various operations.

Operation—first stage of transmission

Transmission of the message as stored in the unit A1, to the unit B3 is accomplished in the execution of one message cycle by the combined line-selector and transmitter of the relay unit A1. Let it be assumed that (1) the message is recorded on the chain in the storage section of the unit A1 with the proper directing and end-of-message combinations preceding and following respectively the body of the message, (2) that the J-cam shaft of the cycling mechanism is dwelling at its No. 1 rest position, and (3) that the chain bearing the message in motion is being advanced toward the control point of the transmitter loop 7 as a result of the engagement of the chain advancing clutch 260 under the control of the storage indicator.

Dwell at No. 1 rest position.—The cam shaft is held in this position (Fig. 42) by the No. 1 detent 248 until the chain link bearing the first directing signal of the message is advanced to a point opposite the feeler CF2. In passing position No. 1 (Fig. 54) the pushed pins of this link engage the feeler shoes 381 (Fig. 52) and cam the latter

outwardly. This allows, as indicated at 567, heading 5, the latch L10 to move into blocking relation to its floating lever FL10 on the next active stroke 568 of which (heading 2) the No. 1 detent 248 is withdrawn, the J-clutch dog 242 being freed for movement into engagement with the tooth of the driving wheel 241 as indicated at 569, heading 15, which is just subsequent to the time when one abrupt or leading surface of the toothed clutch driver 241 passes the No. 1 rest position. When the next tooth passes the No. 1 rest position as indicated at 570, heading 15, its abrupt surface picks up the J-clutch dog, thereby starting the cam shaft toward its No. 2 rest position.

Movement from No. 1 to No. 2 rest positions.—In the first part of this movement, the cam 302 operates as indicated at 571, heading 7, to withdraw the latch L9 (Fig. 45) to stop the chain with the first address link opposite the control point. With the latch L9 thus withdrawn from blocking relation with the floating lever FL9, the follower for return cam 288 operates, as indicated at 572, heading 3, to shift the detent setter 272 into its upper position.

Upon its next active stroke 573, heading 4, the detent setter 272 will, provided the latch L9 remains withdrawn, shift the detent 271 to disengage the clutch and stop the chain, this occurring at 574, heading 1, which is three link cycles after the beginning of the outward movement of the feeler CF2. At this time the pins in the first address link are in position No. 4 (Fig. 54) opposite the center of the transfinger shoes 413 as indicated at 575, heading 8, the non-pushed pins of this link having moved the corresponding transfingers out of their normal positions where the fingers are held so long as the chain remains at rest.

Substantially simultaneously with the entry of the latch L9, the carrier 419 (Fig. 56) for the code bar set devices 418 begins its feeling stroke indicated at 576, heading 9, being moved toward the transfinger tailpieces 417 by the operation of the cam 427. In this movement the code bars which were shifted in the previous message cycle are permitted to move under the action of their springs until their extension bars 439 engage the stop 443. Then a momentary dwell 577 occurs in the movement of the carrier, during which dwell the bail 432 is moved downwardly by its cam 434 as indicated at 578, heading 10, to restore to their normal positions those set devices which were shifted in the previous message cycle.

Thereupon the feeling stroke of the carrier 419 is continued to carry the set devices 418 into operative association with the transfingers, the bail 432 at this time returning to inactive position. The tailpieces 417 of those fingers which have not been shifted and which correspond to the pushed pins of the control link, block the corresponding feeler rods 425 so that the corresponding set devices become shifted in the final portion of the feeling stroke of the carrier. The feeler rods for the other set devices pass the ends of the tailpieces 417 and remain unshifted.

With the set devices on the carrier thus set in accordance with the combination of the first directing signal, the carrier is now moved reversely as indicated at 579, heading 9, and near the latter part of this movement, the arms 424 of the shifted set devices engage with the

extensions 439 of the code bars 436 and shift those bars longitudinally.

Such setting of the code bars forms an aligned groove therein for permitting movement of the combination bar 437 corresponding to the relay unit B2, and immediately thereafter the fluted shaft 440 (Fig. 63) operates under the control of its cam 450, to permit such combination bar to move under the action of its spring through the first step of its movement indicated at 580, heading 11, during which the busy test switch 455^b (Fig. 64) at the relay unit A1, is closed. This switch corresponds to the receiving relay unit B2 and closure thereof serves to select the transmission path leading to this unit and to partially establish a circuit through the busy test magnet 253 (Figs. 42 and 64) of the unit A1 for the purpose of determining whether or not the transmission path leading to the unit B3 is in use by another transmitter in the group D containing the unit A1.

Following the closure of the switch 455^b to effect such selection, the J-cam shaft is stopped in its No. 2 rest position (Fig. 43) by the relief finger 252 which makes an inward stroke 581, heading 13, just before the J-cam shaft has advanced to a point where the finger of the J-clutch dog 242 engages the tip of the relief finger. Upon such engagement, the dog is tipped backwardly and withdrawn from engagement with the toothed driving wheel of the clutch, the cam shaft coming to rest in its No. 2 position.

Dwell at No. 2 rest position.—At the time when the busy test switch 455^b is closed, the corresponding time assignor switch 485 (Fig. 66), which is closed periodically to render operative the testing circuit through the busy test magnet of the relay unit A1, may be closing, opening or held open by the raised portion of the time assignor cam 493. If the selected receiver is available and the switch 485 is being closed in the same link cycle as the busy test switch, the J-cam shaft will be stopped only momentarily in its No. 2 position by the relief finger 252.

In such a case, the magnet 253 of the unit A1 will be energized to a degree sufficient to draw its armature 249 out of the path of the J-clutch dog as indicated at 582, heading 14, so that when the relief finger 252, on its next withdrawing stroke 583, heading 13, moves out of the path of the finger of the clutch dog, the dog will be freed and will move into engagement with the teeth of the clutch driver, as indicated at 584, heading 15, being picked up by the leading surface of the next tooth thereof as indicated at 585 to start the cam shaft from its No. 2 to its No. 3 rest position.

In case the time assignor switch 485 is being opened or is open at the time when the selected busy test switch is closed, the cam shaft is stopped in its No. 2 rest position as just described where it remains for one or more link cycles during each of which the busy test armature 249 acts to block the clutch dog while the relief finger is out of blocking relation with the dog. If the selected receiver is available, the next closure of the busy test circuit by its time assignor switch will effect the withdrawal of the busy test armature so that on the following withdrawing stroke of the relief finger 252, the clutch dog will be allowed to engage the driver, as above described, to start the cam shaft from its No. 2 rest position.

Movement from No. 2 to No. 3 rest position.—Shortly after the starting of the J-cam shaft from its No. 2 rest position, the cam 302 thereon

(Fig. 45) operates to restart the chain in the transmitter loop by allowing the latch L9 to enter with respect to its floating lever FL9 as indicated at 586, heading 7. The clutch 260 controlled by this latch is engaged through the operation of said floating lever on its next active stroke 587, heading 2, during which the detent setter 272 is shifted downwardly, actual engagement of the clutch and therefore starting of the chain past the transmitting control point taking place during the subsequent motion of the detent setter at the point 588, heading 4.

In the initial movement of the chain, the cam 450 (Fig. 62) operates the fluted shaft 466 to permit the combination bar 437 to make the second step of its movement as indicated at 589, heading 11, in which the selecting switches *b* of the relay unit A1 (Fig. 64) are closed to establish the simultaneous transmission path of five independent circuits leading through the magnets 156 of the recorder at the unit B2. This, as indicated by the line 590, comparing headings 8 and 11, occurs substantially simultaneously with the passage of the pushed pins of the used control link out of controlling relation to the trailing surfaces 415 of the transfinger shoes, and with the passage of the pushed pins of the next or unused directing link into engagement with the leading shoe surfaces 414.

Within the tolerance allowed for the execution of the above functions, the earliest possible time at which the selecting switches *b* may be closed by the cam 450 is subsequent to the time when the tips of the floating devices FL1 to FL5 of the relay unit B2 pass the tips of their controlling latches L1 to L5, and passage occurring at the point 591, heading 2. Therefore, even though the controlling engagement between the pins of the used control or directing link may continue until after the closure of the switches *b*, the resulting energization of the magnets 156 at the unit B2 would be ineffective in controlling the recorder push rods 154. As a result the used directing signal is discarded by the advance of the chain before the relay unit B2 is in condition to be controlled thereby.

The first signal combination actually transmitted to the unit B2 and there recorded is the second of the directing portion of the message as recorded in the unit A1, or the first unused combination. As the pushed pins of this combination engage the leading surfaces of the transfinger shoes 413 as indicated at 592, heading 8, the corresponding transmitting switches 458 (Figs. 53 and 64) are cammed open while the other switches 458 corresponding to the unpushed pins are allowed to close, thereby completing circuits through the corresponding magnets 156 of the receiving relay unit B2.

The resultant energization of one or more of the receiver magnets causes movement of their armature latches L1 to L5 inclusive toward the floating levers, movement thereof into blocking position occurring as soon as the floating levers on their return strokes clear the tips of the latches, which occurs at 593, heading 2. Such energization of the magnets continues through the dwell 594 of the floating levers and the initial portion of their next pushing strokes 595 during which the rods operate selectively to set up the combination on the blank chain link then positioned at the recording point of the relay unit B2.

Blocking of one or more of the floating levers FL1 to FL5 in the setting of the first combination at the unit B2 causes the corresponding pin

pushers 154, on the floating lever stroke 595, to actuate the bail 196 (Fig. 26) which shifts the detent setters 189 and 343 for the chain advance and storage indicator control clutches 175 and 333 at the recorder, upwardly, so that on the next active stroke 596 of the detent setter, heading 4, these clutches will be operated to start the chain advance and storage indicator drives of the receiver as indicated along the line 597.

Such starting of the chain in the receiver loop 6 brings a blank link opposite the pin pushers in time to receive the second transmitted combination which is recorded in the floating lever movements 598, heading 2, as a result of the actuation of the transfinders at the relay unit A1 along the lines 599, heading 8. Thus in the advance of the chain in the transmitter loop 7 of the unit A1 and of the chain in the receiver loop 6 of the unit B2, a pushed pin in each row on the transmitter chain causes the transmission of a signal impulse which causes the pushing of a pin in the corresponding row on the receiver chain. No impulses are transmitted by the non-pushed pins so that the corresponding pins in the receiver chain pass the recording point in blanked or unpushed position.

It will thus be seen that the mechanical signal combinations are converted to electrical form for the purpose of transmission and then reconverted by the recorder into mechanical form, so that the message as a whole will be reproduced in the unit B2 in the same form as that in which it was stored in the unit A1, except that one directing combination will have been utilized for selection purposes and discarded.

One link cycle after the entry of the latch L8 to start the chain at the transmitter A1, as above described, the latch L8 is permitted to enter under the control of the cam 377 (Fig. 48) on the J-cam shaft, as indicated at 600, heading 6. This blocks the floating lever FL8 which rocks the shaft 363 and the crank member 364 thereon in a direction to shift the detent setter 359 into its lower position. Therefore on the next setting stroke 601, heading 4, of the detent setter, the clutch 349 is engaged to start the transmitter drive for the storage indicator at the unit A1 exactly one link cycle after starting of the chain advance in the transmitter loop of that unit. The detent setter is periodically returned to its upper position through the operation of the return cam 288 so that the member 364 oscillates continuously so long as the latch L8 remains in its blocking position.

The J-cam shaft of the transmitting relay unit A1 reaches its No. 3 rest position (Fig. 44) just prior to the recordation of the first combination in the relay unit B2, and the cam shaft dwells in this position during the transmission of all of the signal combinations representing the message in the unit A1.

Dwell at No. 3 rest position.—When the end portion, three blank links representing the end portion of the message being transmitted, approaches the transmitting control point in the relay unit A1, the third and final step of the message cycle is initiated. This occurs when the first of these links following the last link of the body of the message arrives in the No. 2 position (Fig. 54) whereupon the feeler CF2 makes its inward or end-of-message stroke 602, heading 5. In this movement, the pawl 401 (Fig. 48) moves into blocking relation to the lug 404 on the crank member 364 which at this time is oscillating under the control of the latch L8, as above de-

scribed; and on the next stroke 603, heading 2, of the floating lever FL8, the No. 3 detent 250 is withdrawn and the J-clutch dog moves as indicated at 604, heading 15, and is picked up by its drive wheel at 605, to start the cam shaft.

Movement from No. 3 to No. 1 position.—In the early part of this movement, the latches L8 and L9 are withdrawn simultaneously, by their cams 302 and 377 (Figs. 45 and 48) as indicated at 606 and 607, headings 6 and 7, and the detent setters 272 and 359 on the next stroke 608 of their return cam follower 290, heading 3, are shifted upwardly where they remain during the eccentric motion 609, heading 4, in which the detents 271 and 358 are operated to interrupt the chain and storage indicator drives at the transmitter of the unit A1, both of these drives stopping at 610, heading 1, three link cycles after the end-of-message stroke of CF2 so that the last link of the body of the transmitted message arrives at position No. 6 (Fig. 54) as the chain comes to rest.

The cam controlling the latch L8 is shaped to cause the transmitter drive of the storage indicator to count the exact number of non-blank links passing the transmitter control point. In this connection it will be remembered that the transmitter drive for the storage indicator is started on the eccentric motion 601, heading 4, which is one link cycle after the institution of the chain advance on the eccentric motion 588 to move the used directing signal away from the transmitter control point. Such drive for the storage indicator is interrupted as above set forth on the eccentric motion 609, heading 4, which is one link cycle subsequent to the time when the first blank or end-of-message link passes the control point, this being indicated at the point 612, heading 8. Thus, the storage indicator drive from the transmitter operates for a time equal to that required to move the non-blank links of a message past the transmitter control point.

At the receiving relay unit B2, the last signal of the message transmitted in the movements 613, heading 8, of the transfinders, is recorded in the stroke 611, heading 2, of the floating levers FL1 to FL5. Therefore disengagement of the storage indicator drive clutch 333 at the recorder occurs on the eccentric motion 609, heading 4, of the detent setter 343, the drive being interrupted at 610. As a result of the control of the clutch 333 by pin pushers, the recorder drive for the storage indicator of the relay unit B2 responds only to the number of address and message signals recorded.

The advance of the chain in the recorder loop 6 continues for three link cycles following the interruption of the storage indicator drive, this being under the control of the feeler CF1 for the purpose of adding three blank or end-of-message links to the message as recorded in the unit B2 and to present the fourth blank link to the recording point, thereby placing the relay unit in condition for the recordation of the first signal of the next message transmitted from any of the units A1 to A4.

This is accomplished by reason of the location of the feeler beyond the receiver control point in a position such that it is held outwardly until the last of the links representing the body of the recorded message arrives in position No. 1 (Fig. 36), when the feeler moves inwardly as indicated at 614, heading 5. When in its outward position, the feeler holds the latch L6 in blocking relation to its floating lever FL6 which periodically rocks the shaft 191 in a direction to con-

tinue the engagement of the chain drive clutch 175.

When the feeler CF1 moves inwardly, the latch L6 is withdrawn. Then after the shifting of the detent setter 189 by the return cam 208 on its next active stroke 615, heading 3, the eccentric motion 616, heading 4, disengages the clutch 175, the chain coming to rest at 617, heading 1, with the first end-of-message link following the body portion of the message in position No. 1 (Fig. 36) and the fourth blank link in position No. 4 opposite the push rods.

Near the end of the movement of the J-cam shaft of the transmitting relay unit A1 toward its No. 1 rest position, the cam 450 thereon operates as indicated at 618, heading 11, to restore the selected combination bar 437 to normal position, thereby successively opening the selecting switches and busy test switch 455^b so as to free the transmission path leading to the receiving relay unit B2 and thus render this unit available for seizure by another of the relay units A1 to A3. Such opening of the busy test switch is made to occur simultaneously with the time interval between the crosses 619, heading 12, at which the time assignor switch for any of the units A1 to A3 may be closed. This avoids shortening of the predetermined period allotted by the time assignor during which the busy test mechanism of these units may operate to seize the receiver of the freed relay unit B2.

Substantially simultaneously with the restoration movement of the combination bar, the cam 302 (Fig. 45) on the J-cam shaft of the unit A1 permits the latch L9 to enter as indicated at 620, heading 7, unless the latch is at this time prevented from entering by the action of the storage indicator whose arm 311 (Fig. 45) holds the latch against entry in the event that there is no other message in storage at the unit A1. Such control is provided for the purpose of preventing idle advancing movement of the chain in the transmitter loop in the event that there is no other message awaiting transmission. If, however, there is a message in storage, the entry of the latch L9 operates to restart the chain advance. This is caused by the floating lever movement 621, and the eccentric motion 622 and occurs at 623, heading 1, as a preliminary to the next message cycle.

The J-cam shaft is or is not stopped in its No. 1 rest position depending upon whether or not another message cycle is to follow immediately. If it is, the first address link of the next message to be transmitted will directly follow the third blank link of the end portion of the transmitted message. In such a case, the first address link will have arrived at position No. 2 (Fig. 54) in the stopping of the chain by the previous withdrawal of the latch L9, and in approaching such position the pushed pins thereon will have moved the feeler CF2 outwardly as indicated at 624, heading 5, and thereby allowed the latch L10 to enter, the No. 1 detent of the J-cam shaft being withdrawn from blocking position on the movement 621 of the floating lever FL10. This occurs prior to the time when the cam shaft arrives at its No. 1 rest position so that the J-clutch is not disengaged and the cam shaft is, therefore, not stopped.

In such event, the first directing link of the new message is brought to rest at 574, heading 1, opposite the transmitters (Fig. 54) by the withdrawal of the latch L9 in the manner above described, but in timed relation to the release of the cam shaft from its No. 3 rest position instead of from its No. 1 rest position, as is the case when

the message is not immediately preceded by another.

In the event that the two succeeding messages are separated by more than three blank or end-of-message links, the feeler CF2 will remain in its inward position until after the J-cam shaft has arrived at its No. 1 rest position and, therefore, will cause the shaft to be stopped in this position where it will remain while the intervening blank links are run past the transmitting control point. When the first address link of the succeeding message passes the No. 1 position (Fig. 54) the No. 1 detent will be withdrawn to initiate the next message cycle as described above.

Operation—second stage of transmission

In the event that no message matter is stored in the storage section of the relay unit B2 when transmission of the message from the unit A1 is initiated, it becomes necessary to run out the blank chain preceding the message in this section in order to bring the directing portion thereof into the transmitter loop preparatory to the execution of the message cycle.

The advance of the chain past the transmitter control point to accomplish this purpose is controlled by the storage indicator at the relay unit B2, whose arm 314 (Fig. 45) moves away from zero position as soon as the receiver drive clutch 333 therefor is engaged as a result of the recordation of the first address signal combination by the push rods of the unit B2. This movement of the arm 314 allows the indicator arm 311 to swing into the position shown in Fig. 45 which permits the latch L9 to enter and thus cause engagement of the chain drive clutch 260 thereby starting the chain advance. Such engagement of the clutch is permitted by reason of the fact that the J-cam shaft is at this time in its No. 1 position, in which position the cam 302 allows the latch L9 to enter.

In case there is another message or a part thereof in storage in the unit B2 at the time when the initial combination of the message transmitted from the unit A1 is received, the chain advance to run out the blank links intervening between the two messages in the unit B2 is initiated by the entry of the latch L9 as the J-cam shaft at such unit approaches its No. 1 rest position after transmitting the previous message, instead of under the control of the storage indicator as in the instance just described. This results from the fact that whenever there is message matter in the storage section of a relay unit, the storage indicator traveller registers above zero.

The message cycle at B2.—As the chain continues to be advanced past the transmitter control point of the relay unit B2, the first directing combination moves into the transmitter loop whereupon a message cycle is initiated. This takes place when the first link of the message is presented to the feeler CF2 and the various functions performed in this cycle are governed by the J-cam shaft in the same manner as has been described in connection with the operation of the relay unit A1. This cycle will therefore be only briefly summarized.

In the first step of the cycle, the combination recorded on the first link representing the message, controls the selection of the path leading to the receiver of the relay unit C8 which is thereupon tested for busy as soon as this path is found to be available, the used directing signal combination is discarded and transmission of the message is effected in the second step of the cycle. Termination of transmission takes place in the third

and final step of the cycle at which time the established transmission path is freed for seizure by any of the other relay units B5 and B8 or by the unit B2 in case another message is awaiting transmission to the unit C8. The recorder of the unit C8 operates in the same manner as the recorder of the unit B2 above described to add the usual three blank or end-of-message links to the message as recorded on the chain in the unit C8.

In case no other message is in the storage section of the relay unit B2 at the time when transmission of the instant message is completed, continued advance of the chain at that unit will be unnecessary and will be prevented by the action of the storage indicator thereof. Under these conditions, only the transmitter drive for the storage indicator will be driven so that its traveller 308 will move into zero position upon the transmission of the last combination of the message. Thus the arm 311 will be moved into a position to prevent entry of the latch L9 which would otherwise be permitted to block the floating lever FL9 by the cam 302 on the J-cam shaft at the unit B2 when the shaft approaches its No. 1 rest position in the termination of the message cycle.

By the two stages of transmission above described, the message as originally recorded in the form of mechanical signal combinations on the storage medium of the relay unit A1 will have been transferred through an intermediate relay unit B2 to a particular one (C8) of a possible 941 relay units C, where it will be reproduced in a form identical to that in which it was recorded in the unit A1 except for the first two combinations of its directing portion which were utilized for line selection while the message was in mechanical form in the units A1 and B2. The first directing combination will have been discarded in the second part of the message cycle controlling the first stage of the transmission, the other combination having been transferred to the unit B2 and there discarded after being used in the selection of the path for the second stage of the transmission.

Operation—Full storage condition

It will be assumed for the purpose of describing the operation under this condition that a message is being transmitted from the relay unit A1 to the unit B2 in the first transmission stage above referred to, the J-cam shaft at the unit A1 being in its No. 3 rest position; that during such transmission the supply of blank chain in the supply section of the unit B2 is becoming exhausted due to the fact that the transmitter at the same relay unit has been unable to transmit message matter out of storage as fast as matter has been recorded; and that the H-cam shaft at the unit B2 is in its No. 1 rest position (Figs. 69 to 70). Moreover, reference will be made to the time charts (Figs. 77 and 78).

The full storage condition arises, in the present embodiment, when the 3000th link passes the recording point and is delivered to the storage section of the relay unit B2. As this condition approaches, the traveller 500 of the loop indicator moves into its full storage position indicated in Fig. 68. Just as the 3000th link passes the recording point, the arm 533 moves the arm 530 from the position shown in Fig. 72 to that shown in Fig. 71, thereby withdrawing the No. 1 detent 526 of the H-cam shaft as indicated at 625, heading 21. The dog of the J-clutch 522 (Fig. 70) is picked up by the next tooth of the drive wheel 523 at a predetermined point in the transmitter and receiver link cycles indicated at 626, head-

ing 22. In the next link cycle, the cams 538 and 539 operate to close the switches 540 and 541 simultaneously, as indicated at 627 and 628, headings 25 and 27. Closure of the switch 541 completes the auxiliary shunt circuit around the busy test locking circuit at the relay unit A1.

The completion of this shunt circuit through the resistance 564 makes the receiver of the unit B2 test busy so long as the switch 541 is closed even though the already closed busy test circuit for that unit may be interrupted by opening of the busy test switch 455^b therein at the transmitting unit A1. The reason for the establishment of this auxiliary circuit will appear later. The other switch 540 when closed completes the full storage circuit through the magnets 544 and 545 at the unit A1, which are thus energized to withdraw the latches L8 and L9 at the relay unit A1, as indicated at 629, heading 24. Such withdrawal causes the disengagement of the chain and storage indicator drive clutches 260 and 355 at the relay unit A1, the chain coming to rest as indicated at the point 630, heading 20.

One link cycle following the closure of the switch 540 to interrupt the operation of the transmitting relay unit A1, the cam 556 on the H-cam shaft operates, as indicated at 631, heading 26, to move the control fingers 563 (Fig. 70) for the latches L1 to L6 in a direction to withdraw all of these latches, thereby causing disengagement of the storage indicator and chain drive clutches 175 and 333 at the recorder of the unit B2, the chain stopping at 632, heading 20.

This one cycle delay in interrupting the operation of the receiving relay unit is for the purpose of insuring that the last transmitted signal combination will be recorded and that another blank link will be presented opposite the push rods 154 for the reception of the initial signal combination when the full storage condition has been cleared and transmission resumed. Immediately following the stopping of the chain at the relay unit B2, the H-cam shaft arrives at its No. 2 rest position where it is stopped by the engagement of its clutch dog 529 with the detent 527, the latter having been moved into the path of the dog when the detent 526 was withdrawn.

Resumption of transmission occurs automatically when the loop indicator traveller 500 of the relay unit B2 moves out of its full storage position, due to the operation of the transmitter only of said unit, which renders a supply of blank chain available for use in the operation of the receiver to record additional message matter transmitted from the unit A1. As the number of links in the storage section of the relay unit decreases below 3000, the arm 533 of the loop indicator moves away from its full storage position and this allows the arm 530 to move by the spring 534 into the position shown in Fig. 72. This withdraws the detent 527 as indicated at 633, heading 21, the clutch dog being picked up at 634, heading 22, to start the cam shaft toward its No. 1 rest position. In the same operation, the detent 526 moves into the path of the dog so as to disengage the clutch and stop the cam shaft when its No. 1 rest position is reached.

In the movement of the H-cam shaft from its No. 2 to its No. 1 rest position, the cam 538 operates as indicated at 635, heading 25, to open the full storage circuit, thus deenergizing the magnets 544 and 545 (Fig. 64) at the unit A1 and permitting the latches L8 and L9 to enter as in-

indicated at 636, heading 24 into blocking position relative to their floating levers. The latter, on their next pushing stroke 637, heading 23, engage the latches and thereby cause engagement of the storage indicator and chain drive clutches 260 and 349 of the relay unit A1, the chain starting at 638, heading 20.

One link cycle following the entry of the latches L8 and L9 to resume transmission from the unit A1, the cam 556 operates, as indicated at 639, heading 26, to withdraw the control fingers 563 so as to free the latches L1 to L5 in time to be controlled by their magnets 156 in the reception of the first signal transmitted in the resumed operation, this signal being recorded in the stroke 640, heading 23, of the levers FL1 to FL5 which also shifts the detent setters 189 and 343 so that the storage indicator and chain drives are re-started simultaneously as indicated at 641, heading 20, under the control of the push rods.

The latch L6 is also freed in this same operation and moves into blocking relation to its floating lever so that this latch alone will control the chain advance to insert the three end-of-message links in the event that all the signal combinations representing the body of the message were transmitted from the relay unit A1 before the interruption of transmission by the full storage mechanism at the unit B2.

Just prior to the arrival of the H-cam shaft in its No. 1 rest position, the cam 539 thereon operates as indicated at 642, heading 27, to open a switch 541 in the auxiliary busy test circuit for a purpose which will now be described.

Operation—abnormal conditions

In the present system, any of the relay units may be under a condition of full storage as regards the reception of message matter thereby without the normal busy test circuit at the associated transmitting relay unit being effective to prevent seizure of the receiving unit by other transmitting units. Such a condition may arise at any receiving relay unit, as for example B2 when, during the transmission of a message thereto from a unit A1, a full storage signal is given by the unit B2 to the unit A1, one link cycle later than the time when the feeler CF2 of the unit A1, makes its normal inward or end-of-message movement 602, Fig. 76, heading 5.

In such a case, the full storage signal would cause engagement of the magnets 544 and 545 of the unit A1 so as to withdraw the latches L8 and L9 as indicated at 643 and 644, headings 6 and 7. This would be subsequent to the withdrawal of the No. 3 detent 250 on the floating lever movement 603, and therefore the J-cam shaft would be released from its No. 3 rest position and in its movement, the active or shifted combination bar would be restored to open the then closed switch 455^b in the busy test circuit maintaining the connection between the units A1 and B2.

Thus, the unit B2 would, if not otherwise prevented, be freed for seizure by any other of the units B, which may have selected the transmission path for the unit B2 and be awaiting connection therewith. If such seizure were made, for example, by the unit A2, energization of its magnet 253 would release its J-cam shaft from its No. 2 position whereupon the chain at its transmitter would be advanced two links before a full storage circuit could be established between the units A2 and B2 by movement of the proper combination bar to close the switch 454^b at A2.

Therefore the full storage condition at the unit B2 would not be movable to energize the full storage stop magnets 544 and 545 at A2 until after passage of the previously used address link and also the first unused address link past the transmitter control point of the unit A2. Thus the first unused directing signal would be discarded, whereas the latter combination should be recorded in the unit B2 for use in selecting the next path of transmission leading to one of the units C.

To prevent the above condition from arising, the auxiliary circuit, including therein the resistance 564 and the switch 541, is provided. When the switch 541 is closed in the initial movement of the H-cam shaft at the relay unit B2, the battery 462 is grounded through the resistance element 564 which draws enough current from the battery to prevent the busy test magnets of the units A2 and A3, in parallel therewith, from being energized to a degree sufficient to move their armatures. But the resistance of the element 564 is not high enough to cause a sufficient voltage drop across the holding coil 497 of the relay unit A1 and thereby cause release of the busy test armature 249 of such unit.

As a result, the unit B2 tests busy to the units A2 and A3 so long as the condition of full storage exists at the unit B2 even though the busy test circuit established in the transmission of the message from A1 to B2 which caused the full storage condition may have been interrupted under the conditions above outlined. During the maintenance of this auxiliary circuit which causes the relay unit B2 to test busy, the relay unit A1 may, if disconnected from the unit B2, seize a connection with any other of the B units.

From an examination of the time chart, headings 5 and 1, it will be apparent that six link cycles elapse from the time when the feeler CF2 at the transmitting relay unit completes its inward movement, as indicated at 602, heading 5, to the time when the chain at the associated receiving relay unit comes to rest as indicated at 617, heading 1, with the fourth blank link following the message opposite the push rods. Furthermore the movement of the loop indicator traveller at the receiving unit into full storage position may take place on any of these link cycles, because the movement of the traveller into such position is caused by the advance of the chain in the receiver loop.

It will also be seen that closure of the auxiliary busy test circuit through the switch 541 occurs at 628, heading 27, in the movement of the H-cam shaft approximately two link cycles after the full storage condition arises as indicated at 625, heading 21. Therefore, to avoid seizure by any other transmitting relay unit of the path leading to a receiving relay unit under full storage condition, until after the auxiliary busy test circuit has been closed by the latter unit, it is necessary to prevent the interruption of the normal busy test circuit by the transmitting relay unit until after the latest possible time at which the auxiliary switch 541 may be closed by the full storage mechanism. This is accomplished by delaying the opening of the busy test switch 455 of the transmitting unit by the combination bar movement 618, heading 11 (Fig. 75), for seven and one-half link cycles following the inward stroke 602, heading 5, of the feeler CF2 at the transmitting unit.

Another abnormal operating condition may arise at the transmitting relay unit when the end-of-message or inward movement 602, head-

ing 5, of the feeler CF2 of a transmitting relay unit takes place one link cycle earlier than the reception of the full storage signal from the receiver to which the message is being sent by said unit. Energization of the magnets 544 and 545 by closure of the full storage circuit there-through would, unless otherwise prevented, withdraw the latches L8 and L9, as indicated at 643 and 644, headings 6 and 7, which is one cycle earlier than their normal withdrawal by the cams 377 and 302, as indicated at 606 and 607.

In such a case, the chain in the transmitting loop would be stopped at 645, heading 1, with the first blank link following the message at the transmitter control point, all of the message matter being properly transmitted. But the storage indicator clutch 349 would be disengaged at 646, heading 4, instead of at 609, when the transmitter drive for the storage indicator is normally interrupted. Consequently the storage indicator would register one more link than it properly should.

To avoid this, means is provided to prevent the energization of the magnets 544 and 545 when the switch 549 normally controlling the full storage circuit is closed one cycle later than the inward movement of the feeler CF2. This is accomplished, in the present instance, by the switch 549 (Figs. 44 and 64) on each relay unit which is closed when the J-cam shaft of the unit is in its No. 3 rest position and which is opened as the No. 3 detent 250 is withdrawn by the stroke 603, heading 2, of FL8 following the movement 602 of CF2. Opening of this switch interrupts the full storage stop circuit so that closure of the receiver control switch 540 will be ineffective to energize the magnets 544 and 545. As a result the latch L8 cannot be withdrawn at 643, heading 6, but will be withdrawn at the normal time by its cam as indicated at 606, heading 6.

Since the switch 549 must be held open for one link cycle, it is necessary to provide the magnetic set device 405 for the No. 3 detent. The cam 407 is provided for moving the detent as indicated at 647, heading 16, out of control by the set device as the No. 3 rest position of the cam shaft is passed and to free the detent as indicated at 648 before the No. 3 rest position is reached.

Relay units—synchronizing

While, as above set forth, the operation of the relay units in an exchange station by means of synchronous motors deriving power from a source of alternating current of constant frequency insures the operation of such units at predetermined speeds, it is also necessary that the various constantly operating parts of each unit operate in proper timed relation to such parts of all other units in the station. It follows, therefore, that provision must be made to insure starting of the units in proper phase relation to each other as well as for maintaining such relation. Thus the floating levers, clutch drivers, etc. of any newly started relay unit must be brought into step with the then operating units so that when transmission of signals from or reception of signals by the new unit is initiated a transverse row of pins in the chain will be passing the transmitter or recording control point at the same time that a row of pins passes the control point of the associated unit.

In the present instance, the above result is accomplished automatically, by taking advantage of the inherent ability of certain types of

synchronous motors driven by alternating current of constant frequency to bring themselves automatically into exact phase relation to the alternating current cycles and therefore in exact phase relation to each other even though they may be started at different times. Moreover, the various parts of each relay unit, having certain motions which must take place at definite times in each link or signal cycle, are driven at speeds such that the number of cycles executed by such parts with the motor running is equal to or is a multiple of the alternating current frequency.

In the present instance therefore the driving connections or gearing between the driving motor of a relay unit and the operating parts such as the floating levers are so proportioned relative to the motor speed that said parts execute 3600 cycles per minute which is the frequency of a 60 cycle alternating current which is most frequently used in present-day practice. In a like manner the driving members of the chain advance, storage indicator and J-cam shaft drive clutches are driven at speeds such that they may be engaged or disengaged at a definite point in each cycle of the floating levers. As a result of this arrangement the synchronous motor of any relay unit will, upon starting, automatically bring and maintain the various operating parts of its unit into proper phase relation to the cyclic movements of the corresponding parts of other relay units then in operation.

It will be understood that the same result can be accomplished by gearing arrangements which would increase the number of cycles executed by the floating levers, etc. to a multiple of an alternating current frequency. In such a case the synchronous motor would not be able to start at a predetermined point in any link cycle but could start at a predetermined point in alternate cycles or every third cycle as the case may be, which would bring its relay unit into synchronism with the other units.

In the appended claims the term "mechanical" as applied to stored signals is intended to denote the physical character of such signals as distinguished from the purely electrical character of the signals as transmitted over the telegraph lines. Thus, the term is intended to embrace signals stored as perforations in a paper tape or the like as well as other known equivalents of the pin storage shown in the exemplary embodiment of the invention.

I claim as my invention:

1. A system of communication having, in combination with a transmitting unit and a plurality of terminal units, a relay unit having a storage medium on which message matter sent from the transmitting unit may be recorded, and means operable automatically upon the recording of message matter on said storage medium to initiate transfer thereof to one of said terminal units selectively.

2. An apparatus for automatically relaying a message from one point to another through an intermediate point in successive independent steps, said intermediate point having means for receiving and storing a message, means operable under the control of a part of the message as stored to select a transmission path leading to the succeeding point, and means operable automatically to effect transmission over the selected path.

3. A telegraph exchange station through which a message may be relayed automatically while represented by a succession of signal combinations comprising, in combination, mechanism operable to convert said combinations alternately from mechanical to electrical form and vice versa, and means operating while said combinations are in mechanical form to select one of a plurality of paths for the transmission of the combinations when again converted to electrical form.

4. The method of communication which consists in transmitting a message in successive stages from one point to another through one or more intermediate points, storing the message mechanically at each intermediate point, and selecting a path for each succeeding stage of transmission under the control of the message as stored.

5. The method of transferring a telegraph message between two points which consists in electrically transmitting directing signals and signals representing the message in successive stages between said points through a plurality of intermediate points, utilizing one of said directing signals at each of said intermediate points to determine the succeeding electrical transmission path, and transmitting the unused directing signals and the message signals over the selected path.

6. The method of communication which consists in sending a message from one point to a predetermined remote point through an intermediate point, storing the message in physical form at the intermediate point, selecting from one of a plurality of transmission paths under the control of the message as stored a path leading to said remote point, and transmitting the message to such remote point as an incident to the selection of said transmission path.

7. The method of relaying a telegraph message through an exchange station which consists in transmitting the message electrically in successive stages, mechanically storing between successive stages the signals representing the message, and selecting an electrical transmission path for each stage under the control of certain of the signals as stored after transmission in the previous stage.

8. In a system of communication, the method of sending a message from one point to another through an intermediate point which consists in first sending the message to the intermediate point together with a directing portion representing the terminal point, feeling of the directing portion mechanically while in signal form to indicate the point to which the message is to be sent, establishing in accordance with such indication a transmission path leading to the desired remote point, and transmitting the message to said desired point.

9. In an automatic signaling system, the method of sending a message from one point to one of a plurality of remote points through one of a plurality of intermediate points which consists in sending the message to one of the intermediate points in advance of the selection of the terminal point, then selecting under the control of the message received at said intermediate point a transmission path leading to the desired terminal point, and transmitting the message over the selected path to the desired terminal point.

10. In a system of communication, the method of sending a message from one point to one of a plurality of remote points through one of a plu-

5 rality of intermediate points, which consists in first selecting an intermediate point adapted for connection with the desired terminal point, sending a message to the selected intermediate point, recording it at such point together with a directing signal representing the desired terminal point, then selecting independently of control from the first point and under the control of the recorded directing signal a transmission path leading to the desired terminal point, and transmitting the message over the selected path to the terminal point.

11. A system for directing the course of a telegraph message over a succession of electrical transmission paths between an originating point and one of a plurality of terminal points through a plurality of intermediate points comprising, in combination, means at said originating point for recording a succession of signal combinations individually representing a predetermined one of said intermediate points and a predetermined one of said terminal points, selecting means responsive to one of said signals for selecting a transmitting path leading to said predetermined intermediate point, means operable to transmit said other signal over said path, recording means at said predetermined intermediate point, and selecting means responsive to the signal as recorded at said intermediate point to select a path leading to said predetermined terminal point.

12. In a system of communication, the method of establishing the course of a message which consists in transmitting line-selecting signals from the originating point to one or more of a plurality of intermediate points, recording the same at the intermediate point or points, and selecting the succeeding path of transmission under the control of a recorded directing signal independently of control from the originating point.

13. In a telegraph system, an exchange station having a plurality of independent paths therein over which messages may be transmitted electrically, and mechanism operable entirely automatically to relay messages over said paths successively including means between successive transmission paths for storing the messages in mechanical form pending retransmission thereof.

14. In a system of telegraphic communication, the method of directing the course of a message from its originating point to a predetermined destination through intermediate relay points, which consists in incorporating in the message as transmitted from the originating point code combinations individually representing the respective relay points, and selecting at each relay point under the control of the code combination representing the next point a transmission path leading thereto.

15. In a telegraph system means for selectively transferring a message in successive electrical transmission stages from an originating point to a predetermined one of a plurality of destinations through a predetermined one of a plurality of intermediate points, said means comprising, in combination, mechanism at said originating point for transmitting the message along with a plurality of control signals collectively representing said predetermined destination and individually representing a path leading to said predetermined intermediate point and a path leading from said intermediate point to said destination, means responsive to said first mentioned control signal to select said first mentioned path leading to said predetermined intermediate point, and means responsive to said second control signal as stored

at said intermediate point to select said path leading to said predetermined destination.

16. The method of selectively transferring a telegraph message to a predetermined destination which consists in electrically transmitting a succession of signal combinations representing the message together with a succession of directing signals collectively representing said destination and individually representing successive relay points through which said message is to be dispatched, recording said combinations in mechanical form at each successive relay point, utilizing one of said direction signals to control the automatic selection of a transmission path leading to the succeeding point, testing the selected path, and effecting retransmission automatically when the path becomes available.

17. In a telegraph system having an originating station, a plurality of intermediate stations and a plurality of terminal stations, the combination of means at said originating station for recording a message in mechanical form with control signals embodied therein representing a predetermined one of said intermediate stations and a predetermined one of said terminal stations, mechanism at said originating station operable in response to said first mentioned control signal to effect transmission of the message to said predetermined intermediate station, means to record the message mechanically at said predetermined intermediate station, and mechanism at said intermediate station operable independently of the mechanism at the originating station and under the control of said other signal to select a transmission path leading to said predetermined terminal station.

18. In a telegraph system the method of message transmission which consists in alternately converting signals representing the message from mechanical to electrical form and vice versa to effect electrical transmission thereof in successive stages while maintaining all of the signals in combination form, and utilizing one of the combinations in mechanical form to select a path for transmission of the message upon the succeeding conversion thereof into electrical form.

19. An apparatus for automatically relaying a message from one point to another through one or more intermediate points successively, each intermediate point having means for receiving and storing a message, a selector operable under the control of a part of the message as stored to establish a transmission path, and means operable automatically to transmit the message with the exception of the aforesaid part over the selected path.

20. The method of automatically relaying a message telegraphically which consists in recording the message in signal form together with a succession of directing signal combinations individually representing successive stations through which the message is to be relayed before reaching its predetermined destination, utilizing one of said directing combinations at each of said stations to select a transmission path leading to the succeeding station, recording the message and the directing combinations at each of said stations pending establishment of the succeeding transmission path, and electrically transmitting the message and the unused directing combinations over said selected path.

21. In a telegraph system, apparatus for transferring a message from one point to another through a succession of intermediate points, means at each of said intermediate points for

storing signals representing the message including one or more directing signals individually designating the succeeding point or points, means operable under the control of the first of said directing signals to select a transmission path leading to the succeeding point, and means operable automatically upon the selection of said path to initiate transmission of the remaining signals thereafter.

22. In a telegraph system, an exchange station having a plurality of independent paths therein over which messages may be transmitted electrically, automatically operable mechanism for relaying messages over said paths successively, and means operating automatically to free each succeeding path upon the transmission of a complete message thereafter.

23. The method of relaying message matter from one point to a remote point, which consists in alternately converting a succession of signal combinations representing the message from electrical to mechanical form and vice versa to effect electrical transmission thereof in successive stages, and incorporating a predetermined control signal in the message upon each conversion to mechanical form.

24. The method of relaying message matter from one point to a remote point, which consists in alternately converting a succession of signal combinations representing the message from electrical to mechanical form and vice versa to effect electrical transmission thereof in successive stages, and automatically adding to the message upon each conversion to mechanical form a control combination of invariable character.

25. In an automatic telegraph system in which a message is selectively relayed to a predetermined destination in successive electrical transmission stages, the combination of a device for effecting one stage of transmission, a traveling medium controlling said transmitting device and adapted to carry a succession of signals representing the message together with a plurality of directing signals to be used individually in controlling the selective transmission of the message in its different stages, a selector mechanism by which said devices may be connected selectively to one of a plurality of transmission paths, and means controlling said mechanism and operable to distinguish between the directing signal to be used in selecting a path of transmission and the directing signal to be used in selecting the path of transmission for the succeeding stage of transmission.

26. A mechanism for directing the course of a telegraph message over successive independent electrical transmission paths comprising, in combination, a traveling medium at the transmitting end of each of said paths for storing the message in mechanical form together with a succession of directing signals individually representing successive ones of said transmission paths over which the message is to be sent, a selector mechanism controllable by one of the directing signals on said medium to select the next transmission path, said selector mechanism having means associated therewith capable of differentiating between the directing signal to be used in selecting one transmission path and the directing signals for selecting the succeeding paths.

27. In a telegraph system, apparatus for transferring message matter from one point to any one of a plurality of receiving units selectively comprising, in combination, means for storing a suc-

cession of signals in mechanical form represented by a plurality of units each having either of two differentiating characteristics, and a selector mechanism adapted for control by certain of the stored signals to select a transmission path leading to one of said receiving units predetermined by the character of the several units of the signal.

28. An apparatus for transferring a message from one point to another automatically having, in combination, means for storing a succession of signals in the form of mechanical combinations and including a directing signal, and means governed in accordance with the character of the individual units of the directing signal for sending the message to one of a plurality of remote points selectively.

29. In a system of communication having a plurality of paths respectively leading from one point to a plurality of remote points, the combination of a signal carrier and a mechanism for selecting one of said paths and adapted for control by a signal on said carrier composed of a plurality of units each having either of two differentiating characteristics, said mechanism including a plurality of elements arranged to be set in accordance with the character of the several units of said signal, the number of selections which may be made by said mechanism being determined by the number of units in said signal.

30. In a telegraph apparatus, the combination of a storage medium adapted to contain a succession of signals composed of an equal number of units each having either of two differentiating characteristics, one of said signals constituting a directing signal representing the destination of the message, and means operating under the control of said directing signal to select from a plurality of transmission paths one leading to said destination.

31. In a telegraph system, apparatus for transferring a message from one point to any one of a plurality of other points selectively comprising, in combination, means for storing a succession of signals in mechanical form represented by a plurality of units each having either of two differentiating characteristics, and a selector mechanism adapted for control by one of the stored signals to select a transmission path leading to one of said receiving units.

32. In a telegraph system having a transmitting station and a plurality of receiving stations, the combination of a plurality of transmission paths each leading from said transmitting station to one of said receiving stations, a signal storage medium at said transmitting station, means to record on said medium a plurality of signals representing a message and a predetermined one of said receiving stations, and means operating automatically in accordance with the character of said last mentioned signal to select the transmission path leading to said predetermined receiving station.

33. An apparatus for transferring a message from one point to another automatically having, in combination, means for storing a succession of signals each in the form of a mechanical signal combination and including a preceding selecting signal representing in codal form a predetermined destination, means operating automatically according to the character of the combination of said selecting signal to select from a plurality of different paths one leading to said destination, and means rendered operative upon the selection of the path to control the transmission of the message signals thereover.

34. The method of transferring a message to one of a plurality of remote points selectively which consists in combining with the message a code signal composed of a plurality of units arranged in a preconcerted combination and representing one of the remote points, and directing the course of the message under the control of said signal.

35. In a system of communication, the combination of a carrier having groups of elements adapted to be arranged in different combinations to represent signals, means operating under the control of certain of said signals as determined by the position thereof relative to the other signals to select a transmission path in accordance with the codal character of such signals, and means operable to transmit the signals not including the used selecting signal over said path.

36. In a telegraph apparatus, the combination of a carrier having signals stored thereon in mechanical form to represent a message, means operating under the control of the first of said signals as stored on the carrier to select a transmission path, means for transmitting the remaining signals over the selected path, and means operating under the control of the signals at the end of the message to free the selected path.

37. In a telegraph system having a medium upon which a message may be stored in signal form, a line selecting mechanism, and a switching means, the method of transferring the message signals from said medium to one of a plurality of points selectively which consists in operating said mechanism in accordance with the first of the stored signals of the message to select an electrical transmission path and thereafter operating said switching means to transmit the remaining signals only over said path.

38. In a system of communication, the combination of a transmitting unit, a plurality of receiving units, a plurality of transmission paths leading from said transmitting unit to said receiving units respectively, a selecting mechanism adapted for control by signals in the form of a plurality of units each having either of two differentiating characteristics and operable to select any one of said paths, said selecting mechanism including a plurality of selecting elements adapted to occupy either of two set positions corresponding to the different units of the selecting signal, a plurality of switches each individual to one of said transmission paths, means operable upon the setting of said elements in a predetermined combination to control a predetermined one of said switches and for establishing a transmission path leading from said transmitting unit.

39. In a telegraph system, the combination with a traveling medium carrying a plurality of elements having either of two differentiating characteristics and grouped to constitute signal combinations, means for selecting one of a plurality of transmission paths over which said signals are to be transmitted including a plurality of individually adjustable code members, and means operable upon said members simultaneously to effect a setting thereof in a combination corresponding to the individual character of a plurality of the elements on said medium.

40. In a telegraph system, the combination of a traveling storage medium adapted to contain a succession of individual signal combinations, and a line selector mechanism comprising a series of code bars, a series of combination bars, means for setting said code bars in accordance with certain of said signal combinations to effect

the movement of the combination bars selectively, and a switching means associated with each of said combination bars and operable in the movement thereof to establish a predetermined transmission path.

41. An automatic telegraph system having a relay mechanism with means for recording a message in the form of mechanical signal combinations, and means for selecting a transmission path operating entirely mechanically under the control of certain of said combinations.

42. An apparatus for transmitting a message from one point to another automatically comprising, in combination, a traveling storage medium, means operable mechanically to select a transmission path, and power-actuated means operable as an incident to the movement of the storage medium to operate said selecting means.

43. In a system of communication, the combination of mechanism for selecting one of a plurality of transmission paths, comprising a plurality of selector elements, a traveling medium for storing mechanical signal combinations, a feeler operatively associated with said storage medium, and means operating under the control of said feeler for governing the movements of said selector elements.

44. In a system of communication, the combination of a storage medium adapted to contain message matter in the form of mechanical signal combinations and including a directing signal, a feeler operatively associated with the storage medium, means for advancing the storage medium relative to said feeler so as to present said directing signal thereto, a plurality of elements each controlling the establishment of a transmission path, and means operating under the control of said feeler to select one of said elements.

45. In a telegraph apparatus, the combination of a storage medium adapted to contain a succession of individual signal combinations, means for advancing the storage medium, a plurality of transmission paths, a feeler operable in the advance of said medium and responsive to one of said signal combinations according to the individual character of the several units thereof, and a selector mechanism operating under the control of said feeler to select one of said transmission paths.

46. In a system of communication, the combination of a selector mechanism including a series of individually movable elements, a storage medium adapted to contain a succession of individual signal combinations, a feeler, means for presenting the first signal combination to said feeler to operate it, means controlled by said feeler for advancing the storage medium, and a second feeler for controlling the operation of said selector mechanism in accordance with the character of said first signal combination.

47. In a telegraph apparatus, the combination of a traveling signal carrier having groups of elements arranged in different combinations to form a succession of signals, transmitting means, means for selecting a path of transmission, and a feeler operative in accordance with the character of the stored signals to control the selecting means and the transmitting means respectively depending upon the position of said signals on the carrier.

48. An apparatus for automatically relaying a message from one point to another comprising, in combination means for recording the message in the form of a succession of signals in mechanical form, and a mechanism for selecting an electrical

transmission path having means adapted to recognize one of said signals by the position thereof relative to the other signals of the message, said mechanism being operable under the control of said signal according to the individual character of the several units thereof.

49. In a telegraph system, the combination of a plurality of electrical transmission paths, a traveling medium adapted for carrying a succession of mechanical signals representing successive messages to be transmitted selectively over said paths, each message comprising a directing signal of variable character, a plurality of message signals of variable character, and a signal of invariable character representing the end of the message and immediately following the last of said message signals, a transmitter, a selector for determining the paths over which the successive messages shall be transmitted, and mechanisms operable in the advance of said medium for controlling said selector in accordance with the character of the directing signals only and the transmitter in accordance with the message signals only of successive messages, said selector and transmitter being nonresponsive to the end of message signals.

50. In a telegraph system, the combination of a plurality of electrical transmission paths, a traveling medium adapted for carrying a succession of mechanical signals representing successive messages to be transmitted selectively over said paths, each message comprising a directing signal and a plurality of message signals, a transmitter, mechanism for selectively establishing any one of said transmission paths, and means operable in the advance of said medium to render said selector mechanism responsive to said directing signals only of successive messages and said transmitter responsive to the message signals only.

51. In a telegraph system including transmission paths, a storage medium for successive permutation codes constituting messages, a transmitter actuable by and in accordance with said codes to relay a message over one of said paths, end-of-message mechanism controllable to stop transmission from said transmitter, feelers selectively conditionable by and in accordance with said codes, and means controlled by the feeling of a consecutive sequence of suitably selected identical code combinations to control said end-of-message mechanism to stop said transmitter.

52. In a telegraph system including transmission paths, a storage medium for successive permutation codes comprising message codes and chosen sequences of codes not employed in the messages, a transmitter actuable by and in accordance with said codes to relay a message over one of said paths, end-of-message mechanism operable to halt transmission from said transmitter, elements controllable by and in accordance with codes stored in said medium to recognize in said codes one of said chosen sequences of codes, and means operable incident to the recognition thereof to operate said end-of-message mechanism to a transmission halting condition.

53. In a telegraph apparatus, the combination of a carrier for signals stored in mechanical form, means operating under the control of certain of said signals to select a transmission path, and transmitting means operable independently of said selecting means and under the control of other signals to transmit the same electrically over the selected path.

54. A telegraph apparatus comprising, in com-

bination, a signal carrier, and line selecting means and transmitting means successively operable under the control of different signals according to their relative positions on the carrier.

55. In a telegraph system, the combination of a medium upon which a message may be stored in signal form, a selecting mechanism, a switching means for establishing a transmission path, and means for operating said selector mechanism in successive steps, first in accordance with the character of certain of the stored signals to select an electrical transmission path leading to a predetermined point, and then to operate said switching means to establish said path.

56. In a telegraph apparatus, the combination of a storage medium having groups of elements arranged in various combinations to form a succession of signals each having a plurality of units adapted to occupy one of two different positions, one of said signals being a control signal, means adapted to recognize the control signal by the position thereof relative to the other signals, and means operating under the control of the last mentioned means and in accordance with the individual character of the several units of the control signal for effecting automatic transmission of the remaining signals to a predetermined point.

57. A telegraph apparatus having, in combination, a line selecting mechanism comprising a series of code bars, a series of combination bars movable selectively under the control of the code bars, a signal responsive means for setting said code bars, and a plurality of switching means respectively controlled by said combination bars to establish different transmission paths.

58. In a telegraph system, the combination of a medium upon which signals may be recorded in the form of mechanical combinations each having a plurality of units of varying character, a transmitter adapted to be controlled by the combinations on said medium, a plurality of transmission circuits associated with said transmitter, switching means in each of said circuits by which said transmitter may be associated with one of said circuits, and mechanism for operating said switching means selectively according to the individual character of each unit of a signal combination stored on said medium.

59. In a telegraph system, the combination of a transmitter having a plurality of switches, a plurality of receivers, a plurality of transmission paths each leading from said transmitter to one of said receivers and each comprising a plurality of circuits, each circuit including one of said switches, means at said transmitter for storing a succession of mechanical signal combinations each composed of a plurality of units arranged to control the respective transmission switches, and switching means by which said transmitting switches may be associated with the path leading to any one of said receivers.

60. In a telegraph system, the combination of a transmitter having a plurality of switches, a plurality of receivers, a plurality of transmission paths each leading from said transmitter to one of said receivers and each comprising a plurality of circuits, each circuit including one of said switches, means at said transmitter for storing a succession of mechanical signal combinations each composed of a plurality of units arranged to control the respective transmission switches, and a code bar selector controllable in accordance with the individual character of certain combinations stored on said medium and

having a plurality of combination bars each constituting a common means for effecting closure of all of the switches controlling the circuits for establishing one of said paths.

61. In a telegraph system, the combination of a storage medium adapted to contain a succession of individual signal combinations, a line selecting mechanism operable under the control of one of said combinations, means for advancing the storage medium, a first switching means operable by said selecting mechanism to establish a transmission path, and a second switching means operable in the advance of the storage medium in response to the succeeding signals to effect the transmission thereof over the selected path.

62. In a telegraph system, the combination of a storage medium comprising a series of individual signal carriers each having a group of pins thereon adapted to be set in different combinations, a line-selector including a feeler responsive to the setting of said pins, a series of code bars, a series of combination bars selectively operable under the control of the code bars, and means for setting said code bars under the control of said feeler.

63. In a telegraph system, the combination of a storage medium comprising a series of individual signal carriers each having a row of pins thereon adapted to be set in different combinations, a series of elements pivoted on axes disposed substantially perpendicular to the axes of said pins, means for advancing one of said signal carriers into operative relation to said elements to move the same into a corresponding combination, a line-selector comprising a series of code bars and a series of combination bars, and means responsive to the setting of said elements for setting the code bars to correspond with the setting of said elements whereby to effect the movement of said combination bars selectively.

64. In a telegraph apparatus, the combination of a storage medium comprising a series of individual signal carriers each having a plurality of individually movable members adapted to be set in different combinations, a series of movable elements one for each of said members, means for advancing one of said signal carriers into operative relation to said elements to move the same into a corresponding combination, a line-selector controlled by said elements comprising a series of code bars and a series of combination bars, and means operable to transfer the combination from said elements to said code bars to effect the movement of said combination bars selectively.

65. In a telegraph apparatus, the combination of a storage medium comprising a series of individual signal carriers each having a plurality of individually movable members adapted to be set in different combinations, a series of movable elements one for each of said members, means for advancing one of said signal carriers into operative relation to said elements to move the same into a corresponding combination, and a line-selector controlled by said elements comprising a series of code bars and a series of combination bars selectively operable under the control of the code bars, and transfer means between said code bars and said elements including a reciprocating carrier having a series of set devices and movable in one direction into operative association with said elements to be set in accordance therewith and in the opposite direction

into engagement with the code bars to set the latter.

66. In a telegraph system, the combination of a traveling medium adapted to carry parallel rows of signal elements constituting combinations, a plurality of individually movable feeler members pivoted on parallel axes extending parallel to the direction of movement of said medium, an arm on each of said members projecting into feeling relation to the elements in one of said rows so as to be swung about its axis according to the individual character of the passing signal elements, a selector having a plurality of members movable respectively in the planes of said axes, and an arm on each of said feeler members positioned to block the corresponding selector member when the feeling member is in normal position.

67. In a telegraph apparatus, the combination of a signal storing medium carrying longitudinal rows of signal elements, a plurality of individually movable members each operable in the advance of said medium to feel successively of the elements in one of said rows so as to remain in normal position when a passing element is of one character and to be shifted out of normal position if the element is of a different character, a selector having a plurality of individually movable elements adapted for movement into feeling engagement with said members so as to be set in accordance with the positions of the members, and means operable to effect movement of said selector elements into operative association with said members and then to free the members so as to permit actuation thereof by other elements on said medium.

68. In a telegraph apparatus, the combination of a signal storing medium carrying a plurality of groups of signal elements, a plurality of individually movable members one for each element of said groups and operable in the advance of said medium to feel successively of the groups of elements, each member remaining in normal position when its corresponding element is of one character and being shifted out of normal position if such element is of a different character, a selector having a plurality of individually movable elements adapted for movement into feeling engagement with said members so as to be set in accordance with the positions of the members, and means supporting said members and arranged to sustain the pressure of said feeling engagement.

69. In a telegraph apparatus, the combination of means for storing signals representing a message, a plurality of transmission paths, a signal responsive mechanism for selecting one of said paths, a transmitter, and means controlled by said mechanism for initiating the operation of said transmitter to send said message over the path selected thereby.

70. In a telegraph system having a transmitting station and a plurality of receiving stations, the combination of means at said transmitting station for storing a message to be sent to a predetermined one of said receiving stations, signal responsive means operable to select a transmission path leading to said predetermined receiving station, and means operable automatically upon the selection of said path to initiate transmission of the message thereover.

71. In a telegraph system having a transmitting station and a plurality of receiving stations, the combination of means at said transmitting station for storing a message to be sent to a predetermined one of said receiving stations, signal re-

sponsive mechanism operable to select a transmission path leading to said predetermined receiving station, means for testing the selected path, and means controlled by said testing means for initiating transmission of the message over said path.

72. In a telegraph system, the combination of a plurality of electrical transmission paths leading to remote receiving stations, a transmitter associated with each of said paths, a signal storing medium for presenting messages in signal form to said transmitter, a selector for determining the path over which successive messages are to be transmitted, and mechanism for testing the selected path, said mechanism being immediately associated with and arranged to control the operation of said transmitter.

73. In a telegraph system having a transmitting station and a plurality of receiving stations, the combination of means at said transmitting station for storing a message to be sent to a predetermined one of said receiving stations, signal responsive mechanism operable to select a transmission path leading to said predetermined receiving station, means rendered operative automatically as an incident to the operation of said selecting mechanism to determine whether said predetermined receiving station is available, and means controlled by said last mentioned means and operable when said path is found to be available to initiate transmission of the message over said path.

74. In a system of communication having a transmitting unit and a plurality of receiving units, a plurality of paths leading from said transmitting unit to said receiving units respectively, a selecting mechanism adapted for control by signals in the form of a plurality of units each having either of two differentiating characteristics and operable to select any one of said paths, said selecting mechanism including a switch, means rendered operative upon the closure of said switch to test the condition of the selected path, and means controlled by said testing means and operable when the selected path is found to be available to initiate transmission of a message thereover.

75. In a telegraph system having a plurality of transmitting stations and a plurality of receiving stations, the combination of a plurality of electrical transmission paths for connecting each of said transmitting stations with each of said receiving stations, means at each of said transmitting stations for mechanically storing a succession of signals to be transmitted to different ones of said receiving stations, automatic selecting mechanism at each of said transmitting stations arranged to be controlled by certain stored signals of each message and operable to select transmission paths leading to predetermined ones of said receiving stations, a transmitter at each of said transmitting stations, mechanism at each of said transmitting stations operating automatically following the operation of said selecting mechanism to determine whether the receiving station selected thereby is available, and means controlled by said testing mechanism for initiating the operation of the associated transmitter.

76. In a telegraph system, apparatus for transferring a message from one point to any one of a plurality of other points selectively comprising, in combination, means for storing a succession of signals in mechanical form represented by a plurality of units each having either of two differentiating characteristics, and a selector

mechanism adapted for control by one of the stored signals to select a transmission path leading to one of said receiving units, said selector mechanism including a series of elements responsive respectively to the character of the individual units of the stored signal, a switching means controlled in accordance with the setting of said elements, and means rendered operative by said switching means to initiate transmission of a message over the selected path.

77. An apparatus for automatically relaying a message from one point to another comprising, in combination, a storage medium, advancing means for the storage medium, means for recording a message on said storage medium, a transmitter operable in the advance of said storage medium, means operable under the control of a part of the message as stored to select a predetermined transmission path, and means operable after the selection of said path to initiate the advance of said storage medium.

78. In a system of communication having a transmitting unit and a plurality of receiving units, the combination of a plurality of paths respectively leading from said transmitting unit to said receiving units, a selecting mechanism adapted for control by signals in the form of a plurality of units each having either of two differentiating characteristics and operable to select any one of said paths, the number of selections which may be made by said selecting mechanism being determined by the number of said units, and means rendered operative by said mechanism to test the condition of the selected path.

79. In a telegraph system, the combination of a plurality of signal receivers, a transmitter, a plurality of transmission paths each extending from said transmitter to one of said receivers, a selector associated with said transmitter, and a plurality of testing circuits corresponding respectively to said receivers and adapted to be rendered operative selectively in the operation of said selector, said testing circuits being separate from said transmission paths and associated with said transmitter.

80. In a telegraph system, the combination of a signal transmitter, a plurality of signal receivers, electrical transmission paths by which said transmitter may be connected selectively with any one of said receivers, a single mechanism associated with said transmitter and operable to determine whether any of said receivers are in use, a plurality of circuits each having a switch located adjacent said transmitter and operable to render said mechanism operative to test one of said receivers, and means for effecting closure of said switches selectively.

81. In a telegraph system, the combination of a signal transmitter, a plurality of signal receivers, electrical transmission paths by which said transmitter may be associated selectively with any one of said receivers, a mechanism associated with said transmitter for testing the condition of any of said receivers, said mechanism including an electromagnet, a plurality of circuits arranged in parallel with each other and in series with said electromagnet, and signal responsive means for rendering said circuits operative selectively.

82. The method of transferring a message to a predetermined destination telegraphically in a plurality of successive independent stages which consists in selecting a path for each transmission stage, periodically testing the condition of said path while retaining the selection thereof, and

initiating transmission over the selected path when said path becomes available.

83. In a telegraph system, the combination of a transmission path, a plurality of transmitters each arranged to send signals over said path, a normally inactive means associated with each of said transmitters and adapted when rendered active to test the condition of said path, and means for rendering the testing means of the different transmitters active one at a time.

84. In a telegraph system, the combination of a plurality of transmission paths, a plurality of transmitters each adapted to send message matter over any one of said paths, a plurality of testing circuits one for each of said transmitters, a plurality of normally open switches each in one of said circuits, and means for causing closure of said last mentioned switches one at a time.

85. In a telegraph system, the combination of a plurality of transmission paths, a transmitter, an electromagnet associated with said transmitter, a plurality of switches arranged in parallel relation to each other and in series relation to said electromagnet each corresponding to one of said paths, a travelling medium for carrying signals and controlling said transmitter, means operable to close said switches selectively, a switch in series with said electromagnet, and means operable to close said last mentioned switch periodically.

86. In a telegraph system, the combination of a plurality of electrical transmission paths, a plurality of transmitters each operable to send message matter over any one of said paths, a plurality of testing means each individual to one of said transmitters and operable to determine the condition of the different paths, each of said testing means including an electromagnet and a normally open switch in series relation, and constantly operating means to close the switches of said testing means one at a time.

87. In a telegraph system, the combination of a plurality of electrical transmission paths, a plurality of transmitters each capable of sending signals selectively over any one of said paths and having a travelling signal-storing medium controlling the character of the transmitted signals, and means operable as an incident to the sending of signals over one of said paths for preventing the advance of the storage medium of any other transmitter which may have selected the same path.

88. In a telegraph system, the combination of a plurality of electrical transmission paths, a telegraph transmitter arranged to send messages over any one of said paths, a signal-storing medium associated with said transmitter, means controlled in accordance with said signals on said medium to select one of said transmission paths, means rendered operative upon such selection to test the condition of the selective path, and means operated by said testing means when the selected path is found to be available to initiate the transmission of a message stored on said medium and to seize the path and thereby prevent seizure thereof by other transmitters associated with the path.

89. In a telegraph system, the combination of a telegraph receiving unit, a plurality of transmitters each capable of association with said unit to send signals thereto, each of said transmitters having a traveling signal storing medium controlling the character of the transmitted signals, switching means operable to preparedly associate more than one of said transmitters with said receiving unit, time assigning means operable to

assign times for initiation of transmission by said transmitter when so preparedly associated, and means operable incident to initiation of transmission by one of said associated transmitters to prevent transmission by associated others thereof.

90. In a telegraph system, the combination of a telegraph receiving unit, a plurality of transmitters each capable of association with said unit to send signals thereto, each of said transmitters having a traveling signal storing medium controlling the character of the transmitted signals and advancing means therefor, switching means operable to conditionally associate more than one of said transmitters with said receiving unit, time assigning means operable to assign times for initiation of transmission by said transmitter when so associated, and means operable incident to initiation of transmission by one of said associated transmitters to withhold operation of the advancing means for the medium of other of said transmitters.

91. In a telegraph system, the combination of a telegraph receiving unit, a plurality of transmitters each capable of conditional association with said unit to send signals thereto, each of said transmitters having a traveling signal storing medium controlling the character of the transmitted signals, switching means capable of conditionally associating more than one of said transmitters with said receiving unit, assigning means operable to complete the association of one of said conditionally associated transmitters with said unit, and means operable coincidentally with the completion of such association to prevent the completion of association of any other of said transmitters with said unit until the association already completed has been discontinued.

92. In a telegraph system, the combination of a telegraph receiving unit, a plurality of transmitters each capable of partial association with said unit to send signals thereto, each said transmitter having a traveling means stored with signals relatively movable with respect to itself and controlling the character of the transmitted signals, switching means operable to conditionally associate more than one of said transmitters with said receiving unit, time assigning means operable to assign times for initiation of transmission by said transmitters when so conditionally associated, means operable incident to initiation of transmission by one of said associated transmitters to prevent initiation of transmission by conditionally associated others thereof, certain of said signals functioning as an end-of-message signal, and means operable by arrival of said end-of-message signal at a transmitter when transmitting to discontinue transmission therefrom and cause said time assigning means to initiate transmission from another transmitter.

93. In a telegraph system, the combination of a telegraph receiving unit, a plurality of transmitters each capable of preliminary assignment for association with said unit to send signals thereto, each of said transmitters having a signal storing medium movable with respect thereto controlling the character of the signals transmitted, switching means capable of preliminarily assigning for association more than one of said transmitters with said receiving unit, assigning means operable to complete the association of one of said preliminarily assigned transmitters with said unit, means operable coincidentally with the completion of such association to prevent the completion of association of any other of said

preliminarily assigned transmitters with said unit until the association of any one already completed has been discontinued, means operable by arrival at a transmitting transmitter of an end-of-message signal to discontinue the complete association of said transmitter with said unit, and means operative incidental to such discontinuance to cause said assigning means to refunction to complete the association of a preliminarily assigned transmitter with said unit.

94. In a telegraph system, the combination of a telegraph receiving unit, a plurality of transmitters, means whereby each is capable of preliminary assignment for association with said unit to send signals thereto, each of said transmitters having a signal storing medium movable with respect thereto controlling the character of the signals transmitted, switching means capable of preliminarily assigning for association more than one of said transmitters with said receiving unit, means operable when said unit is idle to complete the association of one of said preliminarily assigned transmitters with said unit, means operable coincidentally with the completion of such association to prevent the completion of association of any other of said preliminarily assigned transmitters with said unit until the association already completed has been discontinued, means operable by arrival at a transmitting transmitter of a portion of said medium representing an end-of-message signal to discontinue the complete association of said transmitter with said unit, and means caused to operate by said discontinuance to permit said assigning means to refunction to complete the association of one of said preliminarily assigned transmitters with said unit.

95. In a telegraph system, the combination of a telegraph receiving unit, a plurality of transmitters each capable of preliminary assignment for association with said unit to send signals thereto, each of said transmitters having a signal storing medium movable with respect thereto controlling the character of the signals transmitted, switching means capable of preliminarily assigning for association more than one of said transmitters with said receiving unit, assigning means operable to complete the association of one of said preliminarily assigned transmitters with said unit, means operable coincidentally with the completion of such association to prevent the completion of association of any other of said preliminarily assigned transmitters with said unit until the association of any one already completed has been discontinued, and means operable by arrival at a transmitting transmitter of an end-of-message signal to discontinue the advance of the medium of said transmitter with respect to its transmitter.

96. In a telegraph system, the combination of a telegraph receiving unit, a plurality of transmitters each capable of preliminary assignment for association with said unit to send signals thereto, each of said transmitters having a signal storing medium movable with respect thereto controlling the character of the signals transmitted, switching means capable of preliminarily assigning for association more than one of said transmitters with said receiving unit, assigning means operable to complete the association of one of said preliminarily assigned transmitters with said unit, means operable coincidentally with the completion of such association to prevent the completion of association of any other of said preliminarily assigned transmitters with said unit

until the association of any one already completed has been discontinued, means operable by arrival at a transmitting transmitter of an end-of-message signal to stop transmission from said associated transmitter.

97. In a transmission system, the combination of a channel of transmission, a plurality of transmitters of permuted codes, each capable of preliminary assignment for association to said channel to send permutation codes thereover, and each provided with an advanceable signal impressed medium to control its transmission, switching means operable to preliminarily assign for association with said channel more than one of said transmitters, automatically operable means to complete the association of one of said preliminarily assigned transmitters to said channel, means operable coincidentally with such completion to prevent the completion of association of any other of said preliminarily assigned transmitters until the association of the one completed has been discontinued, and means operable by arrival at said transmitter of a portion of said medium impressed with an end-of-message permutation code or codes to discontinue transmission from said transmitter.

98. In a telegraph system, the combination of a plurality of electrical transmission paths, a telegraph transmitter arranged to send messages over any one of said paths, a signal-storing medium associated with said transmitter, means controlled in accordance with said signals on said medium to select one of said transmission paths, means rendered operative upon such selection to test the condition of the selected path including an electromagnet adapted to be energized when the selected path is found to be available, means controlled by said magnet to initiate transmission of a stored message over the selected path, and means controlled by the energization of said magnet and operable to prevent seizure of the selected path by other transmitters associated therewith.

99. In a telegraph system, the combination of a plurality of transmitting devices, a plurality of electrical transmission paths leading from each of said devices, a plurality of busy test circuits each associated with one of said transmitting devices and adapted when closed to test the condition of a transmission path leading to a predetermined remote point, each of said circuits including an electromagnet adapted when energized to a predetermined degree to initiate transmission over said predetermined path, and means rendered operative by the energization of said magnet to prevent effective energization of the magnets of the other busy test circuits as regards the establishment of a path leading to said predetermined point.

100. In a telegraph system, the combination of a signal receiving device, a plurality of transmitting devices, a plurality of electrical transmission paths each originating at one of said transmitting devices and terminating at said receiving device, a plurality of busy test mechanisms each associated with one of said transmitting devices and operable to test the condition of the path leading from the associated transmitting device to said receiving device and to initiate transmission over such path when the same is found to be available, said mechanism having means operating automatically in the establishment of the path to render the busy test mechanisms at the other transmitting devices inop-

erative to seize the path leading to said receiving device.

101. In a telegraph system, the combination of a plurality of electrical transmission paths leading to remote receiving stations, a transmitter associated with each of said paths, a signal storing medium for presenting messages in signal form to said transmitter, a selector for determining the path over which successive messages are to be transmitted, and a plurality of testing circuits arranged in parallel relation and having a common electromagnet therein for controlling the operation of said transmitter, each of said circuits being operative to test the condition of the transmission path selected in the operation of said selector.

102. In a telegraph system, the combination of a signal transmitter, a plurality of signal receivers, electrical transmission paths by which said transmitter may be associated selectively with any one of said receivers, a mechanism for controlling the operation of said transmitter including an electromagnet, a plurality of circuits each individual to a path between said transmitter and one of said receivers, and each having a control switch therein, and signal responsive means associated with said transmitter for operating said switches selectively.

103. In a system of communication having a transmitting unit and a plurality of receiving units, the combination of a plurality of paths leading from said transmitting unit to said receiving units respectively, a selecting mechanism adapted for control by signals in the form of a plurality of units each having either of two differentiating characteristics and operable to select any one of said paths, said selecting mechanism including a plurality of selecting elements adapted to occupy either of two set positions corresponding to the different units of the selected signal, a plurality of switches each individual to one of said transmission paths, means operable upon the setting of said elements in a predetermined combination to control a predetermined one of said switches, and means operable automatically upon the actuation of one of said switches to initiate transmission of a message over the transmission path corresponding thereto.

104. In a system of communication having a transmitting unit and a plurality of receiving units, the combination of a plurality of paths leading from said transmitting unit to said receiving units respectively, a selecting mechanism adapted for control by signals in the form of a plurality of units each having either of two differentiating characteristics and operable to select any one of said paths, said selecting mechanism including a plurality of selecting elements adapted to occupy either of two set positions corresponding to the different units of the selecting signal, a plurality of switches each individual to one of said transmission paths, means operable upon the setting of said elements in a predetermined combination to control a predetermined one of said switches, testing means controlled by the selected switch to determine whether the selected path is available, and means for initiating transmission of a message over the selected path when it is found to be available by said testing means.

105. In an automatic telegraph system, the combination of a relay mechanism with means for storing a message in mechanical form, a line-selector operable under the control of a part of the message as stored, means for effecting trans-

mission over the selected path automatically, and a busy test mechanism for preventing transmission by said last mentioned means while the selected path is in use.

106. In a telegraph apparatus, the combination of a signal carrier, a governing mechanism adapted to control the advance of the signal carrier, means controlled by certain of the signals on said carrier according to the character thereof to control the operation of the governing mechanism, and means operating independently of the governing mechanism for initiating the advance of the signal carrier.

107. In telegraph apparatus, the combination of a storage medium adapted to contain a succession of signals stored in mechanical form and representing a message, and means operable to select a transmission path and transmit the message thereover including a message cycling-mechanism, and a feeler responsive to the first signal on the storage medium to initiate the operation of the cycling mechanism, and means operable independently of the cycling mechanism for advancing the carrier relative to said feeler.

108. In a telegraph apparatus, the combination of a storage medium for message matter, means for advancing the storage medium, a signal-responsive device, a power-actuated governor controlled by said device and operable to interrupt the advance of the storage medium and then to restart the same, and other means controlled by the presence or absence of another message on the storage medium for controlling said advancing means.

109. In a telegraph apparatus, the combination of a travelling medium for storing messages in signal form, a mechanism arranged to execute a multi-step cyclic movement in the transmission of each message recorded on said medium, means controlled by said mechanism for alternately stopping and starting said medium in the successive movements of said mechanism, and means operable independently of said mechanism for initiating the advance of said medium while the mechanism is at rest following the execution of each message cycle.

110. In a telegraph apparatus, the combination of a storage medium for message matter, means operative to advance the storage medium, transmitting means operative in the advance of the storage medium, a power-actuated governor operative to control the advance of the storage medium to effect the transmission of message matter, means operating to detect the approach to the transmitting means of the end of a message and adapted to interrupt the advance of the storage medium through the operation of said governor, said governor being operable to permit the advance of the storage medium to be restarted at a predetermined point after stopping, and other means for controlling such restarting of the storage medium controlled by the presence or absence on the storage medium of another message awaiting transmission.

111. In telegraph apparatus, the combination of a storage medium adapted to contain a succession of signals stored in mechanical form and representing a message, and means operable to select a transmission path and transmit the message thereover including a message cycling-mechanism, and a feeler for controlling the same responsive only to the signals at the beginning and end of the stored message.

112. In telegraph apparatus, the combination of a storage medium adapted to contain a succes-

sion of signals stored in mechanical form and representing a message, and means operable to select a transmission path and transmit the message thereover including a message cycling-mechanism, and a feeler responsive to the first signal on the storage medium to initiate the operations of the cycling mechanism.

113. In telegraph apparatus, the combination of a storage medium adapted to contain a succession of individual signal combinations, means for advancing the storage medium including a power driven mechanism, and means including a feeler responsive to said signal combinations according to the individual character thereof and operable to control said mechanism.

114. An apparatus for transferring a message from one point to another automatically comprising, in combination, a travelling storage medium, means adapted to select a predetermined transmission path, a power-actuated means for operating the selecting means including a clutch, and means operable as an incident to the movement of the storage medium for controlling said clutch.

115. A telegraph apparatus having, in combination, a signal carrier, means for advancing said carrier past a predetermined point of control, a governor for controlling the advance of the carrier having a driving clutch including a rotatable connecting member, a detent for controlling said member, and means operating as an incident to the approach of message matter on the signal carrier to said control point for controlling said detent.

116. In telegraph apparatus, the combination of a storage medium adapted to contain a succession of individual signal combinations, means for initiating the advance of the storage medium, means for selecting a transmission path, transmitting means whereby said signal combinations may be transmitted in electrical form over the selected path, a governing mechanism operable in successive steps to control the selection of said transmission path and the transmission of said signals thereover and means controlled by the advance of the storage medium for initiating the operation of the governor.

117. In a telegraph apparatus, the combination of a travelling storage medium, a transmitting means, a mechanism for selecting a transmission path, and means for controlling said selecting mechanism and said storage medium to effect successively the selection of a path of transmission, transmission over said path, and the freeing of the selected path, the operation of said control means being initiated in the advance of the storage medium.

118. In a telegraph apparatus, the combination of a carrier for a succession of signals, advancing means for said carrier, a line selector mechanism including a feeler responsive to one of said signals, and a governing means operable to stop the advance of the carrier after presenting said signal to said feeler.

119. In telegraph apparatus, the combination of a storage medium adapted to contain a succession of individual signal combinations, a feeler, and means for advancing the storage medium to present the first of said signal combinations to said feeler including a power driven mechanism, and a second feeler for controlling said mechanism.

120. In telegraph apparatus, the combination of a storage medium comprising a chain having a series of links each having a plurality of pins

certain of which are pushed and certain of which are non-pushed to represent different signal combinations, certain of said links having all of their pins set to represent blanks, signal-responsive means, a feeler having a series of shoes one for each of said pins so as to be movable by one or more pins in the advance of the chain, and means for controlling the advance of the chain including a governor adapted to be driven at a predetermined speed and having a clutch operated by said feeler, said feeler being positioned a predetermined point in advance of the signal-responsive means so as to effect the stoppage of the chain with the first non-blank link opposite said signal-responsive means.

121. In telegraph apparatus, the combination of a movable signal carrier, a mechanism for selecting a path over which a message recorded on said carrier may be sent, means operable to present a signal on said carrier to said mechanism, a power actuator for said mechanism releasable from a normal rest position and operable in its movement to control the operation of said mechanism in accordance with the character of said signal, and means operable in the movement of said carrier to control the release of said actuator.

122. In telegraph apparatus, the combination of a movable signal carrier, a mechanism for selecting a path over which a message recorded on said carrier may be sent, means operable to present a signal on said carrier to said mechanism, and a power actuator for said mechanism releasable from a normal rest position and operable in its movement to control the operation of said mechanism in accordance with the character of said signal.

123. An apparatus for transferring a message from one point to another automatically comprising, in combination, a travelling storage medium having a succession of signals stored thereon in mechanical form, mechanism operable to select a predetermined transmission path, and means operable as in incident to the movement of the storage medium to actuate said selecting mechanism, said means including a controller having a rest position at which it dwells during the initial advance of the storage medium and operable from such rest position under the control of the storage medium to govern the operation of the selecting mechanism.

124. In a telegraph apparatus, the combination of a storage medium for message matter, means operable to advance the storage medium, a selector mechanism operable to select a predetermined path of transmission, transmitting means operable in the advance of the storage medium, a power-actuated governor operative to control the advance of the storage medium, and a busy test mechanism operating when the selected path is available to initiate the operation of said governor whereby to effect transmission.

125. In a telegraph apparatus, the combination of a storage medium for message matter, means operative to advance the storage medium, a selector mechanism operable to select a predetermined path of transmission, transmitting means operative in the advance of the storage medium, a governing means for controlling said selector mechanism and also operative to control the advance of the storage medium to effect the transmission of the message matter, and a busy test mechanism for controlling the operation of said governing means to delay transmission until the selected path becomes available.

126. In a telegraph apparatus, the combination of a travelling signal carrier, a governing mechanism adapted to be driven at a predetermined constant speed, means for interrupting the movement of said mechanism at a predetermined point, means operable in the movement of said governing mechanism for controlling the operation of the signal carrier, and electromagnetically controlled means for determining the duration of the dwell in the operation of the governing mechanism by said interrupting means.

127. In a telegraph apparatus, a signal carrier, and means for advancing the carrier including a constantly operating drive element and a driven element, means tending to connect said elements including a spring pressed member, a detent for holding said member in disconnecting relation to said elements, and means for relieving said detent from engagement by said member.

128. In a telegraph apparatus, the combination of a signal carrier, advancing means for said carrier, a governor operable to control the advance of the carrier and including a driving element and a driven element, a dog providing a disengageable connection between said elements, a detent disposed in the path of said dog to disconnect said elements, and means for periodically relieving said detent from engagement with said dog.

129. In telegraph apparatus, the combination of a signal carrier, advancing means for said carrier, a governor operable to control the advance of the carrier and including a driving element and a driven element, a dog providing a disengageable connection between said elements, a magnet having an armature disposed in the path of movement of said dog to disconnect said elements, and means for periodically relieving said armature from engagement with said dog.

130. In a telegraph apparatus, the combination of a signal carrier, and means operable to advance the carrier to present successive signals thereon to a point of control including a driven member and a clutch for operating said driven member having a spring-pressed connecting element, a detent for blocking said element to maintain the clutch disengaged, and means operating to relieve the pressure of said element on said detent in the presentation of each signal to the control point.

131. In a telegraph apparatus, the combination of a signal carrier, a mechanism operative to select a transmission path, a busy test mechanism adapted to determine whether the selected path is available, a rotary governor having a driving element, a driven element having a connecting member normally tending to move into driving engagement with the driving element, a detent controlled by said busy test mechanism and operable to control said connecting member, and transmitting means controlled by said governor when the latter is rendered operative by said busy test mechanism.

132. In a telegraph apparatus, the combination of a signal storage medium, advancing means for the storage medium, mechanism operable to select a transmission path including a feeler responsive to signals on said storage medium, a governor movable in a predetermined cycle and adapted to interrupt the advance of the storage medium during the selection of such transmission path, a busy test mechanism operating when the selected path is not available to effect a dwell in the operation of the governor, and transmitting means controlled in the advance of said

storage medium, said governor being operable under the control of said busy test mechanism to restart the advance of the storage medium whereby to transmit the message matter over the selected path when the latter becomes available.

133. In a telegraph system, the combination of a signal-responsive recording device having an actuator which operates constantly in successive cycles during each of which a signal combination may be recorded, a transmission path associated with said device, a device for transmitting signal combinations over said path, and a mechanism for initiating the operation of said transmitting device in timed relation to and at a predetermined point in the cycle of operation of said actuator, said mechanism having a power-actuated driving means which operates constantly and in synchronism with said actuator.

134. In a telegraph apparatus, the combination of a carrier for message signals including a directing signal, advancing means for said carrier, a governor operable to control said advancing means, means controlled by said governor for selecting a transmission path as determined by the character of said directing signal, and transmitting means operable in the advance of the carrier, said transmitting means including a switch, and said governor being operable to control said switch so as to render the transmitting means ineffective as to said directing signal.

135. In a telegraph apparatus, the combination of a series of feelers cooperating with a storage medium adapted to contain a succession of individual signals representing message matter, means operable under control of said feelers to transmit said signals, a governor operative to control the advance of the storage medium relative to said feelers, means adapted to effect a dwell in the operation of the governor during said transmission, and means operable to detect the approach of the end of a message and to initiate the movement of said governor.

136. In a telegraph apparatus, the combination of a travelling storage medium adapted to contain a succession of individual signal combinations, means operable in the advance of the storage medium to transmit said signal combinations, a governing mechanism adapted to be driven at a predetermined constant speed and operable to interrupt the advance of the storage medium, and means for effecting a dwell in the operation of the governing mechanism during such transmission and including a signal-responsive device for determining the duration of said dwell.

137. In a telegraph apparatus, the combination of a carrier for signals in mechanical form and representing a message including a body portion and an end portion, advancing means for said carrier, a governor operable to control the advance of the carrier, transmitting means operable in the advance of the carrier, means for effecting a dwell in the movement of the governor while the carrier is advancing during transmission of the message, and means operating under the control of the end portion of the message to render the last mentioned means ineffective whereby to start the governor.

138. In telegraph apparatus, the combination of a signal carrier, means for effecting selective transmission of message matter on the carrier including a rotary governor having a multi-cyclic movement and comprising a driving element and a driven element, a clutch including a dog on the driven element normally tending to effect the

connection of the elements, and a plurality of detents disposed at spaced points in the path of said dog and movable into and out of the path of the dog to effect the engagement and disengagement of the clutch.

139. An apparatus for transferring a message from one point to another automatically comprising, in combination, a travelling storage medium having a succession of signals stored thereon in mechanical form, a line-selector adapted to select a predetermined transmission path, means operable as an incident to the movement of the storage medium to actuate said line-selector, and a transmitter operable in the advance of the storage medium, said means including a controller having a rest position during the initial advance of the storage medium and operable from such rest position under the control of the storage medium to govern the operation of the selector, said controller also having another rest position in which it dwells during the advance of the storage medium to effect transmission, and being releasable from such other rest position under the control of the storage medium to free the transmission path held by said selector.

140. In a telegraph apparatus, the combination of a storage medium for message matter, means operative to advance the storage medium, a selector mechanism operable to select a predetermined path of transmission, transmitting means operative in the advance of the storage medium, a power-actuated governor having a multi-cyclic operation and adapted to control the advance of the storage medium to effect the transmission of message matter, a busy test mechanism for controlling the operation of said governor to delay transmission until the selected path becomes available, and means including a feeler operating to detect the approach of the end of a message and adapted to interrupt the advance of the storage medium through the operation of said governor.

141. A telegraph apparatus having, in combination, a storage medium adapted to contain a succession of individual signals including a directing signal, message signals and an end-of-message signal, means for advancing said storage medium, transmitting means, a selector mechanism for selecting a path of transmission, a busy test mechanism for determining whether the selected path is available, and a governor for controlling said advancing means and said selector mechanism, said governor having a driving clutch including a rotatable connecting member, three detents operable to control said connecting member, and means whereby the first of said detents is controlled by the directing signal, the second by said busy test mechanism, and the third by the end-of-message signal.

142. In a telegraph apparatus, the combination of a travelling medium for storing a plurality of signals representing messages to be transmitted, a mechanism arranged to execute three stepping movements in the transmission of each message recorded on said medium, and means controlled by said mechanism in its successive movements for alternately stopping and starting said medium.

143. A telegraph apparatus having a line-selector and a transmitter, and a power-actuated cycling mechanism controlling said line-selector and transmitter and operating in successive steps to effect the selection of a transmission path, transmission over said path, and the freeing of the selected path.

144. In telegraph apparatus, the combination of a storage medium adapted to contain a succession of individual signal combinations, means for initiating the advance of the storage medium, means for selecting a transmission path, transmitting means whereby said signal combinations may be transmitted in electrical form over the selected path, a power-actuated governing mechanism operable in three successive steps to effect the selection of the transmission path, transmission over said path, and freeing the transmission path, and means controlled by the advance of the storage medium for initiating the operation of the governor in its first and third steps.

145. In telegraph apparatus, the combination of a storage medium adapted to contain a succession of individual signal combinations, means for initiating the advance of the storage medium, means for selecting a transmission path, transmitting means whereby said signal combinations may be transmitted in electrical form over the selected path, a power-actuated governing mechanism operable in three successive steps to effect the selection of the transmission path, transmission over said path, and freeing the transmission path, means controlled by the advance of the storage medium for initiating the operation of the governor in its first and third steps, and means controlled by the condition of the selected path to control the governor in its second step.

146. In a telegraph transmitting apparatus, the combination of a travelling medium for storing messages in signal form, a mechanism arranged to execute three stepping movements in the transmission of each message recorded on said medium, and means controlled by said mechanism for successively stopping and starting said medium in the first two of said stepping movements and successively stopping and starting said medium in the third stepping movement of said mechanism.

147. In a system of communication, the combination of means for recording message matter on a storage medium in the form of mechanical signal combinations, line-selecting means, transmitting means, means responsive to the stored signal combinations to operate said selecting and said transmitting means, and a cycling mechanism adapted to control the operation of said selecting means and said transmitting means in successive steps.

148. A telegraph apparatus comprising, in combination, a signal carrier, clutch-controlled means for advancing said signal carrier, a line-selecting and a transmitting means successively operable under the control of different signals on said carrier, a power-actuated governing mechanism for controlling said clutch-controlled means.

149. A telegraph apparatus comprising, in combination, a travelling signal carrier, a line-selecting means and a transmitting means successively operable under the control of signals on said carrier, and a power-actuated governing mechanism controlling the intermittent advance of said carrier to present signals to the line-selecting and transmitting means.

150. A telegraph machine comprising, in combination, feeler mechanism cooperating with a signal storage medium in the form of a band, mechanism operable under control of said feeler mechanism to transmit successive messages on said band over selected paths including a rotary power-actuated governor adapted to be driven intermittently in successive steps through one com-

plete revolution to effect transmission of each message over a selected path.

151. In telegraph apparatus, the combination of a signal carrier, advancing means for said carrier, a governor operable to control said advancing means and including a driving element and a driven element, means providing a disengageable connection between said elements, and means controlled in accordance with the character of the signals on the carrier to control said connection.

152. A telegraph apparatus having, in combination, a signal carrier, means for advancing said carrier including a power-driven mechanism having a clutch and a power-actuated governor for timing the engagement and disengagement of said clutch, said governor being arranged to be driven intermittently at predetermined constant speeds.

153. In a telegraph apparatus, the combination of a power-actuated governing mechanism adapted to be operated in successive steps at constant speeds, an intermittently operable signal carrier advancing means, and means controlled by certain of the signals on the carrier to control the operation of the governing mechanism, the governing mechanism being operable in turn to control the operation of the signal carrier advancing means.

154. In telegraph apparatus, the combination of a signal carrier in the form of a chain having a series of connected links, means for advancing the signal carrier, and means for controlling said advancing means comprising a rotary governor having a toothed driving element, a driven element, and a connecting member for said elements, the teeth of said driving element being spaced apart a distance corresponding to the pitch of the chain.

155. In telegraph apparatus, the combination of a signal carrier, means for advancing the signal carrier in successive signal cycles of equal length in each of which a signal is presented to a predetermined point of control, and means for controlling said advancing means comprising a rotary governor having a toothed driving element, a driven element having a dog normally tending to move into engagement with said driving element, the teeth of said driving element being spaced apart a distance corresponding to the length of a signal cycle, and means disposed in the path of said dog and adapted to be withdrawn to release the dog for engagement with the driving element whereby to start the governor at a predetermined point in any signal cycle.

156. A telegraph apparatus having, in combination, a signal carrier, means for advancing said carrier, a governor for controlling the advance of the carrier having a driving clutch including a rotatable connecting member, a plurality of detents for controlling said connecting member in each revolution of the latter, and means responsive to signals on said carrier for controlling said detents.

157. In a telegraph apparatus, the combination of a signal carrier, means for advancing the signal carrier, and means for controlling said advancing means comprising a rotary governor having a toothed driving element, a driven element having a dog tending to move into engagement with said driving element, a plurality of detents movable into and out of the path of rotation of said dog, and a feeler responsive

to signals on said carrier and operative to control certain of said detents.

158. A telegraph apparatus having, in combination, a storage medium, and means for controlling the transmission of message matter on said storage medium including a governor having a driving clutch with a rotatable control element, a plurality of detents for operating said control element, a feeler responsive to the presence of signals on said carrier for controlling certain of said detents, and electromagnetic means for controlling certain other of the detents.

159. In a telegraph apparatus, the combination of a signal carrier, means for advancing the signal carrier, and means for controlling said advancing means comprising a rotary governor having a toothed driving element, a driven element having a dog tending to move into engagement with said driving element, a plurality of detents movable into and out of the path of rotation of said dog, a feeler responsive to signals on said carrier and operative to control certain of said detents, and electromagnetic means operating to control certain other of said detents.

160. A telegraph apparatus having, in combination, a storage medium adapted to contain a succession of individual signal combinations, means including a clutch for advancing said storage medium, and means for controlling the advance of the storage medium by said clutch comprising a rotary governor having a driving element, a driven element, and means operable to effect the engagement and disengagement of the connection between said elements at predetermined points in the rotation of the governor.

161. In telegraph apparatus, the combination of a storage medium adapted to contain a succession of individual signal combinations, advancing means for the storage medium including a clutch, and a governing mechanism operable to effect the engagement and disengagement of said clutch and including a constant speed drive element, a driven element and means for connecting said elements, and means responsive to the individual character of the signals on the storage medium for controlling said connecting means.

162. An apparatus for automatically relaying a message from one point to another comprising a traveling storage medium, means for recording a message on said storage medium, and mechanism operable under the control of a part of the message as stored to control the advance of the storage medium to effect transmission over a predetermined one of a plurality of paths selectively.

163. In a telegraph apparatus, the combination of a storage medium adapted to contain a succession of signals representing a message, means for intermittently advancing the storage medium to impart successive movements thereto, means operating as an incident to the one of such movements to select one of plurality of transmission paths for the message, means operating as an incident to the other movement to effect transmission of the message over the selected path, and means operating to test the condition of the selected path to determine whether or not it is available for the transmission of a message and operating to control said advancing means to effect a dwell in the operation thereof pending the establishment of the selected path.

164. In a telegraph apparatus, the combination

of a storage medium adapted to contain a succession of signals representing a message, means for advancing the storage medium, means operating as an incident to the movement of the storage medium to select one of a plurality of transmission paths for the message, and means controlling said advancing means to effect a dwell in the operation thereof pending establishment of the selected path.

165. In a telegraph apparatus, the combination of a traveling medium upon which a plurality of messages may be stored as a succession of mechanical signal combinations, advancing means for said medium, a line selector operable in the advance of said medium and in response to a certain signal of each successive message, and a transmitter operable in the advance of the medium and in accordance with the character of the other signals of the successive messages.

166. In a telegraph apparatus, the combination of a storage medium adapted to contain a succession of signals in mechanical form and representing a message, means for intermittently advancing the storage medium to impart successive movements thereto, a line-selecting mechanism and a transmitting mechanism operable as an incident to such advancing movements of the storage medium, and means for rendering the transmitting mechanism inoperative during the operation of said line-selecting mechanism.

167. In a telegraph apparatus, the combination of a traveling storage medium adapted to contain a succession of messages in signal form transmitting means operable in the advance of the storage medium, and means for controlling the advance of the storage medium operable automatically upon the transmission of one message to continue the advance of the storage medium only if another message is stored thereon.

168. In a telegraph apparatus, the combination of a signal storage medium, means for effecting the advance of the storage medium, a line-selector mechanism including a feeler responsive to signals on said storage medium, and means operable to interrupt the advance of the storage medium with one of said signals in operative association with said feeler.

169. In telegraph apparatus, the combination of a traveling band carrying a longitudinal row of uniformly spaced signal elements, a constantly operating drive means for advancing said elements on said band past a fixed point of control, and a positively acting clutch for connecting said band to said drive means and operable upon each disengagement to interrupt the advance of said band with one of the elements thereon in a predetermined position relative to said control point.

170. In a telegraph apparatus, the combination of a storage medium comprising a series of signal carriers each adapted to contain a signal combination, a signal responsive device operatively associated with the storage medium, and means for advancing the storage medium to present said carriers to said device in successive signal cycles comprising a constantly operating drive element, a driven element operatively connected with the storage medium, and a clutch operable in one signal cycle to govern the connection between said elements during the next signal cycle.

171. In telegraph apparatus, the combination of a storage medium adapted to contain a succession of signals representing a message, a signal responsive device, and means for controlling the advance of the storage medium including a clutch

having two differentially driven elements, and a detent adapted when moved into blocking relation to one of said elements to effect the rotation of the other element and vice versa.

172. In a telegraph apparatus, the combination of a signal storage medium, and mechanism for advancing the storage medium including a clutch having a control element, a constantly reciprocating actuator for said control element, and a latch movable into and out of position to render said actuator effective to move the clutch control element.

173. In a telegraph apparatus, the combination of a signal storage medium, and mechanism for advancing the storage medium including a clutch having a control element, a constantly reciprocating actuator for said control element, a latch movable into and out of position to render said actuator effective to move the clutch control element, and electromagnetic means for controlling said latch.

174. In a telegraph apparatus, the combination of a signal storage medium in the form of a continuous band having a driving sprocket, power actuated means for driving said sprocket including a clutch having a toothed element with a pitch equal to the spacing of signals on the band, a dog adapted to engage said element to effect the rotation of said sprocket, power actuated means for operating said dog, and signal controlled means for governing the operation of said dog.

175. In a telegraph system, the combination of a signal recorder, a signal transmitter, a traveling medium for carrying signals from said recorder to said transmitter, a device operable to detect the presence of message signals on the medium between said recorder and said transmitter, a device responsive to the character of the signals on said medium passing said transmitter, and means controlled by the joint action of said devices for governing the advance of said medium past said transmitter.

176. In a telegraph apparatus, the combination of a storage medium adapted to contain a succession of signals in mechanical form and representing a message, means for intermittently advancing the storage medium to impart successive movements thereto, and a line-selecting means and a transmitting means respectively operable as an incident to two successive movements of the storage medium.

177. In a telegraph apparatus, the combination of a storage medium adapted to contain a series of signals representing a succession of messages which may be of different lengths and spaced different distances apart, means for controlling the advance of the storage medium to impart successive movements thereto of varying lengths, the alternate movements varying in length according to the spacing of successive messages and the other movements varying in length according to the lengths of the successive messages, a line-selector operable in accordance with a signal presented thereto in each of said alternate movements, and a transmitting means operable in accordance with the signals presented thereto in said other movements.

178. In a telegraph apparatus, the combination of a traveling storage medium adapted to contain a succession of signals representing a message, a signal responsive device, means for advancing the storage medium past said device including a clutch having a movable control element, and means operating in the approach of the message

to said signal responsive device to operate said control element.

179. In telegraph apparatus, the combination of a traveling medium for carrying signals in mechanical form, a signal responsive device associated with said medium, means for advancing the medium past said device, and a feeler associated with said medium beyond said device and operable in response to certain combinations to control said advancing means.

180. In telegraph apparatus, the combination of a traveling medium for carrying signals in mechanical form, a signal responsive device controlled from said medium, and a feeler associated with said medium and operable in response to certain signal combinations thereon to control said advancing means.

181. In a telegraph apparatus, the combination of a storage medium for mechanical signal combinations representing message matter, means for advancing the storage medium past a predetermined point at a uniform rate during the presentment of a plurality of signal combinations to said point, a signal responsive device, and means controlled by said device and operable to interrupt the operation of said advancing means with the storage medium in a predetermined relation to said point.

182. In a telegraph apparatus, the combination of a storage medium carrying groups of movable elements adapted to be set in different signal combinations, means for advancing the storage medium, and a feeler operatively associated with the storage medium and responsive to the character of the combinations in each successive group to control said advancing means.

183. In a telegraph apparatus, the combination of a traveling storage medium adapted to contain a succession of messages in signal form, mechanism for controlling the advance of the storage medium, and means operating according to the spacing of messages on the storage medium to control the operation of said mechanism.

184. In a telegraph apparatus, the combination of a storage medium, signal responsive means for recording message matter on the storage medium, means for controlling the advance of the storage medium relative to said signal responsive means including a clutch having a control element, power actuated means for operating said control element, and a feeler positioned to be controlled by the storage medium after the recording of signals thereon and operable to control said power actuated means.

185. In a telegraph apparatus, the combination of a storage medium, means for recording message matter on said storage medium, means for advancing the storage medium including a clutch having a control element, a constantly reciprocating actuator operatively connected with said clutch control element and having a control member, and a feeler operating under the control of message matter recorded on the storage medium and adapted to control said member.

186. A telegraph relay mechanism comprising, in combination, a traveling storage medium in the form of a band, means operable to record a message on said band with means operating as an incident to the recording means for advancing the band relative thereto, means operable to transmit the message stored on the band, means for advancing the band relative to the transmitting means, and means operatively associated with said transmitting means and controlled by a

part of the message as stored to establish a path for the transmission of the message.

187. A telegraph relay mechanism having, in combination, a traveling band upon which message signals may be impressed, recording and transmitting devices associated with said band at spaced points, means operable automatically upon the recordation of message signals on said band by said recording device to advance the band, and mechanism operable as an incident to the advance of the band to select an outgoing transmission path and to initiate the transmission of the signals over said path.

188. In telegraph apparatus, the combination of a traveling signal storing medium, a device for recording signals on said medium, signal responsive means spaced from said device, line selecting mechanism controlled by said signal responsive means, transmitting means, and means operable upon the recordation of signals upon said medium to advance said signals to said signal responsive means to effect operation of said mechanism and then to effect transmission over the selected path.

189. A telegraph machine comprising, in combination, a storage medium in the form of a band, means for recording a message on the band, a transmitter operable under the control of message matter on said band, and means for advancing the band relative to the recording means and the transmitter independently including independently operable clutches each adapted to effect a positive quick engageable and disengageable connection with a source of power.

190. A telegraph machine having, in combination, a frame, a plurality of sprockets arranged in two sets, the sprockets of each set being supported by said frame for rotation about fixed parallel axes, an endless flexible chain extending around the sprockets of one of said sets then around the sprockets of said other set whereby to define two sets of loops having adjacent movable ends and fixed ends defined by said sprockets, said chain carrying groups of signal elements capable of arrangement in different combinations, means guided in said frame for movement between said sprockets and connecting the movable ends of the loops in one section to the movable ends of the loops in said other section, and two signal responsive devices each associated with said chain between said sets of loops.

191. A telegraph machine having, in combination, an endless flexible band having groups of control elements which may be set in different combinations, said band having two sets of parallel loops, one set constituting a storage section, the other set constituting a supply section and having its loops arranged in end-to-end relation relative to the loops in said storage section, a recording device operatively associated with said band in advance of said storage section, a second device controlled by said band beyond said storage section, and power means for driving each of said sections at a plurality of different points.

192. A telegraph machine having, in combination, an endless flexible band carrying control elements to be set in different combinations, one portion of said band being arranged in a series of parallel loops each having a fixed and a movable end, another portion of said band being arranged in a similar series of loops with their movable ends adjacent the movable ends of said first mentioned loops, bodily movable means connecting the movable ends of each pair of aligned loops, and power driving means for imparting

differential advancing movements to each of said loops while maintaining the loops in each series of uniform lengths and a fixed overall length for each pair of aligned loops.

193. A telegraph machine having, in combination, a signal recording device, a signal responsive device, an elongated flexible signal carrier to and from which signal combinations are transferred in the operation of said recording and signal responsive devices respectively, advancing means engaging the carrier at a plurality of spaced points, the portions of the carrier between the adjacent points forming loops, and power mechanism for driving said advancing means to impart variable advancing movements to the different loops of said carrier depending on whether either or both of said devices are operating.

194. A telegraph machine having, in combination, a signal recording device, a signal transmitting device, a storage medium comprising a band upon which signal combinations may be recorded mechanically by said recording device and carried to said transmitting device, said band being extended between said devices and arranged in a plurality of loops the lengths of which are variable according to the number of signal combinations in storage, and power driving mechanism engaging said band at a plurality of points and operable to impart advancing movements to said band while maintaining a predetermined length relationship of the loops regardless of whether they are being shortened or lengthened.

195. A telegraph machine having, in combination, a flexible band upon which signal combinations may be stored mechanically, said band being arranged in a series of parallel loops to form a storage section of variable signal capacity, a device at one end of said section to record signal combinations on said band and to feed the same into said section, a device at the other end of said section arranged to be controlled in accordance with the combinations on said band, a plurality of sprockets engaging said band at a plurality of points in said section, and means for rotating said sprockets at increasing speeds when said last mentioned device alone is operating, at decreasing speeds when said recording device is operating, and at the same speed in case both of said devices are operating.

196. A telegraph machine having, in combination, a flexible band on which signal combinations may be stored mechanically, a recording device for impressing signals upon said band, a signal responsive device controlled by said band, a plurality of drive sprockets engaging said band at spaced points between said recording and signal responsive devices, the portions of said band between said sprockets forming loops, means for maintaining said loops taut, and mechanism operable to drive the successive sprockets in a direction to advance the engaged portions of said band toward said transmitting device at successively decreasing speeds when said recording device alone is operating, at increasing speeds when said transmitting device alone is operating and at the same speed when both of said devices are operating.

197. A telegraph machine having, in combination, a recording device, a signal responsive device, a flexible band upon which signal combinations may be stored mechanically, said band being arranged between said devices in a series of loops the lengths of which vary according to the

number of signal combinations in storage, a pair of terminal drive sprockets engaging said band adjacent said recording and signal responsive devices respectively, sprockets engaging said band intermediate said terminal sprockets to form a series of loops of variable lengths, power driven mechanism operable during the operation of said recording device to drive the adjacent terminal sprocket at a predetermined speed and during the operation of said signal responsive device to drive the other terminal sprocket at a predetermined speed, and means for driving said intermediate sprockets to maintain a predetermined length relationship of said loops.

198. A telegraph machine having, in combination, a recording device, a signal responsive device, a flexible band upon which signal combinations may be stored mechanically, said band being arranged between said devices in a series of loops the lengths of which vary according to the number of signal combinations in storage, a pair of terminal drive sprockets engaging said band adjacent said recording and signal responsive devices respectively, a sprocket engaging said band intermediate said terminal sprockets to form a loop of variable length, power driven mechanism operable during the operation of said recording device to drive the adjacent terminal sprocket at a predetermined speed and during the operation of said signal responsive device to drive the other terminal sprocket at a predetermined speed, and means for driving said intermediate sprocket to maintain said loop taut, including a differential gear having an intermediate member connected to said intermediate sprocket, and a pair of terminal members driven from the respective drive mechanisms for said terminal sprockets.

199. A telegraph machine having, in combination, a recording device, a signal responsive device, a flexible band upon which signal combinations may be stored mechanically, said band being arranged between said devices in a series of loops the lengths of which vary according to the number of signal combinations in storage, a pair of terminal drive sprockets engaging said band adjacent said recording and signal responsive devices respectively, a sprocket engaging said band intermediate said terminal sprockets to form a loop of variable length, power driven mechanism operable during the operation of said recording device to drive the adjacent terminal sprocket at a predetermined speed and during the operation of said signal responsive device to drive the other terminal sprocket at a predetermined speed, and means for driving said intermediate sprocket, including a differential gear having an intermediate member connected to said intermediate sprocket, and a pair of terminal members connected to the respective drive mechanisms for said terminal sprockets, the gears of said differential being constructed to impart an advancing movement to said intermediate member which is equal to one-half of the combined movements of said terminal members.

200. In a signalling apparatus, the combination of a recording device, a signal responsive device, a plurality of drive sprockets arranged in two sets, a signal carrying medium in the form of a band extending from said recording device to said signal responsive device around the sprockets of one of said sets to form a storage loop of variable length and from said signal responsive device to said recording device around

said other set of sprockets to form a supply loop of variable length, drive means for rotating one sprocket of each of said sets to feed the medium from said supply loop to said recording device and to deliver the medium from said recording device to said storage loop, a second drive means for one sprocket of each of said sets operable to deliver the medium from said storage loop to said signal responsive device and from said signal responsive device to said supply loop, and a differential gearing driven from each of said drive means and operable to drive the other sprocket of each of said sets at differential speeds depending on whether either or both of said devices are operative.

201. A telegraph machine having, in combination, a flexible band for carrying signals in the form of mechanical combinations, means associated with said band at one point for recording signal combinations thereon, means associated with the band at another point and arranged to be controlled in accordance with the combinations thereon, and power driving means engaging said band at a plurality of points intermediate said recording and control points and operable to impart advancing movements at different speeds to different portions of said band.

202. A telegraph machine having, in combination, a flexible band for carrying signals in the form of mechanical combinations, means associated with said band at one point for recording signal combinations thereon, means associated with the band at another point and arranged to be controlled in accordance with the combinations thereon, and power driving means engaging successive portions of said band between said points and imparting to such portions advancing movements at the same or different speeds depending upon whether one or both of said recording and control means are operating.

203. A telegraph machine having, in combination, a flexible band for carrying signals in the form of mechanical combinations, means associated with said band at one point for recording signal combinations thereon, means associated with the band at another point and arranged to be controlled in accordance with the combinations thereon, and power driving means engaging different portions of said band between said recording and control points and operable to impart to successive portions of the band advancing movements at decreasing speeds when said recording means alone is operating, at increasing speeds when said control means alone is operating, and at the same speeds when both of said means are operating.

204. In a signalling apparatus the combination of a recording device, a signal responsive device, a signal carrying medium in the form of a band having terminal portions associated respectively with said recording and signal responsive devices and movable independently of each other and of the portion intermediate said devices, and means operable as an incident to the movement of the respective terminal portions to impart advancing movements to said intermediate portion.

205. A telegraph machine having, in combination, a flexible signal carrier arranged in a series of loops, means associated with said carrier at one point for recording signal combinations thereon, means at another point arranged to be controlled by the combinations on said carrier, two independently operable drive mechanisms for ad-

vancing said carrier past said recording and said control points respectively, and a separate drive mechanism for advancing that portion of said carrier which is located between said recording and control points.

206. A telegraph machine having, in combination, a flexible signal carrier arranged in a series of loops, means associated with said carrier at one point for recording signal combinations thereon, means at another point arranged to be controlled by the combinations on said carrier, two independently operable drive mechanisms for advancing said carrier past said recording and said control points respectively, and a separate drive mechanism operable to impart successive accelerating and retarding movements to that portion of said carrier between said recording and control points.

207. A telegraph machine having, in combination, a flexible band for carrying signals in the form of mechanical combinations, said band being arranged in a series of parallel loops constituting a section for storing variable quantities of signals, a device at one end of said section operable to record combinations upon said band and to deliver the same to said section, a device at the other end of said section controlled by the combinations on said band, and a power mechanism for driving the band in said storage section to lengthen said loops when said recording device alone is operating, to shorten the loops when the said other device alone is operating and to maintain the loops of constant lengths during the advance of a band therethrough when both of said devices are operating.

208. A telegraph machine having, in combination, a flexible band for carrying signals in the form of mechanical combinations, said band being arranged in a series of parallel loops constituting a section for storing variable quantities of signals, a device at one end of said section operable to record combinations upon said band and to deliver the same to said section, a device at the other end of said section controlled by the combinations on said band, a power driving means operable as an incident to the operation of said recording device, a second power driving means operable as an incident to the operation of said other device, a plurality of sprockets engaging said band at different points in said section, and means driven from each of said drive mechanisms and operable to drive said sprockets in the same direction but at different speeds depending on whether either or both of said driving mechanisms are operating.

209. A telegraph machine having, in combination, a band capable of carrying signal combinations and forming a storage section of variable capacity, recording and signal responsive devices at opposite ends of said section, means operable to advance portions of said band through said recording device, means operable to advance portions of said band through said signal responsive device, and independent power driven mechanism for advancing said band through said section, and a pair of clutches governing the operation of said mechanism, one of said clutches being responsive to the advance of the band through said recording device, the other being responsive to the advance of the band through said signal responsive device.

210. A telegraph machine having, in combination, a band for carrying signal combinations and forming a storage section of variable capacity, recording and signal responsive devices at opposite

ends of said section, means to advance said band through said recording device into said section, means to advance said band out of said section through said signal responsive device, two power driven mechanisms operable independently to impart differential advancing movements to said band at different points in said section, and means operable to combine the drives from each of said mechanisms so as to impart such differential advancing movements to said band in said section as to maintain a definite length relationship of the loops in said section.

211. A telegraph machine having, in combination, a signal carrier comprising a band, a pair of spaced sprockets engaging said band and rotatable on fixed parallel axes, a member supporting the portion of said band between said sprockets for bodily movement and forming an elongated loop of invariable length with a substantially straight run opposite said sprockets, a signal responsive device operatively associated with and having means for advancing the band in said run whereby to move said member in one direction, other means operable to drive said sprockets in a direction to move said member in the opposite direction, and means controlled by the movement of said member by said advancing means for governing the operation of said driving means.

212. A telegraph machine having, in combination, a signal carrier comprising a band having an elongated loop, means in said loop providing a straight run intermediate the ends thereof and movable independently of said ends, a signal responsive device associated with said run, and means operative as an incident to the actuation of said signal responsive device for advancing the loop.

213. A telegraph machine having, in combination, a signal carrier comprising a band having a loop, means supporting said loop for movement independently of the adjacent portions of said band, a signal responsive device, and means operative as an incident to the actuation of said signal responsive device for advancing said loop, and independent means operable to withdraw portions of said band from said loop and to supply equal lengths of band to the loop.

214. A telegraph machine having, in combination, a signal carrier comprising a band having a loop, means supporting said loop for movement independently of the adjacent portions of said band, a signal responsive device associated with and having means for advancing said loop, independent means operable to withdraw portions of said band from said loop and to supply equal lengths of band to the loop, and means responsive to the position of said loop for governing the operation of said last mentioned means.

215. In a signalling apparatus the combination of a flexible signal carrier arranged to form an elongated loop of variable length and an adjacent loop of substantially invariable length, and power driven means for operating said loops independently.

216. In a signalling apparatus the combination of a flexible signal carrier arranged to form an elongated loop of variable length and an adjacent loop, and means within said adjacent loop maintaining the shape thereof and mounted for bodily rectilinear movement.

217. In a telegraph apparatus, the combination of independently operable transmitting and recording devices, a band upon which signals may be impressed, said band extending through said devices, and intermittently operable power mech-

anism for automatically feeding portions of said medium to said devices according to the individual requirements of the devices.

218. A telegraph machine having, in combination, a traveling signal carrier comprising a band having two spaced loops of invariable lengths arranged for independent bodily movement relative to the portion of said band intermediate said loops, said intermediate portion being arranged to form a plurality of loops of variable lengths, a recording device associated with one of said first mentioned loops, a device associated with and controlled by the signals on the other of said first mentioned loops, and clutch controlled means responsive to the position of both of said first mentioned loops and operable to lengthen, shorten or maintain constant said intermediate loops depending on whether either or both of said recording and controlled devices are operating.

219. A telegraph machine having, in combination, a traveling signal carrier comprising a band arranged in a series of loops, individual clutch controlled means for advancing each of the terminal loops of the series, a separate clutch controlled driving means for advancing the other loop or loops, a signal recording device associated with one of said terminal loops, and a device associated with said other terminal loop and controlled in accordance with the character of the signals on said band.

220. A telegraph machine having, in combination, a signal carrier comprising a band having two spaced loops arranged for independent bodily movement relative to the portion of the band between said loops, said intermediate portion being arranged to form a plurality of loops of variable lengths, a recording device associated with one of said loops and having a clutch for effecting advancing movement of the loop, a signal responsive device associated with and controlled by the signals on the other bodily movable loop and having a clutch for effecting movement of the loop, two power driven mechanisms for driving the band in said intermediate loops, one having a clutch controlled automatically as an incident to the movement of said recorder loop, the other having a clutch controlled automatically as an incident to the movement of said other loop, and means for combining the drives of said mechanisms to lengthen said intermediate loops when the recording device alone is operating, to shorten the loops when said signal responsive device alone is operating, and to advance the band through said loops while maintaining their lengths constant when both of said devices are operating.

221. A telegraph machine having, in combination, a signal carrier comprising a band arranged to form spaced loops, a recording device associated with one of said loops, a signal responsive device associated with the other of said loops, independently operable means each associated with one of said devices for advancing the band in the adjacent loop, and independent means operable automatically to maintain taut that portion of the band between said loops.

222. A telegraph machine having, in combination, a signal carrier comprising a band providing a signal storing section of variable capacity and having a pair of loops each at one end of said section, a recording device adapted when operated to advance the band through one of said loops into said section, a signal responsive device adapted when operated to advance said band out of said other loop, and mechanism operable automatically as an incident to the opera-

tion of said devices to supply portions of the band to each of said devices according to whether either or both of said devices are operating.

223. A telegraph machine having, in combination, a signal carrier comprising a band having two spaced loops of invariable lengths, individual clutch controlled means for effecting bodily advancing movements of the respective loops, independent means controlled jointly by the positions of said loops and operable to govern the advance of that portion of the band intermediate said loops, and two signal responsive devices each operatively associated with one of said loops.

224. A telegraph machine having, in combination, a signal carrier comprising a continuous band having two spaced loops of invariable length mounted for individual bodily movement, and a plurality of loops of variable lengths disposed between said first mentioned loops.

225. In a signalling apparatus the combination of a signal carrying medium in the form of a continuous band having two spaced loops each arranged for individual bodily movement throughout a predetermined range, a recording device associated with one of said loops, a signal responsive device associated with the other loop, means operable to impart differential advancing movements to the portion of said band intermediate said loops, and two independent control means for said advancing means operable in the movement of the respective loops into one of their limiting positions.

226. In a signalling apparatus the combination of a recording device, a signal responsive device, a signal carrying medium in the form of a band having terminal portions associated respectively with said recording and signal responsive devices and movable independently of each other and of the portion intermediate said devices, and means operable as an incident to the movement of the respective terminal portions to impart differential advancing movements to said intermediate portion according to whether either or both of said devices are operating.

227. A telegraph machine having, in combination, a signal carrier comprising a band, a signal recording device and a signal responsive device associated with said band at spaced points, independently operable drive mechanisms for imparting advancing movements at equal speeds to said band at each of said points, and a separate drive mechanism for advancing the intermediate portions of said band.

228. A telegraph machine having, in combination, a signal carrier comprising a band, a signal recording device and a signal responsive device associated with said band at spaced points, independently operable drive mechanisms for imparting advancing movements at equal speeds to said band at each of said points, and a separate drive mechanism operating when both of said devices are operable to advance the intermediate portion of said band from said recording device to said signal responsive device at the same speed as said first mentioned drive mechanisms.

229. In a signalling apparatus the combination of a recording device, a signal responsive device, and means for carrying signals from said recording device to said signal responsive device comprising an endless flexible band extending successively through said devices and providing two sections of variable lengths, one for storing signals between said recording and signal responsive devices, said band, in passing from said signal

device, being led around said recording device to said other section.

230. In a signalling apparatus the combination of a recording device, a signal responsive device, and means for carrying signals from said recording device to said signal responsive device comprising an endless flexible band extending successively through said devices and providing two sections of variable length, one for storing signals between said recording and signal responsive devices, said band in passing from said signal responsive device being led to said section around one of said devices.

231. In a telegraph apparatus, the combination of a traveling medium upon which signals may be stored, a signal recording device and a signal responsive device associated with said medium at spaced points, driving means for advancing said medium from said recording device to said signal responsive device, and two clutch controlled means driven from said driving means and operable independently or simultaneously to advance the medium past said devices.

232. In a telegraph apparatus the combination of two signal responsive devices arranged in closely spaced relation, and means for carrying signals from one of said devices to the other comprising a flexible band having two closely spaced parallel runs forming a longitudinally extensible and contractible loop section between said devices, the length of band in said section when the latter is of minimum length being substantially equal to the distance of said devices.

233. In a telegraph apparatus the combination of two signal responsive devices arranged in closely spaced relation, and means for carrying signals from one of said devices to the other comprising a flexible band, guide means defining two closely spaced parallel runs forming a longitudinally extensible and contractible loop the length of which may be shortened to form a substantially straight length of band between the guide means which determines the spacing of said runs.

234. A relay for a telegraph system comprising, in combination, an endless flexible band arranged in a series of loops certain of which constitute a signal storage section of variable capacity and other of which constitute a supply section of variable capacity, and two signal responsive devices associated with said band closely adjacent opposite ends of said storage section.

235. In a telegraph apparatus the combination of a series of closely spaced drive sprockets, a corresponding series of idlers, a flexible band for carrying signals extending alternately around said sprockets and idlers to form a plurality of parallel loops, and two signal responsive devices each associated with said band immediately adjacent the terminal one of said drive sprockets.

236. In a signalling apparatus, the combination of a signal carrier comprising a plurality of elongated links pivotally connected together to form a chain, a plurality of spaced parallel pins mounted on each of said links for individual axial movement into either of two set positions, a rotatable sprocket around which said chain travels, a member rotatable with said sprocket, a plurality of individual pushing elements carried by said member and spaced to correspond to the spacing of the pins on said links, each of said elements being mounted for movement into axial engagement with the pins on one of the links engaging said sprocket, and means operable in the rotation of said sprocket to move said elements toward said chain and thereby move all of

the pins of the successive links into one of said set positions.

237. In a signalling apparatus, the combination of a flexible signal carrier, pins carried by said carrier at spaced points and mounted for axial movement perpendicular to the carrier into either of two set positions, means for advancing said carrier in an arcuate path, a member movable in unison with said carrier, a plurality of individual pushing elements spaced to correspond to the spacing of successive pins on said carrier when the latter is traversing said arcuate path, and means operable to move said elements individually toward said carrier whereby to shift the successive pins thereon into a predetermined set position.

238. In a signalling apparatus, a flexible signal carrier, a plurality of axially movable pins mounted on said carrier, means guiding a portion of said carrier, an element movable with said carrier during its movement through said guiding means, and means operable during such movement to effect relative movement between said carrier and said element whereby to shift one of said pins into a predetermined set position.

239. In a signalling apparatus, the combination of a signal carrying member, a plurality of control pins carried by and shiftable transversely of said member into either of two set positions, a pushing element, means for advancing said member and said element in unison with the element opposite one of said pins, and means operating during such advancing movement to effect relative movement between said member and said element toward each other whereby to shift said pin into one of said positions.

240. In a signalling apparatus, the combination of a signal carrying member having a row of pins mounted for individual axial movement into either of two set positions, a pushing element, means supporting said element for engagement with one of said pins and for advancing said element in unison with said member, and cam means operable during such advancing movement to effect relative movement between said member and said element in a direction to shift one of said pins into a predetermined set position.

241. In a signalling apparatus, the combination of a signal carrier having a plurality of pins shiftable into either of two set positions, a plurality of individually movable setting elements operatively associated with successive pins on said member for a substantial length of its advancing movement, and means for operating the individual elements during such movement to set all of said pins in a predetermined position on said member.

242. In a signalling apparatus, the combination of a traveling carrier having a succession of axially movable pins, and means movable with the carrier in the advance thereof and operable to shift all of said pins into the same position.

243. In a signalling apparatus the combination of a traveling carrier having a succession of axially movable pins, and individually movable members mounted for advancing movement along with the successive pins of said carrier and operable in such movement to shift said pins into the same positions.

244. In a signalling apparatus, the combination of a traveling carrier having successive transverse rows of axially movable pins, a plurality of setting members mounted for bodily movement along with the successive groups of

pins, and means operable in the advance of said carrier to effect relative movement of said members and their associated pins in a direction axially of the pins whereby to shift the pins of each group into the same position.

245. In a telegraph apparatus, the combination of a storage medium having a succession of individual signal carriers guided for movement in a predetermined path and each having a predetermined number of pins axially movable in a direction transversely of the direction of movement of the carrier so as to be capable of occupying either of two set positions, and a pair of feelers respectively arranged for operative association with the opposite ends of the pins so as to be controlled thereby according to the setting of the pins.

246. In a telegraph apparatus, the combination of a storage medium guided for movement in a predetermined path and comprising a series of individual signal carriers each having a row of pins movable in a direction transversely of the direction of travel of the carriers, means for setting said pins in various combinations, means for holding the pins in each carrier in their set relation including a resilient strip engaging opposite sides of adjacent pins, and a device responsive to the pins of successive carriers.

247. In a selectively operable mechanism, a control form comprising a pair of parallel side members secured together in spaced relation, a row of pins each having bearings in said members so as to be movable relative to each other, and means tending to hold the pins in position including a resilient strip extending longitudinally between said members and interlaced about the pins.

248. In a telegraph apparatus, the combination of a travelling medium upon which signals may be stored, means operable to advance said medium past a point of control, a constantly operating shaft, a clutch having driving and driven members connected respectively to said shaft and said advancing means, a plurality of devices operable simultaneously and selectively in the recordation of individual signals on said medium, and means controlled by each of said devices for governing the operation of said clutch.

249. In a telegraph apparatus, the combination of a storage medium adapted to contain a succession of signals representing a message, an electromagnetically controlled power-actuated means for recording signals on said storage medium, and means for effecting a continuous advance of the storage medium during the reception of a succession of signals including a clutch controlled by said recording means.

250. In a telegraph apparatus, the combination of a storage medium adapted to contain a succession of signals representing a message, signal responsive means including a plurality of reciprocatory elements operable to record message matter on the storage medium, individual actuating members for said elements operating in unison, electromagnetically controlled means for governing the selective operation of said elements by said members, and means operating in the movement of any one of said elements by its actuating member for effecting the continuous advance of the storage medium.

251. In a telegraph apparatus, the combination of a storage medium, means operative to record message matter on the storage medium including a constantly reciprocating actuator,

means for advancing the storage medium in successive signal cycles including a clutch having a control element, signal-responsive means for controlling the operation of the recording means by said actuator, means operative as an incident to the operation of the recording means to move said clutch control element in a direction to advance the storage medium, and means operable in any signal cycle when permitted by said signal-responsive control element to effect the movement of said clutch control element in a direction to interrupt the advance of the storage medium.

252. In a telegraph system, the combination of a travelling medium upon which signals may be impressed, a signal-controlled mechanism for recording signals on said medium, a constantly operating power actuator for said mechanism, power driving means driven in synchronism with said actuator, and means controlled by the character of the signals recorded by said mechanism for controlling the connection between said driving means and said medium.

253. In a telegraph apparatus, the combination of a medium for carrying signals in the form of mechanical combinations, a signal-responsive device operable in successive cycles to record the elements of a single signal combination on said medium simultaneously and including a constantly operating power actuator and signal receiving means controlling said actuator, means operating in synchronism with said actuator for advancing said medium to present successive blank portions of the medium to the point of recordation, and control means for said advancing means operable upon the reception of signal combinations by said receiving means to initiate the advance of said medium past said recording point and upon the discontinuance of the signals to interrupt the advance of said medium with a blank portion thereof opposite said recording point.

254. In telegraph apparatus, the combination of a storage medium, a device for recording message matter on the storage medium, means for advancing the storage medium past the recording device including a constantly driven shaft, a clutch for effecting a connection between said shaft and the storage medium, and means operating upon said clutch as an incident to the recording of message matter on the storage medium and adapted to maintain said driving connection during the reception of a succession of signals.

255. In telegraph apparatus, the combination of a travelling signal storage medium carrying a succession of axially movable pins, clutch control means for advancing the successive pins continuously past a point of control, a pushing member arranged for endwise engagement with the successive pins passing said point of control, and means for reciprocating said pushing member in timed relation to the operation of said advancing means.

256. In a telegraph apparatus, the combination of a travelling signal storage medium, means operable to record signals on said medium comprising a reciprocable actuator, and power-actuated means for said actuator operable to move the same positively in opposite directions.

257. In a telegraph apparatus, the combination of a travelling signal carrier, means operable to record signals on said medium including a recording element, an actuator for said element comprising a lever pivoted between its ends and

having said element connected to one end thereof, power-actuated means for moving the axis of said lever positively in opposite directions, and a latch device movable into and out of holding relation to the other end of said lever.

258. In a telegraph apparatus, the combination of a travelling signal carrying medium, means operable to control the advance of said medium including a control element, an actuator for said element comprising a lever pivoted between its ends and having said element coacting with one end thereof, power-actuated means for moving the axis of said lever positively in opposite directions, and a latch device movable into and out of holding relation to the other end of said lever.

259. In a telegraph apparatus, the combination of a travelling signal carrying medium, means operable to record signals on said medium including a recording element, an actuator for said element comprising a lever pivoted between its ends and having said element coacting with one end thereof, power-actuated means for moving the axis of said lever positively in opposite directions, a latch device movable into and out of holding relation to the other end of said lever, and signal-responsive means for controlling said latch device.

260. In a telegraph system, the combination of a signal transmitting device, a travelling signal carrying medium, means to advance said medium past said device, a recording device arranged to be controlled in accordance with signals sent by said transmitting device, a storage medium upon which signals are impressed by said recording device, means for advancing said recording medium, and means operable to start and stop said transmitter and recorder advancing means in predetermined timed relation.

261. In a telegraph system, the combination of a signal transmitting device, a travelling signal carrying medium, means to advance said medium past said device, a recording device arranged to be controlled in accordance with signals sent by said transmitting device, a storage medium upon which signals are impressed by said recording device, means for advancing said recording medium, and means operable to interrupt said transmitter and recorder advancing means in predetermined timed relation and in successive order.

262. In telegraph apparatus, the combination of a storage medium comprising a series of individual signal carriers each having a group of elements adapted to be arranged in different combinations, a line-selector, a feeler responsive to the arrangement of said elements, a series of code bars and a series of combination bars selectively operable under the control of the code bars, and means for setting said code bars under the control of said feeler when the latter is set according to the first of said combinations, switching means adapted to be closed in the movement of each of said combination bars to establish a transmission path, and a second switching means adapted to be operated by said feeler under the control of succeeding signals to effect transmission thereof over said path.

263. In telegraph apparatus, the combination of a storage medium comprising a series of individual signal carriers each having a row of pins thereon adapted to be set in either of two positions so as to represent different combinations, means for advancing the signal carriers, and a signal-responsive device comprising a plurality of pivoted elements adapted to be moved in the advance of the carriers by said pins when

in one of said positions, said elements having cam-faced shoes adapted to be engaged by pins projecting from said carriers, and switching means comprising contacts controlled in the operation of said elements, the cam faces of said shoes being operable in the engagement therewith of corresponding pins in successive carriers to hold the contacts unchanged.

264. In a telegraph apparatus, the combination of a storage medium comprising groups of elements adapted to be arranged in different combinations, means for advancing the storage medium, a signal-responsive device comprising a plurality of pivotally mounted members movable under the control of said elements in the advance of the storage medium, and normally closed switches adapted to be opened by said members.

265. In a telegraph apparatus, the combination of a storage medium having individual signal carriers each having a transverse row of elements adapted to be set in different combinations, means for advancing the signal carriers, transmitting means including switching means comprising a set of switch contacts for each of said elements, and means operative in the advance of the carriers to control the operation of the several sets of switch contacts simultaneously.

266. In a telegraph apparatus, the combination of a storage medium adapted to contain a succession of signals representing a message, means for advancing the storage medium, feeling means comprising a plurality of individually movable elements operatively associated with the storage medium so as to be actuated selectively in accordance with the character of the signals in the advance of the storage medium, transmitting means controlled by said feeling means, and means operable to prevent transmission of certain of the signals on the storage medium in the movement thereof past the feeling means.

267. In a telegraph system, the combination of a transmitting relay unit and a plurality of receiving relay units, each of said units having a traveling carrier upon which a succession of signal combinations may be recorded, each of said combinations being composed of a plurality of elements each of which may have either of two differentiating characteristics, mechanism by which all of the elements of the individual combinations on the transmitting carrier may be transferred simultaneously to and reproduced on the carrier of one of said receiving units, and means operable selectively to bring said transmitting unit into operative association with a predetermined one of said receiving units.

268. In a telegraph system, the combination of a transmitter having a plurality of switches, a plurality of receivers, a plurality of transmission paths each leading from said transmitter to one of said receivers and each comprising a plurality of circuits each circuit including one of said switches, means at said transmitter for storing a succession of mechanical signal combinations each composed of a plurality of units arranged to control the respective transmission switches, and mechanism operable in accordance with the character of one of said stored signals for selecting one of said transmission paths.

269. In a telegraph system, the combination of a transmitter having a plurality of switches, a receiver having a plurality of control magnets each corresponding to one of said switches, a traveling signal storing medium associated with said receiver, recording means controlled by said magnets and adapted to impress received signals

on said medium, a traveling storage medium associated with said transmitter and having a succession of groups of signal units, the elements in each group being arranged to control the corresponding transmitting switches simultaneously in the advance of the transmitting storage medium, and a plurality of circuits extending between said transmitter and receiver and each including in series relation one of said switches and the corresponding one of said magnets.

270. A telegraph exchange system for automatically relaying to one of a plurality of stations a message represented by a succession of signal combinations each composed of a plurality of units, comprising, in combination, mechanism operable in response to successive combinations to convert the units thereof simultaneously from mechanical to electrical form and vice versa, and means responsive to one of the combinations of a message while in mechanical form to select one of a plurality of paths for the transmission of the message when again converted to electrical form.

271. In a telegraph system, the combination of a transmitter, a receiver, power means for driving said transmitter and receiver in synchronism, a storage medium associated with said transmitter for controlling the operation thereof, said medium being adapted to carry a succession of signals each composed of an equal number of units, and a plurality of electrical circuits extending between said transmitter and said receiver arranged for use simultaneously in the transmission of the different units of successive signals.

272. In a telegraph apparatus, the combination of a travelling carrier having a succession of transverse rows each of a uniform number of movable elements adapted to be set in various combinations to represent signals, and a transmitter having a plurality of individually movable members one for each of the several elements in each row and respectively adapted to be controlled according to the setting of the elements in successive rows, said members being arranged for association with all of the elements in each row simultaneously, and switching means controlled by said members to effect transmission of the several units of the successive signals simultaneously.

273. The method of transferring a plurality of signal combinations of uniform length over a succession of electrical transmission paths, which consists in simultaneously converting the units constituting each successive signal from mechanical to electrical form to transmit said units, and then simultaneously converting the different units of the successive transmitted signals into mechanical form.

274. In a telegraph apparatus, the combination of a traveling medium upon which a plurality of messages may be stored as a succession of mechanical signal combinations, advancing means for said medium, a line selector operable in the advance of said medium and in response to a certain signal of each successive message, a transmitter operable in the advance of the medium and in accordance with the character of the other signals of the successive messages, and other means operating in the advance of the medium and in response to a signal indicating the end of each message to free the transmitter from the path over which the message was sent.

275. In a telegraph system, the combination of a signal receiver, a plurality of independently operable transmitters each adapted for connection with said receiver for sending message signals thereto, means associated with each of said trans-

mitters and operable upon the complete transmission of a message by one of said transmitters to free it from said receiver, thereby rendering the receiver available for the reception of message matter from other transmitters.

276. In a telegraph system, the combination of a plurality of telegraph relay units each having a transmitter and means for recording a succession of signals representing a message and the end thereof, a telegraph receiver arranged for connection with the transmitter of each of said units through the medium of electrical transmission paths, means at each unit for detecting the end-of-message signal of each message transmitted therefrom, and means at each of said units controlled by the detecting means thereof and operable to free the unit from said receiver.

277. In a telegraph system, the combination of a signal receiver, a transmitter, a signal storage medium associated with said transmitter mechanism adapted to record successive groups of signal combinations on said medium, each group representing a message having a control signal of a predetermined character incorporated therein, means for establishing a transmission path between said transmitter and receiver, means for advancing said medium to control said transmitter and thereby send a message to said receiver, and means for feeling of the storage medium and responsive to the control signal of each message operable upon the complete transmission of each message to free the transmitter from the receiver to which the message was sent.

278. In a telegraph system, the combination of an electrical transmission path, a traveling signal carrier, a device responsive to message combinations of current and no current signal units received over said path and operable to record said combinations on said carrier, and means associated with said device and operable automatically to incorporate in the successive messages recorded on said carrier a control combination of the same character.

279. In a telegraph system, the combination of a plurality of signal receivers, a transmitter, a storage medium associated with said transmitter and adapted to contain a plurality of groups of mechanical signal combinations, each group having a plurality of signals representing a message to be transmitted to one of said receivers and a control signal of invariable character, means operable to extend a transmission path from said transmitter to any one of said receivers, means controlled in accordance with said message signals for controlling the operation of said transmitter in sending successive messages over different transmission paths, and means responsive to the control signal of each message and operable upon the complete transmission of the message to free said transmitter from the receiver with which it is associated.

280. In a telegraph system, the combination of a travelling medium for storing signal combinations, a recorder for impressing on said medium a succession of signals representing a message followed by a predetermined signal representing the end of the message, a transmitter adapted to be controlled by said message signals, a receiver, means for establishing a path for the electrical transmission of the message signals from said transmitter to said receiver in the advance of the traveling medium through said transmitter, means for detecting the approach of said end-of-message signal to said transmitter, and means controlled by said detecting means for interrupt-

ing the connection between the transmitter and receiver.

281. In a telegraph system, the combination of a travelling signal carrying medium, a signal responsive device operable to record successive received signals on said medium, and means operating automatically to add to each message as recorded on said medium a control signal representing the end thereof.

282. In a telegraph system, the combination of a transmission path, a device operable to transmit combinations of electrical signal units over said path, a travelling signal carrying medium, a device for receiving signals sent over said path and recording them on said medium, and means operable automatically upon the interruption of transmission over said path to add to the signals on said medium one or more combinations indicating the end of a message.

283. In a telegraph machine, the combination of a travelling signal carrying medium, recording and signal-responsive devices associated with said medium at spaced points and defining a storage section of variable signal capacity between such points, and means for controlling one of said devices comprising a threaded member, a non-rotatable traveler carried by and movable according to the direction of rotation of said member, means operable to drive said member in one direction during the delivery of signals into said section, and independent means operable to drive said member in the opposite direction during the withdrawal of signals from said section.

284. In a telegraph machine, the combination of a signal recording device, a signal responsive device, a differential gear having two terminal members and a terminal member driven by said intermediate members, means operable during the operation of said recording device to rotate one of said terminal members in one direction, means operable during the operation of said recording device to rotate said other terminal member in the opposite direction, and means controlled from said intermediate member for governing the operation of one of said devices.

285. In a telegraph machine, the combination of a traveling medium for carrying signal combinations, independently operable recording and signal-responsive devices associated with said medium, a threaded shaft, means including a differential gear for driving said shaft in opposite directions as incidents to the operation of said recording and signal-responsive devices respectively, a non-rotatable member threaded on said shaft, and means actuated upon the movement of said member into a predetermined position for governing the operation of one of said devices.

286. In a telegraph machine, the combination of a signal recording device, a signal-responsive device, a screw shaft driven differentially in opposite directions as incidents to the operation of said recording and signal-responsive devices respectively, an arm rotatable with said shaft, a member threaded on said shaft, a control element adjacent said arm and adapted to be urged into the path of said arm in the movement of said member into a predetermined position, and means controlled by said element for governing the operation of one of said devices.

287. A telegraph machine having, in combination, a signal-responsive device, a recording device, a controller for governing the operation of one of said devices, two elements mounted for simultaneous movement in different directions and at different speeds, means operable to drive

each of said elements in one direction when said recording device alone is operating and in the opposite direction when said signal-responsive device alone is operating, the higher speed element being arranged to govern the actuation of said controller, said other element being arranged to effect relative movement of said controller and said first mentioned element into and out of operative association with each other.

288. A telegraph machine having, in combination, a recording device, a signal-responsive device, a member arranged to govern the operation of one of said devices, an element governing the actuation of said member, a second element, means operable to drive said elements differentially as incidents to the operation of said devices, said second element being driven at a slower speed than said first element and operable when in a predetermined position to cause actuation of said member by the first element.

289. In a telegraph apparatus, a signal carrying medium arranged to travel in an endless path and having a section in which signals may be stored in variable quantities between two fixed points, recording and signal-responsive devices associated with said medium at said points, a controller governing the presentation of portions of said medium to one of said devices, an element for actuating said controller, means operable to drive said element in one direction or the other depending on which of said devices is operating, and a member driven simultaneously with but at a substantially slower speed than said element, and operable to control the operative association of said element and said controller.

290. In a telegraph apparatus, the combination of a signal recording device, a signal-responsive device, a signal storage medium in the form of a band arranged to carry signal combinations from said recording device to said signal-responsive device, means for presenting successive portions of said medium to said recording device including a clutch arranged to be engaged or disengaged on each signal cycle of said recording device, means for presenting to said signal-responsive device successive portions of said medium bearing signals including a clutch arranged to be engaged or disengaged on each signal cycle of said signal-responsive device, a differential gear having its members connected respectively to the driven members of said clutches for rotation in opposite directions, and a controller associated with the intermediate member of said differential gear.

291. In a telegraph apparatus, the combination of a travelling medium comprising a plurality of signal carriers, a device operable to record signal combinations on said carrier, means operable in successive signal cycles of said device to present successive signal carriers thereto including a clutch arranged to be engaged or disengaged in each of said signal cycles and having a constantly rotating driving member, and an indicator connected to the driven member of said clutch for registering the number of carriers passing said recording device.

292. In a telegraph apparatus, the combination of a signal carrying medium having a predetermined signal storage capacity, recording and signal-responsive devices through which medium may travel successively, mechanism operable to indicate the quantity of said medium between said devices including a member movable in opposite directions at speeds proportionate to but substantially less than the speeds at which said

medium is presented to said recording and signal-responsive devices respectively.

293. In a telegraph apparatus, the combination of a recording device, a transmitting device, a signal carrier in the form of a band extending between said devices, and means operable automatically to advance blank portions of the band through said recording device whereby to complete the transmission of message matter stored between said devices.

294. In telegraph apparatus, the combination of a recording device, a signal-responsive device spaced from said recording device, a band upon which a succession of messages may be recorded in signal form with variable lengths of blank portions of the band between them, and means operable according to the length of band between said devices to advance blank portions of said band past said recording device independently of the operation thereof whereby to permit all of the signals on said band to be run through said signal-responsive device.

295. In a telegraph apparatus, the combination of a recording device, a transmitting device, a signal carrier in the form of a band extending between said devices, and means controlled as an incident to the operation of said transmitting device and operable to control the advance of blank medium through said recording device to complete the transmission of message matter between said devices and to interrupt such advance of the band through said recording device when said transmitting device ceases to operate.

296. In a telegraph machine, the combination of a signal recording device, a signal-responsive device operable at the same speed as said recording device, a member driven differentially from said devices so as to be advanced in one direction when said recording device alone is operating, in the opposite direction when said signal-responsive device alone is operating, and to remain at rest when both of said devices are operating, and means controlled by said member when moved in one direction by one of said devices to initiate the operation of said other device.

297. In a telegraph apparatus, the combination of a recording device, a transmitting device, a signal carrier in the form of a band extending between said devices, mechanism for advancing the band past said recording device, and two independent control means operable to initiate the operation of said mechanism, one of said control means being operable as an incident to the operation of said recording device, the other control means being operable as an incident to the operation of said transmitting device.

298. A telegraph machine having, in combination, a signal recording device, a signal-responsive device, a signal storage medium comprising a band arranged in a series of loops of variable lengths to form a signal storage section of variable capacity between said devices, and means operable when said loops have been reduced to a predetermined length by the operation of the signal-responsive device to initiate the advance of the blank band past said recording device into said section.

299. A telegraph machine having, in combination, a signal-responsive device, a recording device, a signal carrier comprising a continuous band extending through said devices, advancing means for supplying the band in blank form to said recording device, a second advancing means for supplying the band bearing signals to said signal-responsive device, and means responsive

to the operation of said last mentioned advancing means for initiating the operation of said first mentioned advancing means.

300. A telegraph machine having, in combination, a continuous band upon which signal combinations may be impressed, said band constituting a storage section of variable capacity, a pair of independently operable devices at opposite ends of said section for supplying the band to and withdrawing the band from said section, means responsive to the advance of said band by said withdrawing device to initiate the advance of the band into said section by said supplying device and to interrupt the advance of the band into said section when said withdrawing device ceases to operate.

301. A telegraph machine having, in combination, a signal carrying medium comprising a continuous band forming a signal storage section of variable capacity, independently operable devices associated with said band at opposite ends of said section and operable respectively to supply to and withdraw portions of said band from said section, means operating to register the length of band between said devices, and means controlled by said registering means when the length of band in said section is reduced to a predetermined point to initiate the operation of said supplying device.

302. A telegraph machine having, in combination, a recording device, a signal-responsive device, a signal carrier comprising a continuous band extending between said devices and providing a storage section of variable capacity, an indicator member driven differentially from said devices so as to move in one direction during the individual operation of the recording device and in the opposite direction during the individual operation of said signal-responsive device, and means operated by said member in moving into a predetermined position in said first mentioned direction of movement for initiating the advance of said band through said recording device while the latter device remains idle.

303. In a telegraph system, the combination of a station having a signal transmitter, a station having a power-actuated recorder controlled by signals sent from said transmitter, and means controlled from said recording station for interrupting the operation of said transmitter and subsequently initiating the operation of said transmitter to resume transmission.

304. In a telegraph system, the combination of a signal transmitting device, a signal receiving device, an electrical transmission path by which said devices may be associated, and means operating independently of said transmission path for controlling the operation of the transmitting device as an incident to the operation of the receiving device.

305. A telegraph machine having, in combination, a signal recorder, a storage medium by which signals may be carried, means operable to advance said medium to said recorder to supply the operating requirements thereof, and means operable when the supply of storage medium approaches exhaustion to interrupt the operation of said advancing means.

306. In a telegraph apparatus, the combination of a signal recording device, a signal storing medium adapted to be supplied in blank form to said device, and automatically operable means adapted, when the available supply of the blank medium becomes exhausted, to interrupt the operation of said recording device.

307. In a telegraph apparatus, the combination of a signal recording device, a signal storing medium, means for advancing the medium in blank form to said device, and automatically operable means operative when the available supply of the blank medium becomes exhausted to interrupt the operation of said advancing means and to resume the operation thereof when a predetermined supply of blank medium again becomes available.

308. In a telegraph apparatus, the combination of a signal carrying medium arranged to travel in an endless path, recording and signal-responsive devices associated with said medium and defining between them a supply section and a signal storing section, means for advancing the medium from said supply section to said recording device, means operable to detect the reduction of the medium in said supply section below a predetermined point, and means controlled by said detecting means and operable automatically to interrupt the operation of said advancing means and to resume the operation thereof when a predetermined supply of the medium is again available in said supply section.

309. In a telegraph apparatus, the combination of a signal carrying medium arranged to travel in an endless path, recording and signal-responsive devices associated with said medium and defining between them a supply section and a signal storing section, means for advancing the medium from said supply section to said recording device, means operable to detect the reduction of the medium in said supply section below a predetermined point, and means controlled by said detecting means and operable automatically to interrupt the operation of said advancing means.

310. In a telegraph apparatus, the combination of a signal recording device, a signal carrying medium providing a limited source of supply for said device, means operable to advance successive portions of said medium through said device, means operable to detect the reduction of the quantity of the medium to a predetermined point, and two independent means for governing the operation of said advancing means one controlled by said recording device and the other by said detecting means.

311. In telegraph apparatus, the combination of a storage medium having a predetermined maximum capacity to store message matter, means operative to record message matter on the storage medium including means for advancing the medium, and means operative to interrupt the operation of said advancing means automatically when the capacity of said storage medium to receive additional message matter has become exhausted.

312. In telegraph the combination of a storage medium having a predetermined maximum capacity to store message matter, means operative to record message matter on the storage medium, means operable as an incident to the recording of message matter on the storage medium to advance the same, and means operable independently of the last mentioned means when the capacity of the storage medium approaches said maximum to render said advancing means inoperative.

313. In a telegraph system, the combination of an electrical transmission path, a signal recording device at one end of said path, a traveling signal carrying medium associated with said recording device, means for advancing the medium past said recording device, a transmitting device at the opposite end of said path, a traveling signal carry-

ing medium for controlling said transmitting device, advancing means for said last mentioned medium, and means operable to interrupt the operation of said recorder and transmitting advancing means in timed relation.

314. In a telegraph system, the combination of an electrical transmission path, a signal recording device at one end of said path, a traveling signal carrying medium associated with said recording device, means for advancing the medium past said recording device, a transmitting device at the opposite end of said path, a traveling signal carrying medium for controlling said transmitting device, advancing means for said last mentioned medium, and means operable to interrupt the operation of said transmitting and recording advancing means successively and in a predetermined timed relation.

315. In a telegraph system, the combination of an electrical transmission path, a signal responsive device at one end of said path, a traveling signal carrying medium associated with said device, means for advancing the medium past said device, a transmitting device at the opposite end of said path, a traveling signal carrying medium for controlling said transmitting device, advancing means for said last mentioned medium, and means operable to temporarily interrupt and to restart said transmitter and recorder advancing means in timed relation.

316. In a telegraph system, the combination of a transmitter, a receiver, a transmission path for connecting said transmission and said receiver, a traveling medium associated with said receiver upon which received signals may be recorded, means associated with said receiver for interrupting the operation of said transmitter, and means operating in timed relation to said last mentioned means to interrupt the operation of said receiver with a blank portion of said medium in operative association therewith.

317. In a telegraph system, the combination of a station having a power actuated transmitter, a station having a power actuated receiver, means at one of said stations for stopping and restarting said receiver and transmitter in timed relation, and means responsive to the operation of said receiver for controlling said last mentioned means.

318. In a telegraph system, the combination of a signal transmitting device, a signal receiving device, an electrical transmission path by which said devices may be associated, an auxiliary circuit by which the operation of said transmitting device may be controlled from the receiving device, and selectively operable means to establish said path and said circuit.

319. In a telegraph system, the combination of a transmitter and a receiver arranged for association by an electrical transmission path, a signal storing medium associated with said receiver and adapted to be supplied thereto in blank form, and means operable when the available supply of blank medium becomes exhausted to interrupt the operation of said receiver and transmitter automatically.

320. In a telegraph apparatus, the combination of a transmitter and a recorder arranged for association through an electrical transmission path, a traveling medium upon which signals may be recorded by said receiver, means for detecting a reduction in the quantity of medium available for said recorder to a predetermined point, and means controlled by said last mentioned means for interrupting the operation of said transmitter and the advance of said medium past the recorder.

321. In a telegraph apparatus, the combination of a transmitter and a recorder arranged for association through an electrical transmission path, a traveling medium upon which signals may be recorded by said receiver, means for detecting a reduction in the quantity of medium available for said recorder to a predetermined point, and means controlled by said last mentioned means for interrupting the operation of said transmitter and the advance of said medium past the recorder in a predetermined timed relation.

322. In a telegraph system, the combination of a signal storing medium, a recorder, means for advancing the medium past the recorder, a transmitter, a transmission path extending between said transmitter and said recorder, and means operable to interrupt the operation of said transmitter and said advancing means when the supply of medium for said recorder approaches a stage of exhaustion and to restart the transmitter and advancing means in timed relation when a predetermined supply of medium is again available for said recorder.

323. In a telegraph system, the combination of a signal transmitting device, a signal receiving device, an electrical transmission path by which said devices may be associated, means operating automatically upon the establishment of said path to provide an independent circuit between said devices, and means operable as an incident to the operation of said receiving device to control the operation of said transmitting device through the medium of said circuit.

324. In a telegraph system having two stations, the combination of a transmission path extending between said stations, a signal transmitter at one of said stations, a traveling medium for carrying signals located at said other station, a signal responsive device for recording received signal combinations on said medium, an auxiliary electrical circuit extending between said stations, means at said receiving station operable to control said circuit when the available supply of said medium approaches a state of exhaustion, and means controlled through said circuit for automatically interrupting the operation of said transmitter.

325. In a telegraph system having a plurality of receiving and transmitting stations, the combination of a signal transmitter at each of said transmitting stations, a signal receiver at each of said receiving stations, a plurality of transmission paths by which one of said transmitters may be associated with any one of said receivers, a plurality of auxiliary control circuits, one corresponding to each of said paths, and selectively operable means by which one of said paths and one of said circuits may be established between one of said transmitters and any one of said receivers.

326. In a telegraph system having a plurality of receiving and transmitting stations, the combination of a signal transmitter at each of said transmitting stations, a signal receiver at each of said receiving stations, a plurality of transmission paths by which one of said transmitters may be associated with any one of said receivers, a plurality of auxiliary control circuits, one corresponding to each of said paths, selectively operable means for establishing a predetermined one of said auxiliary circuits between one of said transmitters and one of said receivers, and means operable from one of said receivers through the medium of said predetermined circuit for con-

trolling the operation of the associated transmitter.

327. In a telegraph system, the combination of a transmitter, a receiver, an electrical transmission path over which signals may be sent from said transmitter to said receiver, an auxiliary electrical circuit extending between said transmitter and receiver, an electromagnet in said circuit controlling the starting and stopping of said transmitter, and a switch in said circuit and associated with said receiver and operable as an incident to the operation of the receiver.

328. In a telegraph system, the combination of a transmitter, a travelling signal carrying medium arranged to control said transmitter, a receiver, an electrical transmission path over which signals may be sent from said transmitter to said receiver, an auxiliary electrical circuit extending between said transmitter and receiver, an electromagnet in said circuit controlling the advance of the medium at said transmitter, and a switch in said circuit and associated with said receiver and operable as an incident to the operation of the receiver.

329. In a telegraph machine, the combination of a travelling signal carrier, recording and signal responsive devices associated with said carrier at spaced points, an indicator, means driven differentially from said devices and operable to move said indicator in one direction as an incident to the operation of said signal responsive device and in the other direction as an incident to the operation of said recording device, and means operable upon movement of said indicator into a predetermined position for governing the advance of said carrier past one of said points.

330. In a telegraph machine, the combination of a travelling medium for carrying signal combinations, independently operable recording and signal responsive devices associated with said medium, a member driven differentially from each of said devices as an incident to the operation of the respective devices, and means actuated by said member and operable to govern the operation of one of said devices.

331. In a telegraph machine, the combination of a travelling medium having a section adapted for storing variable quantities of signals mechanically, a device for recording signals on said medium, means operating under the control of said device for advancing the storage medium, means operable independently of said recording device for advancing the storage medium past the recording point, and means operable to count the number of signals of predetermined character delivered to said section in the operation of said recording device.

332. In a telegraph machine, the combination of a signal recording device, a signal responsive device, a travelling signal carrier providing a storage section of variable capacity between said devices, and means operable to detect the presence of signals of certain character in said section.

333. In a telegraph machine, the combination of a signal recording device, a signal responsive device, a travelling signal carrier providing a storage section of variable capacity between said devices, and means operable to detect the presence of signals representing message matter.

334. In a telegraph machine, the combination of a signal recording device, a signal-responsive device, a travelling signal carrier providing a storage section of variable capacity between said devices, an indicator, means operable to move said indicator in one direction a distance correspond-

ing to the number of signals carrier into said section from said recording device, and means operable to move said indicator in the opposite direction a distance corresponding to the number of signals carried out of said section through said signal responsive device.

335. A telegraph machine having, in combination, a recording device, a signal-responsive device, a travelling signal-carrying medium comprising a band forming a signal storage section of variable capacity between said devices, an indicator, means for operating said indicator to count the number of signal combinations of a predetermined class delivered into said section from said recording device, and means operating said indicator to subtract from the number of signals registered thereby the number of signals passing out of said section in the operation of said signal-responsive device.

336. A telegraph machine having, in combination, a recording device, a signal-responsive device, means interposed between said devices for storing signals mechanically and in variable quantities, means operable to count the signals of predetermined character passing into said storing means from said recording device, means operable to count the signals of the same character passing out of said storing means through said other device, and means responsive to each of said counting means to indicate the number of said signals in said storing means.

337. In a telegraph machine, the combination of a signal carrier, a device operable in successive cycles to advance signals on said carrier successively past a point of control during each of such cycles, and means for counting the signals passing said point including a clutch adapted to be engaged or disengaged during each signal cycle.

338. In a telegraph machine, the combination of a signal recording device, a signal-responsive device, a travelling signal carrier providing a storage section of variable capacity between said devices, an indicator for counting the signals of a certain character delivered into said section comprising a constantly operating drive means, a clutch controlling the drive of said indicator from said drive means, and means responsive to the character of the signals impressed upon said carrier by said recording means for governing the engagement and disengagement of said clutch.

339. In a telegraph machine, the combination of a signal recording device, a signal-responsive device, a continuous band for carrying signal combinations from said recording device to said signal-responsive device, means for advancing lengths of said band in blank form to said recording device, and a mechanism for counting the number of signals recorded on said band through said recording device including a clutch, constantly driven means therefor, an indicator member driven during engagement of said clutch, and means responsive to the character of the signals as recorded on said band for causing engagement of said clutch.

340. In a telegraph machine, the combination of a signal carrier, a device operable in successive cycles to advance said carrier past a point of control, means for counting the signals passing said point including a clutch adapted to be engaged or disengaged during each signal cycle, and a feeler responsive to the signals passing said point for governing the engagement of said clutch.

341. A telegraph machine having, in combination a travelling signal-carrying medium, means

for advancing signals on said medium past a point of control, and means for counting the signals passing said point, said last mentioned means comprising an indicator member, means for driving said member in one direction, a clutch for controlling said driving means, and means operative in the movement of signals away from said point to cause engagement of said clutch, said last mentioned means being inoperative during the advance of blank storage medium through said recording device.

342. In a telegraph machine, the combination of a travelling medium constituting a signal carrier of variable capacity, a device associated with said carrier at a fixed point of control and operable to record signals thereon, a signal-responsive device associated with said carrier at another point of control and arranged to be controlled in accordance with the signals thereon, independent means for advancing said carrier past said recording and control points respectively, differential gearing having an intermediate member arranged to be driven in opposite directions by its two terminal members, an indicator movable with said intermediate member, a clutch for driving one of said terminal members, means determined by the character of the signals passing said recording control point to control the engagement of said clutch, a clutch for driving said other terminal member, and means determined by the character of the signals passing said other control point to govern the engagement of said last mentioned clutch.

343. An apparatus for automatically relaying a message from one point to another comprising means for recording a message in the form of a succession of signals in mechanical form, a signal-responsive device, means for detecting the presence of stored message matter, and means operable under the control of said detector to present the first of said stored signals to said device.

344. In telegraph apparatus, the combination of a recording device, a signal-responsive device spaced from said recording device, a band upon which a succession of messages may be recorded in signal form with variable lengths of blank portions of the band between them, and means operable independently of the length of band between said devices to effect the advance of said blank portions relative to said signal responsive device whereby to present the successive messages thereto, said means acting automatically to interrupt the advance of the band when there is no message matter on the band between said recording and signal-responsive devices.

345. In a telegraph apparatus, the combination of a travelling storage medium adapted to contain a succession of messages in signal form, transmitting means operable in the advance of the storage medium, a line-selector, and means operable upon the transmission of one message to advance the succeeding message to said line selector.

346. In a telegraph machine, the combination of a travelling medium upon which signal combinations may be recorded mechanically, a recorder and a transmitter associated with said medium and providing a signal storage section of variable capacity between them, drive means operable in accordance with the number of signals delivered into said section by said recorder, drive means operable in accordance with the number of signals passing out of said section through said transmitter, an indicator operated differentially

from each of said drive means so as to register the quantity of signals stored in said section, and means controlled from said indicator for initiating the advance of said storage medium toward said transmitter.

347. In a telegraph machine, the combination of a signal storage medium comprising a continuous band, recording and signal-responsive devices associated with said band at spaced points, means operable to advance said band past said signal responsive device, and means responsive to the character of signals recorded on said band for initiating the operation of said advancing means.

348. In telegraph apparatus, the combination of a recording device, a signal-responsive device, a band for carrying signals and providing a storage section of variable capacity between said devices, means operable independently of the length of band in said section to detect the presence of message signals thereon, means operable to indicate the length of band in said section, means controlled by said detecting means for effecting the advance of said band past said signal-responsive device whereby to run out the blank portions of the band in advance of the message signals in said section, and means responsive to said indicating means for advancing the band through said recording device into said section whereby to permit continued advance of the band past said signal responsive device after the band in said section has been reduced to its minimum length.

349. A relay unit of the character described comprising, in combination, a storage medium in the form of a band, means for recording a message on the storage medium, a transmitter operable under the control of message matter stored on said medium, means for driving the recording means and the transmitter either simultaneously or independently, means controlled by the operation of the recording means for initiating the operation of the transmitter, and means for controlling the advance of the band at the recording means operating as an incident to the operation of the transmitter.

350. In a telegraph apparatus, the combination of a carrier for a succession of signals in mechanical form and representing a message, and a mechanical feeler adapted to recognize certain only of said signals according to the position thereof relative to the other signals of the message.

351. In telegraph apparatus, the combination of a storage medium having groups of movable elements adapted for arrangement in different combinations to represent signals, feeling means mechanically associated with said elements, and a member controlled by said feeling means and movable into one position upon the movement past said feeling means of a group of signal elements arranged in a certain combination and in the opposite direction upon the passage of a group of elements arranged in any other combination.

352. In telegraph apparatus, the combination of a storage medium having groups of movable elements adapted for arrangement in different combinations to represent signals, feeling means mechanically associated with said elements, and a member controlled by said feeling means and movable into one position upon the movement past said feeling means of a group of signal elements all of which have a common characteristic and in the opposite direction upon the passage

of a signal having elements of different characteristics.

353. In a telegraph apparatus, the combination of a traveling medium upon which signal combinations may be stored, a feeler operatively associated with said medium and operable in the advance thereof to detect the presence of a predetermined signal combination thereon only when preceded by a different combination, means for advancing said medium relative to said feeler, and means controlled by said feeler for governing the operation of said advancing means.

354. In a telegraph apparatus, the combination of a traveling signal carrier adapted to contain a succession of individual signal combinations, and means for controlling the advance of the carrier including a feeler mechanically associated with said carrier and movable into one position upon the presentation thereto of a signal having a predetermined character and preceded by a signal of a different character.

355. In a telegraph apparatus, the combination of a storage medium comprising a chain having a series of links each having a plurality of pins certain of which are pushed and certain of which are non-pushed to represent different signal combinations, certain of said links having all of their pins non-pushed to represent blanks, a feeler having a series of shoes one for each of said pins and movable thereby to distinguish between blank and non-blank links, and means for controlling the advance of the chain including a clutch governed by said feeler.

356. In a telegraph apparatus, the combination of a traveling medium having a succession of groups of elements, the elements of each group being individually adjustable into either of two set positions, a feeler carrying a series of shoes each positioned in the path of one element of the successive groups on said medium so as to be engaged and cammed laterally by its element provided the latter is in one of said set positions, and means controlled by the movements of said feeler for governing the advance of said medium.

357. In a telegraph apparatus, the combination of a traveling chain having a plurality of interconnected links each carrying a row of pins individually adjustable into either of two set positions in a direction perpendicular to the path of movement of the chain, a member mounted for movement transversely of said chain, and a plurality of shoes on said member each providing a cam surface disposed in the path of one of said pins of the successive chain links when said pin is in one of said set positions.

358. In a telegraph apparatus, the combination of a traveling medium having a succession of groups of elements, the element of each group being individually adjustable into either of two set positions, a plurality of cam members each disposed in the path of one element of the successive signal groups when said element is in one of said set positions and moved out of the path of the element when the latter is in said other set position, means operable to advance said medium past said members, and means controlled jointly by a plurality of said members for governing the operation of said advancing means.

359. In a telegraph system, the combination of an electrical transmission path, a transmitting device for sending signals over said path, a recording device adapted to receive and record signals sent over said path, and power driving mechanisms individual to said devices and each operable automatically upon starting to bring its de-

vice into exact synchronism with the other devices then in operation, said mechanisms being driven from a common source of power.

360. A telegraph system having, in combination, a transmitting device, a device adapted to receive and record signals sent by the transmitting device, a source of alternating current of constant frequency, synchronous motors individual to said devices and having rotary armatures, said motors deriving power from said source of current, and means driven by each of said motors to effect the transmission and recording operations in successive signal cycles each having a predetermined phase relation to the alternations of said current.

361. A telegraph system having, in combination, a plurality of relay units, each comprising a travelling signal storage medium, a recording device and a transmitting device, the transmitting device of one unit being operable to transmit signals on its associated storage medium to control the operation of the recording device at another unit so as to transfer said signals to the storage medium at the last mentioned unit, a source of alternating current of constant frequency, synchronous motors individual to said relay units and having rotary armatures, said motors deriving power from said source of current, and mechanisms driven from each motor for advancing the storage medium to effect the operation of the recording and transmitting devices in successive signal cycles each having a predetermined phase relation to the alternations of said current.

362. A telegraph machine having, in combination, a traveling medium carrying groups of elements each representing a signal, means for advancing said medium to move successive signals thereon past a point of control, a synchronous alternating current motor, and mechanism driven from said motor and operable to drive said advancing means at a speed such that the number of signals passing said control point is equal to or is a multiple of the frequency of the alternating current driving said motor.

363. In a telegraph system, the combination of a plurality of electrical transmission paths, a plurality of transmitting devices for sending signals over said paths, a plurality of recording devices adapted to receive and record signals sent over said paths, synchronous motors individual to said devices arranged to be driven from a source of alternating current of predetermined frequency, and mechanisms driven by the individual motors and operable to drive the respective devices at predetermined speeds such that the number of signals transmitted or recorded by any of said devices is equal to or a multiple of the frequency of said alternating current.

364. In a telegraph machine, the combination of a storage medium, means for recording message matter on the storage medium, means for transferring message matter from the storage medium, a power-actuated drive means, means deriving power from the last mentioned means for advancing the storage medium relative to the recording and transfer means independently, and means operable when the quantity of message matter in storage increases beyond a predetermined amount in one direction to stop said power-actuated drive means.

365. In a telegraph system, the combination of a transmitting means, a travelling storage medium controlling the operation of said transmitting means, a device arranged to record combinations of electrical signal units sent from said

transmitting means, means associated with said device for stopping said transmitter and recording device, and means controlled from said recording device for interrupting the advance of said storage medium.

366. In a telegraph system, the method of transmitting a telegraph message which comprises, receiving the message from the calling station over a first communication circuit, recording in a control-form the address, the body, the signature and a message-end signal and storing the control-form until the message-end signal is received, disconnecting the first communication circuit under control of the message-end signal, and thereafter establishing a communication circuit with the called station automatically under control of the recorded address and retransmitting the message thereover.

367. In a telegraph system, the method of transmitting a telegraph message which comprises, receiving the message over a communication circuit, recording the message, storing the record until the message is completely received, disconnecting the used communication circuit, thereafter establishing another communication circuit automatically under control of the recorded message, and retransmitting the message thereover.

368. In a telegraph system, telegraphic substations, a central station, lines connecting said substations to said central station, a recording receiver, means to connect one of said substations to said receiver, to produce a message record at said receiver under control of the connected substation and subsequently to disconnect said recording receiver from said substation, and means controlled automatically by said message record after said disconnection to select and connect a further one of said substations, and to transmit thereto.

369. In an automatic telegraph system, the combination of a transfer point, means for transmitting to said transfer point a series of messages each including a directing signal of a predetermined code combination and a plurality of signal combinations representing the body of the message, means at said transfer point for storing said messages, a plurality of terminal points, and means operative in response to the permutational character of the directing signals of the messages stored in said storage means to transfer the bodies thereof selectively to said terminal points.

370. In an automatic telegraph system, the combination of an originating point, an intermediate point and a plurality of terminal points, means at the originating point for transmitting to the intermediate point a succession of messages each including a direction signal in the form of a preconcerted signal combination and a plurality of signal combinations representing the body of the message, and means at said intermediate point operative in accordance with the permutational character of the direction signals to transfer the bodies of the messages selectively to said terminal points.

371. In an automatic telegraph system, the combination of an originating point, an intermediate point and a plurality of terminal points, means at the originating point for transmitting to the intermediate point a succession of messages each including a direction signal in the form of a preconcerted signal combination and a plurality of signal combinations representing the body of the message, means for storing the messages at said intermediate point, and means for

establishing paths from the intermediate point to the terminal points selectively in accordance with the permutational character of the direction signals in said storage means.

372. In a telegraph system, a telegraph circuit, a form with a message recorded thereon, transmitting means for transmitting code signals over said circuit under control of the record on said form, and means controlled jointly by the record on the form and by the position of the form as determined by the amount of message matter recorded thereon for stopping said transmitting means.

373. In a telegraph system, a telegraph circuit, a message record comprising recorded code signals and an end-of-message signal, transmitting means including mechanism controlled in accordance with the code signals of the record for transmitting a message over said circuit, and other mechanism controlled by the end-of-message signal of said record for stopping said transmitting means.

374. A telegraph transmitter for transmitting code signals under control of a record containing message matter and an end-of-message indication, sensing mechanism operated in accordance with the message matter of the record for controlling the transmission thereof, and other sensing mechanism operated in accordance with the end-of-message indication of said record to control the operation of the transmitter.

375. In a telegraph system, two stations, a telegraph circuit connecting said two stations, switching apparatus at both stations, a record form, means controlled in accordance with certain records on said form to control apparatus at the same stations, and means controlled in accordance with other records on said form to control over said circuit the apparatus at the other stations.

376. In a telegraph system, a telegraph transmitter, a control form, means controlled by the record on the form, means responsive according to the supply of record bearing form, and means operated by either of said means to stop said transmitter.

377. In a telegraph system, in combination, an originating station, an intermediate station, a plurality of terminal stations, means at said originating station for transmitting a related series of permutation signals, means at said intermediate station for receiving said signals, and means at said intermediate station controlled in accordance with the permutational value of certain of said signals to relay the remainder of the signals to a particular one of said terminal points.

378. A system for transmitting messages from one station to a selected one of a plurality of other stations, means at said one station for compiling a message in the form of a series of station identifying permutation signals varying in their permutational values in accordance with the designation of the receiving station and a further series of permutation signals representing message matter, means at said one station for transmitting the signals, and means intermediate said one station and said other stations responsive to said station identifying signals for directing said further signals to the proper one of said other stations.

379. In a telegraph system, the combination of a line, means for transmitting a succession of permutation code signals over said line, a plurality of other lines, means operated in accordance with the permutational value of cer-

tain of the transmitted code signals for selectively establishing connections over which other of said code signals may be transmitted to any one of said other lines, and means responsive to the establishment of a connection for initiating the transmission of said other signals.

380. In an automatic telegraph system, the combination of a transfer station, a plurality of terminal stations, and a plurality of transmission paths respectively leading to said terminal stations, said transfer station having means for receiving a succession of signals, and means responsive to one only of said signals for selecting any one of said transmission paths.

381. A selecting mechanism comprising, in combination, a plurality of elements to be operated individually or in combinations, a plurality of actuating levers, a reciprocable support for said levers, said levers being pivotally mounted intermediate their ends on said support and having one end operatively associated respectively with said elements, and selectively operable means adapted to hold the other ends of said levers against movement selectively whereby to effect the operation of said elements in the reciprocation of said support.

382. The combination of a plurality of elements to be operated in different combinations selectively, a power driven reciprocable support, a plurality of actuating members mounted on said support for movement therewith and also independently thereof, and selectively operable means for governing the independent motion of said actuating members.

383. A mechanism for recording signals on a signal carrying medium comprising, in combination, a recording element, an actuator for said element comprising a lever pivoted intermediate its ends and having one end cooperatively associated with said element, power actuated means for shifting the pivot of said lever, and a latch device movable into and out of holding relation to the other end of said lever.

384. A mechanism for recording signals on a signal carrying medium comprising, in combination, a plurality of recording elements, a reciprocable member, an actuator for each element comprising a lever pivoted on said member and having one end cooperatively associated with the element, power actuated means for reciprocating said member, and a latch device for each lever adapted to be moved into holding relation to the other end of the lever to render the lever operative to actuate the associated element as an incident to the reciprocation of said member.

385. An electric signalling system having in combination with a plurality of points to which intelligence is to be distributed selectively, of a distributing mechanism having means for storing a group of received signals in permutational form, including a directing signal and one or more intelligence signals, and switching mechanism operative automatically in response to the directing signal of said group for effecting transmission of the intelligence signal or signals to a selected one of said points according to the permutational value of said directing signal.

386. In a selectively operable mechanism, the combination with a driving shaft and a driven shaft, of a clutch adapted to operatively connect said shafts, a movable control element for engaging and disengaging said clutch, a constantly reciprocating actuator for said control element, a latch movable into and out of position to render said actuator effective to move said control element, and selectively operable

means for controlling the position of said latch.

387. In a selectively operable mechanism, the combination with a driving shaft and a driven shaft, of a clutch having driving and driven members operatively associated with said shafts and adapted when engaged to provide a positive driving connection between the shafts, a movable control element operative to engage and disengage said members, and means for moving said control element including a constantly reciprocating support, a lever member pivoted intermediate to ends on said support and reciprocable therewith, a link interposed between said control element and one end of said lever member, a latch movable into and out of blocking relation with the other end of said lever member to render the same effective to move said control element through the medium of said link as an incident to the reciprocation of said support, and selectively operable means for moving said latch.

388. In a selectively operable mechanism, the combination of a signal carrying medium for controlling the mechanism, a driving shaft and a driven shaft, a clutch having driving and driven members operatively associated with said shafts and operative when engaged to provide a positive driving connection between the shafts, a movable control element for engaging and disengaging said members, a constantly reciprocating actuator for said control element, a latch movable into and out of position to render said actuator effective to move said control element, and means operated under control of a signal on said medium for positioning said latch.

389. In a mechanism adapted to be selectively controlled by a flexible band containing a succession of signals, the combination of a driving shaft and a driven shaft, a clutch for operatively connecting said shafts including a driving and a driven member adapted when engaged to provide a positive driving connection between the shafts, a control element for engaging and disengaging said members, a constantly reciprocating actuator for said control element, a latch movable into and out of position to render said actuator effective to operate said control member, a device responsive to signals on said band, and means controlled by said device for moving said latch into operative relation to said actuator.

390. In a signal responsive apparatus, the combination with a control form, of a clutch device to be operated, a feeler operatively associated with the control form, and power driven mechanism operative under the control of said feeler to actuate said clutch device, said power driven mechanism including a power driven reciprocable support, an actuating member mounted on said support for movement therewith and also independently thereof, and a latch device operatively associated with said feeler and governing the independent motion of said actuating member, said actuating member being operative in such independent movement thereof to actuate said clutch device.

391. In a selectively operable mechanism, the combination of a series of controlling elements adapted to be set in permutational combinations, a series of code bars, a series of combination bars selectively operable under the control of said code bars, and transfer means interposed between said code bars and said elements including a reciprocating carrier having a series of set devices and movable in one direction into operative association with said elements to be set in accordance with the setting of the elements and in

the opposite direction into engagement with the code bars to set the latter.

392. In a selectively operable mechanism, in combination, a series of controlling elements adapted to be positioned selectively in different permutational combination, a series of controlled elements adapted to be set in corresponding combinations, and means for transferring different combinations from the controlling to the controlled elements comprising a reciprocable support, a plurality of transfer members mounted on said support for movement therewith and also independently thereof so as to be capable of occupying either of two positions on the support, and means for reciprocating said support to carry said transfer members first into operative association with said controlling elements so as to be positioned differentially relative to the support according to the setting of the controlling elements and then out of association with the controlling members to permit resetting of the latter, said transfer members being operative to shift the controlled elements in the last mentioned movement of the support.

393. In a selectively operable mechanism, the combination of a controlling element adapted to occupy either of two positions, a controlled element also adapted to occupy either of two positions, and a transfer mechanism interposed between said elements, said transfer mechanism including a reciprocable support and a member pivotally mounted on said support for movement into either of two positions, and means for reciprocating said support to bring said member into operative association with said controlling element and said controlled element successively, said controlling element being operative in accordance with its position to control the positioning of said member and said member in turn being operative to similarly control the positioning of said controlled element.

394. In a selectively operable mechanism, the combination of a controlling element adapted to occupy either a normal position or an operated position, a controlled element adapted to occupy either a normal position or an operated position, and a transfer mechanism interposed between said elements, said transfer mechanism including a reciprocable support and a member mounted on said support for movement into either of two positions relative to the support, said member being arranged to cooperate with said elements successively in the reciprocation of said support, and said controlling element when in operative position acting to move the member into one position and said member acting when in said one position to move said controlled element from normal to operated position, and means for reciprocating said support.

395. In a selectively operable mechanism, in combination, a transfer device comprising, a first group and a second group of settable elements, means for setting the elements of the first group in permutational combinations corresponding to code signals, power operated mechanism for transferring the setting of the elements of the first group to the elements of the second group, and means associated with the elements of the second group and operative to retain the elements in set position so that the elements of the first group may be reset in another combination.

396. In a selectively operable mechanism, in combination, a mechanically operating signal translating mechanism comprising a recipro-

cable support, a plurality of levers pivotally mounted intermediate their ends on said support, a like plurality of members disposed so that each member is adapted to coact with one end of a corresponding one of said levers, means for setting said members in permutational combinations to thereby position certain of the members in blocking relation to the associated levers, means for reciprocating said support in timed relation to the setting of said members to shift the levers into operative relation with the set members and thereby transfer the setting of the members to the levers, and a series of signal determining elements operable by said levers.

397. In a selectively operable device, the combination of a mechanically operating signal translating mechanism comprising a reciprocable support, a plurality of levers pivotally mounted intermediate their ends on said support, a like plurality of members disposed so that each member is adapted to coact with one end of a corresponding one of said levers, means for setting said members in permutational combinations to thereby position certain of the members in blocking relation to the associated levers, a shaft operable through a cycle in timed relation to the setting of said members, cam means carried by said shaft for reciprocating said support to shift said levers into operative relation with the set members and thereby transfer the setting of the members to the levers, and a plurality of signal determining elements operable by said levers.

398. In a selectively operable device, the combination of a mechanically operating signal translating mechanism comprising a reciprocable support, a plurality of levers pivotally mounted intermediate their ends on said support, a like plurality of members disposed so that each member is adapted to coact with one end of a corresponding one of said levers, means for setting said members in permutational combinations to thereby position certain of the members in blocking relation to the associated levers, a shaft operable through a cycle in timed relation to the setting of said members, cam means carried by said shaft for reciprocating said support to shift said levers into operative relation with the set members and thereby transfer the setting of the members to the levers, a plurality of signal determining elements operable by said levers, and means for restoring said levers to normal position in response to the operation of said shaft through its cycle.

399. In a selector mechanism, in combination, a series of combination bars, a group of code bars adapted to be set in permutational combinations to selectively control said combination bars, spring means tending to move said combination bars into operative engagement with said code bars, a bail operative to hold said combination bars out of engagement with said code bars against the action of said spring means, means for setting said code bars while the combination bars are out of engagement therewith, and cam means operating in timed relation to the setting of said code bars for withdrawing said bail to release the combination bars for selective control by the code bars.

400. In a selector mechanism, in combination, a series of combination bars supported for endwise movement, a group of code bars supported transversely of said combination bars and adapted to be set in permutational combinations, said

code bars having notches arranged in coded combinations so that a channel is formed in each setting of the code bars for releasing a particular one of the combination bars for movement while the other combination bars are blocked by engagement with unnotched portions of the code bars, spring means tending to move said combination bars into engagement with said code bars, means acting against said spring means for holding the combination bars out of engagement with said code bars, and means for momentarily withdrawing said holding means to place the combination bars under control of said code bars.

401. In a selector mechanism, in combination, a group of code bars, means for setting said code bars in different combinations, a series of combination bars supported for movement under control of said code bars, said combination bars being blocked against movement by engaging said code bars and released selectively in accordance with the setting of the code bars, a spring operatively associated with each combination bar tending to move the same into engagement with said code bars, means operative to hold said combination bars out of engagement with said code bars to permit the setting of the code bars, and means for momentarily withdrawing said holding means to permit said combination bars to move so that all of the combination bars except the selected one engage with and are blocked by said code bars.

402. In a cyclically operable mechanism, in combination, a power actuated governor for controlling the operating cycles of the mechanism comprising a rotatable driving element, a rotatable driven element having a member movable into driving engagement with said driving element to operatively connect the elements, and a plurality of detents movable into and out of the path of rotation of said member to effect its engagement with or disengagement from said driving element, and means for operating said detents selectively to control said governor.

403. In a selectively operable mechanism, the combination of a signal carrying medium, means for advancing said medium to control said mechanism, a governor for controlling the advance of said medium having a driving clutch including a rotatable connecting member, a plurality of detents for controlling the revolution of said connecting member, and means responsive to signals on said medium for controlling said detents.

404. In a selectively operable mechanism, the combination of a signal carrying medium, means for advancing said medium to control the mechanism, and means for controlling said advancing means comprising a rotary governor having a toothed driving element, a driven element having a dog movable into engagement with the teeth of said driving element, a plurality of detents movable into and out of the path of rotation of said dog to effect its engagement with or disengagement from said driving element, and a feeler responsive to certain signals on said medium and operative to control said detents.

405. The combination of a selector mechanism, a power-actuated governing mechanism adapted to be operated in successive steps at constant speeds, a signal carrying medium arranged for intermittent advance to control said selector mechanism, and means controlled by certain of the signals on said medium to control the operation of said governing mechanism, the governing mechanism being operable in turn to control the advance of said medium.

406. In an automatic signal transmission system, in combination, a transfer station, a plurality of terminal stations, transmission paths extending from said transfer station to said terminal stations, means for receiving permutational code signals, means controlled by certain of said code signals for selecting a transmission path to a designated terminal station, and means for transmitting code signals over the selected path, all of said means being located at said transfer station.

407. In an electrical signaling system, in combination, a receiving station, means at said station for receiving a series of code signals each comprising a predetermined combination of impulses, the impulses of each signal being received simultaneously over separate signaling channels, a plurality of terminal stations accessible from said receiving station, and signal controlled means at the receiving station for selecting a particular one of said terminal stations and for controlling said station in accordance with certain of said received signals.

408. In a selector mechanism, a set of selecting members to be variously positioned for effecting a selective conditioning to one of a plurality of selectable devices, a set of code receiving elements, means for simultaneously imparting motion to said elements for causing them to assume positions in accordance with a code, and cam means for moving said elements simultaneously to impart their assumed positions to said selecting members.

409. In a mechanical selecting apparatus, a set of code receiving and transferring elements, means for permitting said elements to be moved concurrently to assume the various positions of a code, and means for moving said elements concurrently for transferring the assumed positions to associative selecting members.

410. In a mechanical permutation code selecting apparatus, a set of code transfer elements including means for moving said elements simultaneously to impart to them a code combination setting, and other means for thereafter moving said set of code elements simultaneously for communicating the setting to associative selecting members.

411. In a selecting device, a plurality of elements to be individually and selectively conditioned, a cyclically operative means for restraining the selective movement of said elements until a predetermined instant in each operative cycle, and means to promote the instantaneous movement of a selected element at the predetermined instant.

412. The combination of a selector mechanism including a pair of selectable elements, a shaft comprising a driving portion and a driven portion, a clutch connecting said portions, means for disengaging said clutch in two radial positions, a clutch release lever under control of one of said elements for disengaging said clutch in one of said positions, and a clutch release lever under control of the other of said elements for disengaging said clutch in the other of said positions.

413. In combination, a constantly rotating member, a member to be driven by said constantly rotating member, a driving connection between the two members, means comprising a plurality of pivotally mounted members for locking the second recited member against rotation, and further means acting independently upon the ineffectiveness of said means for locking said second recited member against rotation.

414. The combination in a telegraph apparatus

having signal controlled line selecting means and signal transmitting means, of control means operated initially to condition the selecting means for operation and subsequently to condition the transmitting means for operation, and means operative automatically upon the transmission of a message for returning said control means to its starting position to condition the apparatus for the transmission of another message to a selected line.

415. The combination in a telegraph apparatus having means for recording on a control form a series of signals representing messages and having means for transmitting the messages as recorded on the control form, of control means adapted to be operated in successive steps through a definite cycle in the transmission of each message and effective in one of said steps to initiate the operation of the transmitting means, and means operable automatically following the transmission of the message for initiating the operation of said control means in its final step to condition it for the next message cycle.

416. In a telegraph system, in combination, means for directing the course of a message from an originating point to a predetermined one of a plurality of terminal points through a series of intermediate points comprising, means at the originating point for transmitting a series of control signals collectively designating the predetermined terminal point, mechanism at the first intermediate point of the series operated under control of one of said signals for selecting a transmission path leading toward said predetermined terminal point, means at the last intermediate point of the series operated under control of another of said signals for selecting a transmission path leading to said predetermined terminal station, and means at each intermediate point for relaying the message over the selected transmission path to the succeeding intermediate or terminal point.

417. In a telegraph system, in combination, means for selectively directing the course of a message through a plurality of stations under control of a series of directing signals, comprising, means at each station operated under control of certain of the directing signals for selecting the next station to which the message is to be transmitted and for transmitting the unused directing signals to the selected station, and means at each station for storing said unused signals pending the selection of the next station.

418. In a signal controlled mechanism, the combination of a storage medium for permutational signal combinations, advancing means for said medium, and means operative in response to a plurality of consecutive identical signal combinations on said medium for interrupting the advance thereof by said advancing means.

419. In a selector mechanism, a plurality of selectable elements, means for selecting said elements individually in accordance with their related signals occurring in a record, a specially selectable element, and means for selecting said element under the control of consecutively occurring similar signals.

420. A signal controlled mechanism having, in combination, means for sensing signal combinations on a control form, a plurality of independently operable elements normally responsive to successive individual signal combinations, and means operative according to the like or unlike character of a plurality of signal combinations

sensed by said sensing means for controlling the operation of the mechanism.

421. A signal controlled mechanism having, in combination, means for sensing signal combinations on a control form, a plurality of independently operable elements normally controlled by said sensing means in response to successive signal combinations on the control form, and means controlled by said sensing means only in response to a plurality of signal combinations simultaneously sensed by said sensing means for controlling the mechanism.

422. In a signal controlled mechanism, the combination of sensing means for simultaneously sensing a plurality of signal combinations on a control form, feed mechanism for advancing the control form, and means operable by said sensing means in response to the simultaneously sensed signal combinations for controlling said feed mechanism.

423. In a system of communication, the method of establishing the course of a message which consists in transmitting permutation code signal combinations consisting of line selecting signals and message signals from one and the same signal originating instrumentality to an intermediate point, recording the same at the intermediate point, and selecting the succeeding path of transmission for the message signals under the control of a recorded directing signal independently of control from the originating instrumentality.

424. In a system of communication, the method of establishing the course of a message which consists in transmitting message and line selecting signals in permutation code of the same number of units and the same timing from the originating point to one or more of a plurality of intermediate points, recording the same at the intermediate point or points, and selecting the succeeding path of transmission under the control of a recorded directing signal independently of control from the originating point.

425. In a system of communication, the method of establishing the course of a message which consists in transmitting permutation code signal combinations consisting of line selecting signals and message signals from the originating point to one or more of a plurality of intermediate points, employing identical code combinations under one circumstance as message intelligence and under another circumstance for line selecting, recording the same at an intermediate point, and selecting the succeeding path of transmission for the message signals under the control of a recorded directing signal independently of control from the originating point.

426. In a system of communication, the method of establishing the course of a message which consists in transmitting line selecting signals from the originating point to one or more of a plurality of intermediate points and also transmitting an activating signal, recording the same at the intermediate point or points, and causing the activating signal to permit the selection of the succeeding path of transmission under the control of a recorded directing signal independently of control from the originating point.

427. In a system of communication, the method of establishing the course of a message which consists in transmitting line selecting signals and message signal from an originating point to one or more of a plurality of intermediate points, recording the same at the intermediate point or points, storing the line selecting and message signals until a succeeding path is free, selecting the

succeeding path of transmission under the control of a recorded line selecting signal independently of control from the originating point and thereafter sending on over the selected succeeding path the stored message signals.

428. In a system of communication, the method of establishing the course of a message which consists in transmitting line selecting and message signals consisting of permutation code combinations from an originating point to an intermediate point, recording the same at an intermediate point upon one and the same medium, and selecting the succeeding path of transmission for certain of the signals under the control of a recorded line selecting signal independently of control from an originating point.

429. The method of transferring a message to one of a plurality of remote points selectively which consists in causing to be emitted from the same sending instrumentality and to be combined with the message a code signal composed of a plurality of units arranged in a preconcerted combination and representing one of the remote points and directing the course of the message under the control of said signal.

430. The method of transferring a message to one of a plurality of remote points selectively which consists in combining with the message signals directing impulses in code of the same number of units and the same timing, said code signals being composed of a plurality of units arranged in a preconcerted combination with a certain signal or signals representing one of the remote points and directing the course of the message under the control of the signal or signals.

431. The method of transferring a message to one of a plurality of remote points selectively which consists in combining with the message code signals composed of a plurality of units arranged in a preconcerted combination and representing one of the remote points, directing the course of a message under control of said signal, utilizing the same code combination for the transmission of intelligence under one circumstance and for directing the course of the message under another circumstance.

432. The method of transferring a message to one of a plurality of remote points selectively which consists in combining with the message signals other code signals consisting of activating signals and directing signals each composed of a plurality of units arranged in a preconcerted combination and wherein the directing signals represent one of the remote points, causing the activating signals to set up a condition whereby the directing signals are enabled to direct the course of a message and under said condition directing the course of a message under the control of a directing signal.

433. The method of transferring a message to one of a plurality of remote points selectively which consists in combining with the message signals a code signal composed of a plurality of units arranged in a preconcerted combination, and representing one of the remote points, storing at an intermediate point the directing and message signals when the path of further transmission of the message is not free and automatically directing the course of the message when the path of further transmission is free under the control of a code signal.

434. The method of transferring a message to one of a plurality of remote points selectively which consists in combining with message code combinations representing the message a code

signal combination composed of a plurality of units arranged in a preconcerted combination and representing one of the remote points, storing the code combinations at an intermediate point in one and the same medium and directing the course of the message from the point of storage under the control of said signal.

435. In a telegraph system, a signal emitting instrumentality for emitting a succession of signals, a part of which represent message matter and part of which represent a destination for message matter, apparatus for transferring message matter represented by said part from one point to any one of a plurality of remote points selectively comprising, in combination, means for storing a succession of said signals in mechanical form represented by a plurality of units each having either of two differentiating characteristics, and a selector mechanism adapted for control by certain of the stored signals to select a transmission path leading to one of several receiving points predetermined by the character of the several units of a signal.

436. Apparatus for transferring a message from one point to another automatically, having, in combination, means for storing a succession of signals in the form of mechanical combinations and including a directing signal stored in the same means which stores other signals, and means governed in accordance with the character of the individual units of the directing signal for sending the message represented by other mechanical combinations to one of a plurality of remote points selectively.

437. Apparatus for transferring a message from one point to another automatically, having, in combination, means for storing a succession of permutation code signals in the form of mechanical combinations and including a directing signal, and characterized in that the message representing and directing signal consist of code of the same number of units and the same timing, and means governed in accordance with the character of the individual units of the directing signal for directing the message to one of a plurality of remote points selectively.

438. Apparatus for transferring a message from one point to another automatically, having, in combination, means for storing a succession of signals in the form of mechanical combinations and including a directing signal, instrumentalities whereby the same signal combination may serve under one circumstance for transmission of intelligence and under another circumstance for controlling the course of the message, and means governed in accordance with the character of the individual units of the direction signal for sending the message to one of a plurality of remote points selectively.

439. Apparatus for transferring a message from one point to another automatically, having, in combination, means for storing a succession of signals in the form of mechanical combinations and including a directing signal, means for transmitting and receiving an activating signal whereby said directing signal is made effective to form a directing function, and means governed in accordance with the character of the individual units of the directing signal for sending the message to one of a plurality of remote points selectively.

440. Apparatus for transferring a message from one point to another automatically, having, in combination, means for storing a succession of signals in the form of mechanical combinations

and including a directing signal, means governed in accordance with the character of the individual units of the directing signal for sending the message over a transmission path to one of a plurality of remote points selectively, means for holding the message stored when the transmission path or the one point is unavailable for further transmission and automatically sending on the stored message when the transmission path and the one point become available.

441. In a telegraph system, a central station, other stations, a plurality of telegraph channels connecting said other stations to said central station, storing means at said central station for storing character signals received over incoming channels, means to select one of said other stations and means to transmit the stored signals thereto either before or after completing the storage of a message.

442. In a communication system, a central station, a plurality of communication lines, storing means at said central station for storing character signals received over said lines, switching means for selecting one of said lines over which said signals are to be retransmitted and retransmitting means controlled by said switching means for repeating said signals over a selected line.

443. A telegraph exchange system comprising transmission channels, a plurality of transmitters, selective switching means for interconnecting said transmitters and said channels, means for controlling said switching means and means whereby said controlling means is responsive to code signals of predetermined character preceding and following each group of message signals.

444. A multi-office telegraph communication system comprising means for storing message groups of signals at a point intermediate the originating and final offices of the system, means controlled at said intermediate point for selecting a relay channel for the stored signals and means for automatically repeating signals over a selected channel as soon as the latter becomes idle.

445. A telegraph system having, in combination with a transmitting unit and a plurality of receiving recorder units, a channel to each of said recorder units, means to store all or a part of a message and transmit the same over any of said channels and means for automatically initiating the operation of said transmitting means as soon as the selected channel is idle.

446. A telegraph system having, in combination with a transmitting unit and a plurality of receiving units, a channel to each of said receiving units and means controlled by said transmitting unit to store all or a part of a message and transmit the same over any of said channels as soon as the selected channel is idle.

447. A telegraph system having, in combination with a transmitting unit and a plurality of receiving recorder units, a channel to each of said recorder units, means to store a message and transmit the same over any of said channels and means for automatically initiating the operation of said transmitting means as soon as the selected channel is idle.

448. A telegraph exchange system comprising transmission channels, a plurality of transmitters, selective switching means for interconnecting said transmitters and said channels, means for controlling said switching means and means whereby said controlling means is responsive to code signals of predetermined character preceding each group of message signals.

449. A telegraph exchange system comprising

transmission channels, a plurality of transmitters, selective switching means for interconnecting said transmitters and said channels, means for controlling said switching means and means whereby said controlling means is responsive to code signals of predetermined character following each group of message signals.

450. In a telegraph system, a central station, a plurality of telegraph channels terminating at said central station, a character storage device individual to each incoming channel for storing character signals received thereover, a plurality of outgoing telegraph channels at said central station, a character storage device associated with each outgoing channel, means for transmitting characters from any of said first-mentioned storage devices to any of said second-mentioned storage devices and means for transmitting characters from each of said second-mentioned storage devices over its associated outgoing channel.

451. In a telegraph exchange system, an office, incoming and outgoing lines terminating thereat, signal storage devices associated with the incoming lines, other signal storage devices associated with the outgoing lines, means for repeating the signals stored in one of the storage devices associated with incoming lines and for storing said signals in one of said other signal storage devices and means for repeating the signals stored in said one of said other signal storage devices over an outgoing line.

452. In a telegraph system, a central station, a plurality of incoming telegraph channels terminating at said central station, a plurality of character storage devices for storing characters received thereover, a plurality of outgoing channels at said central station, character storage devices associated with predetermined ones of said outgoing channels, means for initiating the transmission of message groups of characters from said first-mentioned storage devices to any of said second-mentioned storage devices, means controlled by predetermined character signals so transmitted for interrupting transmission from said first-mentioned storage devices at the end of each message group and means for transmitting characters from each of said second-mentioned storage devices over its associated outgoing channel.

453. In a telegraph system, a central station, a plurality of telegraph channels terminating at said central station, a plurality of character storage devices for storing character signals received over incoming channels, a transmitter associated with each storage device for repeating signals stored therein and switching means for connecting each of said transmitters to any one of a plurality of outgoing telegraph channels.

454. In a telegraph system, a central station, a plurality of telegraph channels terminating at said central station, a plurality of character storage devices for storing character signals received over incoming channels, a transmitter associated with each storage device for repeating signals stored therein, switching means for connecting each of said transmitters to any one of a plurality of outgoing telegraph channels, and means for initiating the operation of said transmitters when the same are connected to an outgoing channel.

455. The method of relaying telegraph messages through stations or offices intermediate the origin and destination which comprises storing and reproducing at least a part of the message at the intermediate station or office, extending the communication circuit selectively to the prop-

er outgoing channel and automatically seizing the channel and initiating retransmission thereover as soon as the same is idle.

456. A telegraph system comprising a plurality of stations, channels connecting said stations, a plurality of receiving-storing devices at one of said stations for simultaneously storing messages received over incoming channels, operable means at said one of said stations for selecting outgoing channels over which the stored messages are to be relayed, and means operating automatically to free each channel upon the completion of the transmission of a message thereover from one of said devices and initiate the transmission of another message stored upon another of said devices.

457. A telegraph system comprising a plurality of signal transmitters, a plurality of signal receivers, operable connecting means associated with said transmitters for connecting more than one of said transmitters at the same time to any one of said receivers and means for rendering said connected transmitters operative in sequence.

458. A telegraph exchange system comprising signal transmitters, a plurality of telegraph transmitting channels, operable switching means for connecting any of said transmitter to any one of said channels and means responsive to the transmission of a predetermined signal for releasing a channel connected to one transmitter and rendering the same available to another transmitter.

459. A telegraph exchange system comprising signal transmitters, a plurality of telegraph transmitting channels, operable switching means for connecting any of said transmitters to any one of said channels and means responsive to the transmission of an end-of-message signal by a transmitter connected to one of said channels for releasing said one of said channels.

460. In a system for relaying messages from devices of original storage at an exchange or switching point comprising said devices of original storage, outgoing channels leading away from said exchange to which messages stored in one of said devices may be transmitted, transmitter means for such transmission, and storage means whereby a plurality of messages directed to the same outgoing channel may be simultaneously automatically transmitted from a correspondingly plural number of devices of original storage, and means effective to execute said simultaneous transmitting operation independently of the idle or busy condition of the said transmitter means of the channel to which said plurality of messages are to be transmitted.

461. In a system for relaying information represented by successive discrete groups of code combinations comprising a message and its address through a switching office, channels of electrical transmission leading from said office, devices for first storing each of said discrete groups mechanically, storage instrumentalities associable with only outgoing lines for controlling transmission thereover, means including transmission means and conductors operable to relay successive of said discrete groups from said devices to different of said storage instrumentalities selectively in accordance with their respective addresses, and transmitter stopping means to stop said transmission means upon completion of transmission of a complete message to one given storage instrumentality.

462. In a message directing system, a switching

office comprising devices for first storing messages, a plurality of means geographically within the same office for again storing the same messages, and means including electrical transmitters for relaying different messages to different of said plurality of means selectively in accordance with their addresses.

463. In an exchange system for relaying messages through an exchange from incoming channels to outgoing channels, storage devices of initial storage in said exchange of messages intended for various outgoing channels, other storage devices associated with definite outgoing lines, and means for electrically transmitting successive messages stored in any one device of initial stor- 15

age to different of said other storage devices according to the particular outgoing channel for transmission over which they are respectively intended, whereby blocking of messages for one address by messages for another address in said devices of initial storage is reduced.

464. In a system for relaying messages through an office, devices for storing messages in said office, other storage instrumentalities for storing messages in said office, and means whereby messages are transmitted from storage in one or another of said devices to one or another of said storage instrumentalities selectively according to their respective addresses.

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