Aug. 5, 1947. C. J. YOUNG 2,425,076

SECRET FACSIMILE SYSTEM

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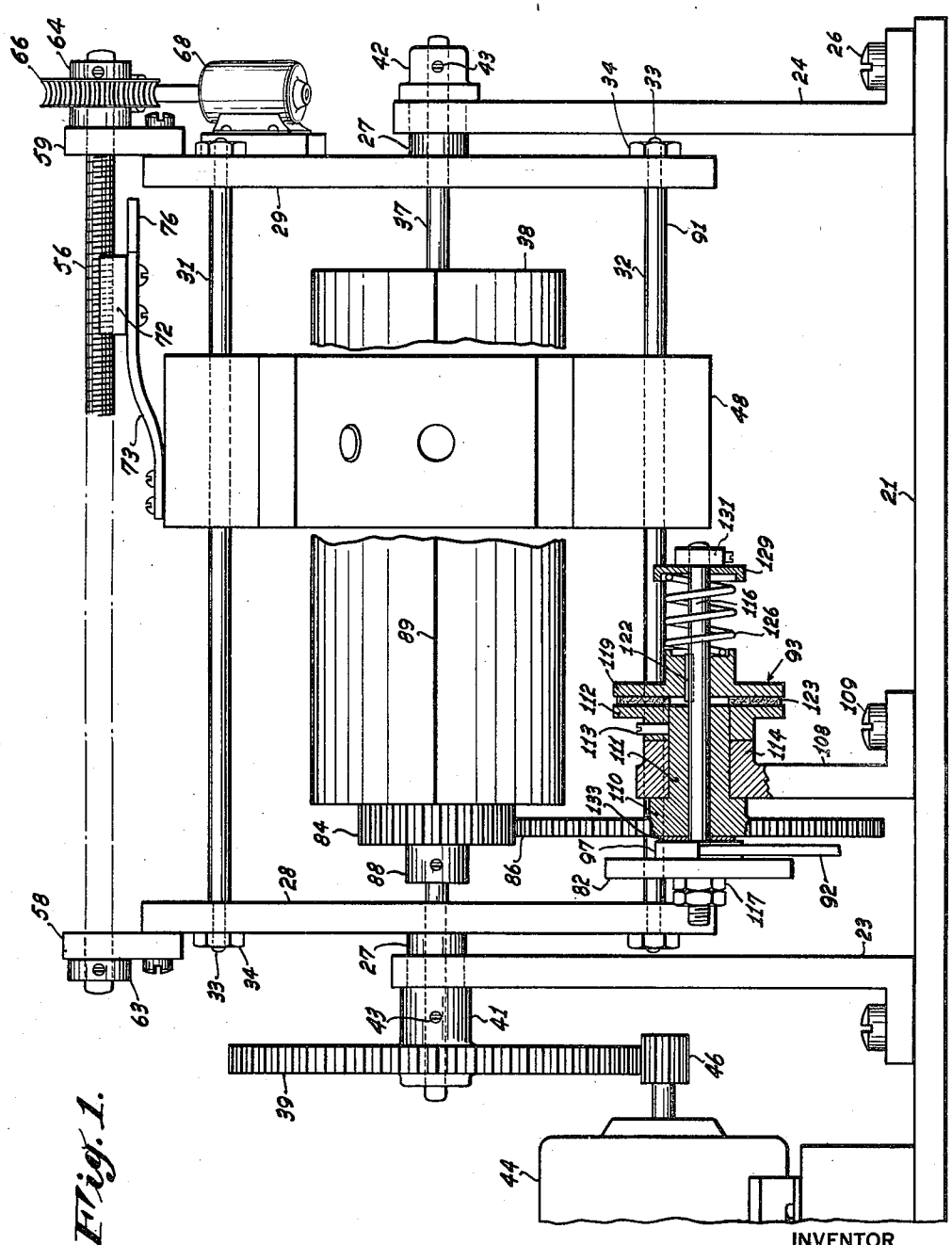


Fig. 1.

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Fig. 2.

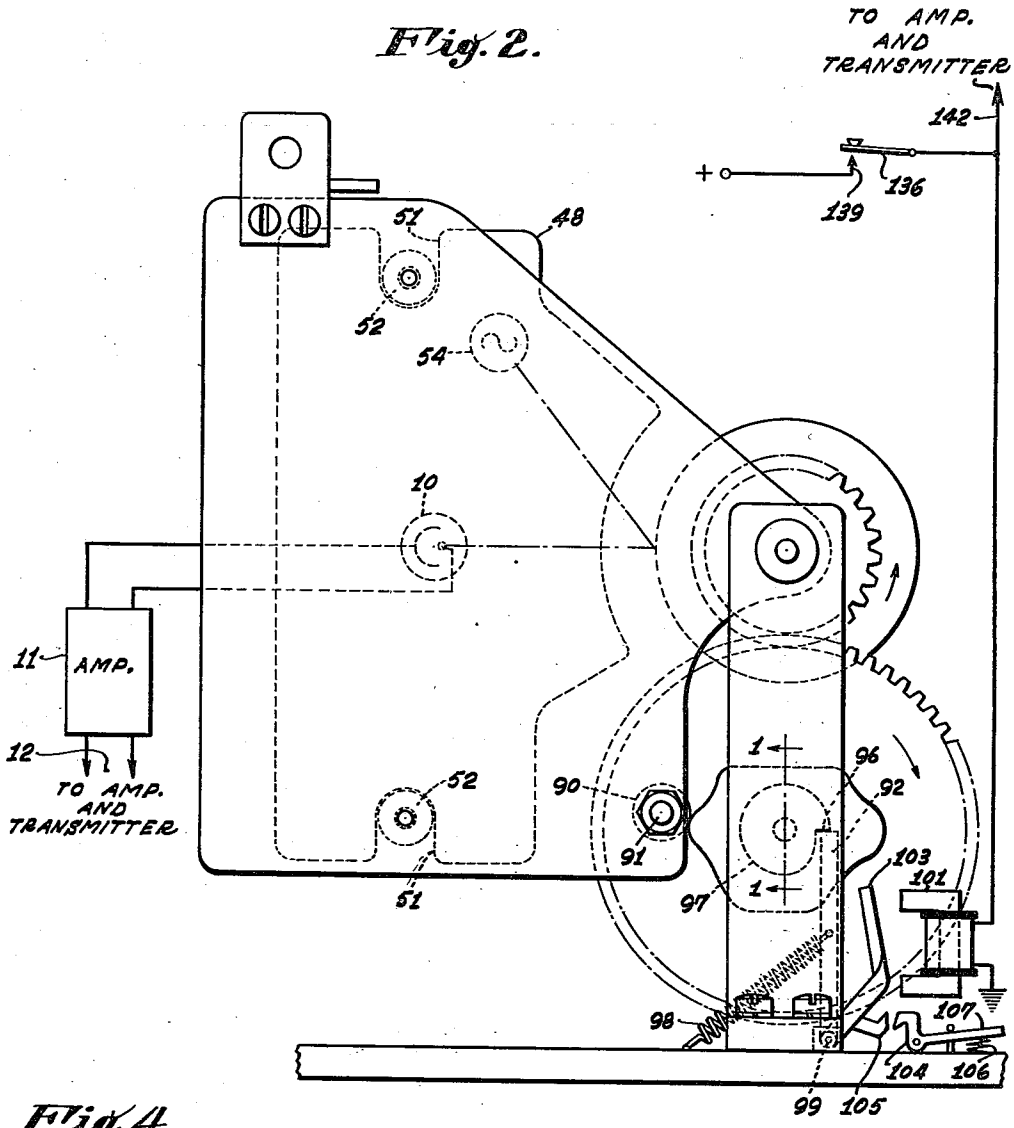
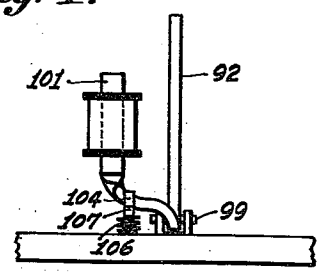


Fig. 4.



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Fig. 5.

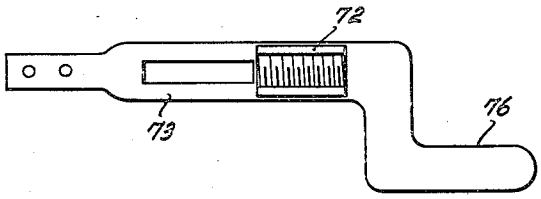


Fig. 3.

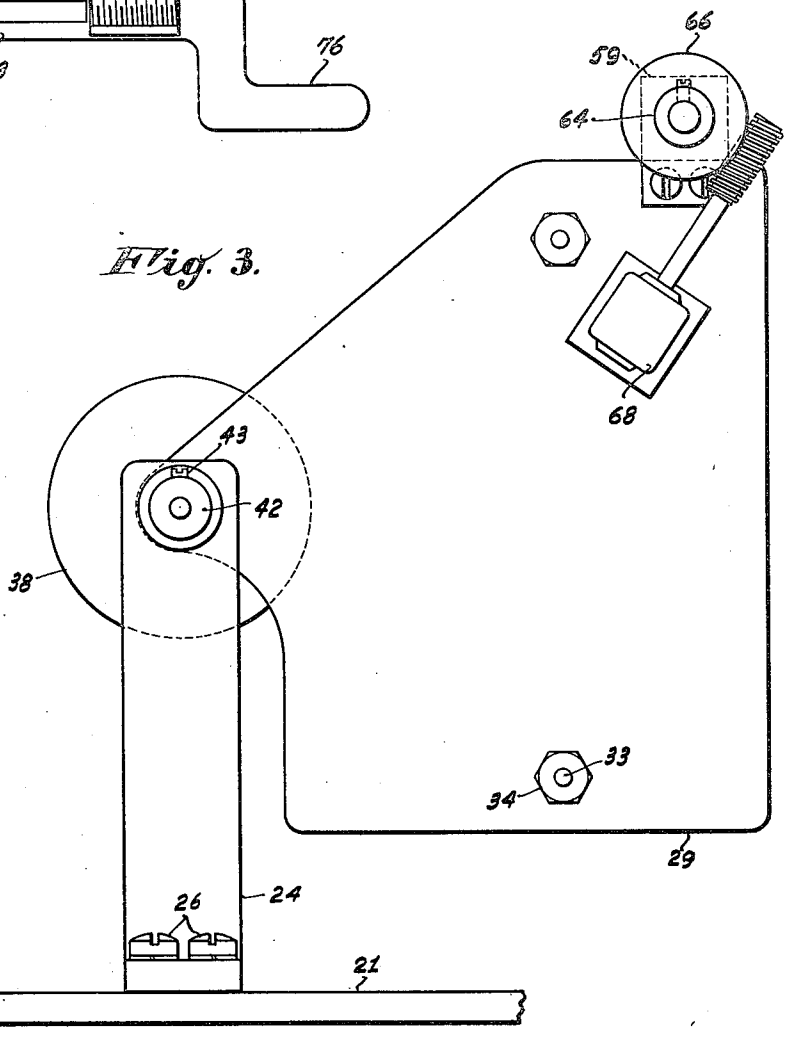
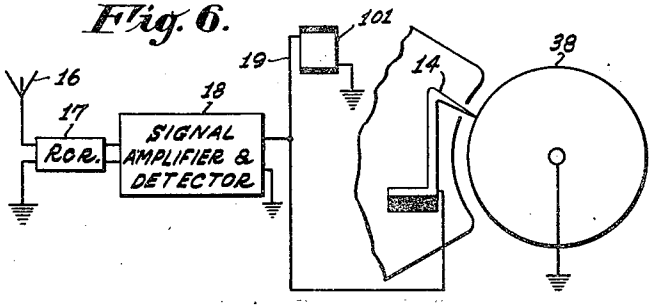


Fig. 6.



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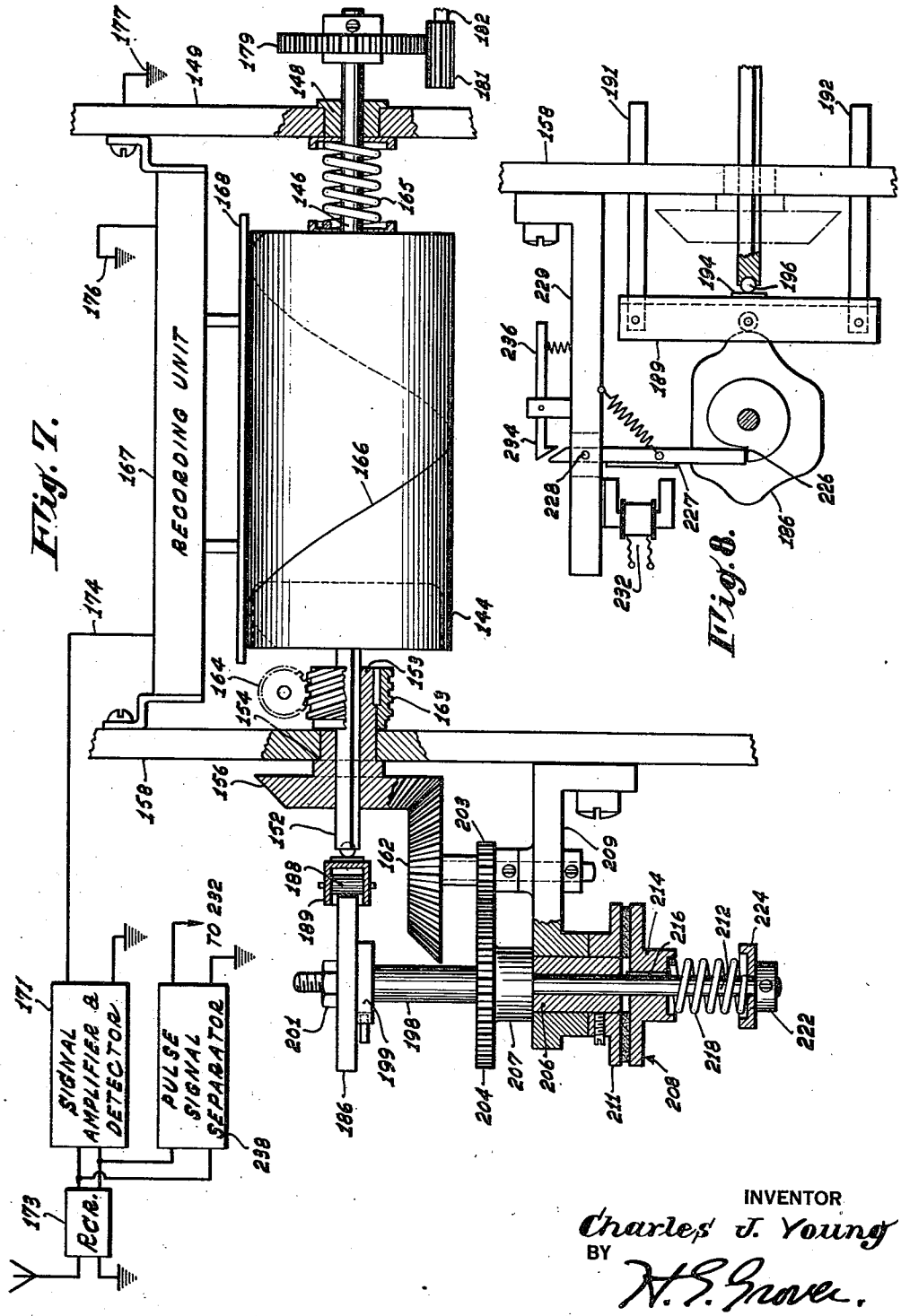
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SECRET FACSIMILE SYSTEM

Filed Feb. 26, 1944 4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,425,076

SECRET FACSIMILE SYSTEM

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Application February 26, 1944, Serial No. 524,117

4 Claims. (Cl. 178—22)

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The present invention relates to communication systems and more particularly to systems for sending and receiving facsimile signals in secrecy. More particularly, the present invention relates to a secret facsimile communication system wherein a movable member at the transmitter and a corresponding movable member at the receiver are caused to have substantially identical speed variations.

Briefly, according to the invention, in a scanner in which one element moves with respect to another to cause generation or recording of image signals, the rate of this movement is varied in accordance with a prearranged plan at both the transmitting and receiving station or stations. One of the elements which moves with respect to the other operates at speeds regularly employed. The irregularity in rate is produced by movement of the other element in a predetermined manner. Any desired synchronizing and phasing scheme may be employed, the secrecy feature being obtained locally at the transmitter and at the receiver.

To be intelligible, the received image must be recorded with scanning speed changes along the direction of a scanning line, which correspond exactly with the speed variations introduced at the transmitter. If these variations in speed are not obtained at the receiver in accordance with a predetermined plan, nothing which is intelligible will be recorded.

The primary object of the present invention is to provide novel methods of and apparatus for preventing the intelligible reception of facsimile signals by anyone except authorized persons.

Another object is to provide a facsimile transmitter and/or a facsimile recorder having means for varying the degree of departure from the normal scanning speed during a single scanning excursion of an element of a scanning means.

A further object is to provide a novel arrangement for obtaining changes in relative speed of the parts of a facsimile machine in accordance with a predetermined code.

Other and more specific objects of the invention will become apparent and suggest themselves to those skilled in the art to which the invention is directed upon reading the following specification and claims in connection with the drawings in which:

Fig. 1 is a view in elevation of a facsimile machine embodying the invention. This view is partially sectioned on line 1—1 of Fig. 2.

Fig. 2 is a view in elevation taken from the left of the machine of Fig. 1.

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Fig. 3 is a view in elevation taken from the opposite side of Fig. 1.

Figs. 4 and 5 are details of the structure of the machine of Fig. 1.

Fig. 6 is a fragmentary view of the machine of Fig. 1 showing it arranged as a recorder.

Fig. 7 is a view in plan, partially sectioned, of a machine embodying the invention in modified form, certain of the well known parts being omitted for the sake of clearness of illustration.

Fig. 8 is a plan view of a portion of the machine of Fig. 7.

The machine of Fig. 1 may be used as a transmitting scanner or as a recording scanner, usually referred to as a recorder, with very slight modification of parts as shown in Fig. 6 of the drawings. With the machine of Fig. 1 in operation as a generator of image signals, the output of the phototube 10 may be applied to an oscillator-modulator and radio transmitter (not shown) by way of a pre-amplifier 11 and the terminals 12 as indicated in Fig. 2. With the machine of Fig. 1 in operation as a recorder of image signals, a scanning electrode such, for example, as a stylus 14 (Fig. 6), replaces the phototube 10 of Fig. 2. Radio signals are intercepted by an antenna 16 connected to a radio receiver 17. A signal amplifier and detector 18 serves to amplify image signals which are supplied to the stylus 14. Any desired signal separating means is represented by the connection 19. The purpose of this will be pointed out hereinafter.

From the foregoing, it will be seen that a complete facsimile system is disclosed diagrammatically, and it will be understood that this system apart from features of this invention may operate in the usual manner to generate, transmit, and record image signals. Synchronization of the interconnecting machines in this system may be obtained in any well known manner.

The machine of Figs. 1 to 5 comprises a base 21 which forms the principal support for the operating parts and driving mechanism of the apparatus. Uprights 23 and 24 are secured to the base 21 by any desired fastening means such as screws 26. The uprights serve as bearings for journals 27, extending from movable frame members 28 and 29 which are secured together by rods 31 and 32. A suggested mode of attachment is shown which comprises a reduced threaded end 33 upon each rod which receives a securing nut 34.

The journals 27 are apertured concentrically to receive a shaft 37 upon which is secured a copy holding drum 38. Driving power is imparted to the shaft 37 by a gear 39 secured on one end.

The hub 41 of this gear in conjunction with a collar 42 secured upon the shaft prevents longitudinal movement. The gear 39 and the collar 42 may be detachably secured to the shaft by any suitable means such as by set screws 43.

The gear 39 is driven by a motor 44 through a pinion 46. The motor 44 is preferably a synchronous or other speed controlled motor so as to insure synchronous operation of the several machines comprising the communication system.

The rods 31 and 32 serve as guides for a scanning head assembly 48 which is movable axially along the drum 38 to produce scanning of a sheet secured to the drum as it rotates. The scanning head 48 is provided with recesses 51 (Fig. 2) in which are seated apertured slides 52 which receive the rods 31 and 32.

When the machine is to be used as a transmitter for generating image signals, the scanning head 48 will contain an exciter lamp 54 from which is projected a beam of light to be reflected from the subject copy of the drum 38 into the previously mentioned phototube 10 in well known manner.

A lead screw 56 is journaled in extensions 58 and 59 of the frame members 28 and 29. A collar 63 together with the hub 64 of a worm wheel 66 prevents end-play of the lead screw 56.

To provide for rotation of a lead screw 56 at a speed which is correlated with the speed of rotation of the drum 38 for producing the usual helical scanning movement, the worm wheel 66 is driven from a small synchronous motor 68 secured to the frame member 29. The motor 68 may be connected to the same power source as the motor 44 or to a separate frequency controlled power source so that these two motors will operate in synchronism.

The scanning head 48 is provided with a half nut 72 carried by a spring 73. The resiliency of this spring permits the half nut 72 to be disengaged from the lead screw 56 by applying pressure manually or by an electromagnet to a thumb piece 76.

From the parts thus far described, it will be seen that the scanning head 48, which is normally carried by guides rigidly secured to a stationary part of the machine, such as the base, is carried by the movable frame composed of the frame members 28 and 29 which are capable of concentric movement about the drum 38. If this movable frame is moved in the direction of rotation of the drum, the scanning speed along a scanning line will be reduced, and if it is moved in a direction opposite to the direction of rotation of the drum, the scanning speed along a scanning line will be increased.

The change in scanning rate may be produced and controlled in a manner now to be described. A cam 82 having any desired predetermined shape is driven from the copy holding drum shaft 37 through a pinion 84 and gear 86. The pinion may be of a unitary part of the drum 38 in which case both the drum and the pinion may be secured to the shaft 37 by a set screw 88. The scanning drum may be provided with a paper holding clamp or the like, shown diagrammatically and indicated by reference character 89. The clamp 89 may be used to correlate the angular position of the subject copy sheet on the drum 38 with respect to the position of a recording blank in the recorder, thereby providing for phasing of the received copy. This may be accomplished in other ways, for example, by a line scribed on the drum which will serve as a guide

for locating the sheet; by a signal or signals derived from a mark on the subject copy sheet, or recording blank in a predetermined position with respect to the inscribed or recorded copy; or by any of the foregoing suggested means in combination. Other framing or phasing means well known to those skilled in the art may also be used. Preferably, there is to be no regular or periodic relationship between the position of the subject copy sheet and the angular position of the cam 82 or other connection between the several parts of the machine which could serve to aid in deciphering received copy. It is also essential that the phasing signal, ordinarily transmitted at the start of each scanning line, be blanked out by a commutator from the actual transmission in order that no clue be given to the average scanning speed or to the pattern of the cams.

The frame composed of the members 28 and 29 is supported on the cam 82 by means of a cam following roller 90 (Fig. 2) which is rotatably carried by a rod 91 extending from between the frame members 28 and 29 to which it may be secured in the same manner as the rods 31 and 32. The axis of the cam 82 and of the roller 90 preferably lie on an arc having as its center the axis of the shaft 37.

It is necessary that the rate of change of scanning at each machine correspond exactly throughout the length of a transmission. In order that this be so, the recorder and scanner drums must first be phased or framed with each other by any of various means known in the art, and then the recorder and scanner cams must be started simultaneously from a predetermined position. This may be accomplished by driving the cam 82 from the gear 86 through a magnetic clutch, or by the equivalent arrangement shown comprising a detent 92 and a slipping-drive clutch 93. The detent 92 engages a notch 96 (Fig. 2) formed in the periphery of a ratchet disc 97 secured to or integral with the cam 82. The detent 92 is held in engagement with the notch 96 by a spring 98, and it is rocked about its supporting pivot 99 by an electromagnet 101, the terminals 102 of which are connected to a starting pulse source. The armature 103 of the magnet 101 may be formed integrally with the detent arm as shown so that the detent 92 and the armature 103 form a bell crank. The lower end of the armature 103 is bent laterally as shown to clear the gear 86. To retain the detent 92 out of engagement with the ratchet disc 97 after the magnet has been energized, a latch member 104 is provided which will engage and hold a toothed projection 105, formed on the armature section of the detent 92. A compression spring 106 biases the latch member 104 to a position where it will catch the tooth 105. The tooth 105 may be released by pressing the thumb piece 107.

The gear 86 and the clutch 93 together with its associated parts is journaled in a bracket 108 detachably secured to the base 21 by suitable fastening means such as a screw or bolt 109. The hub 110 of the gear bears against the face of the bracket 108 to retain the gear in place laterally, and the portion 111 of the hub providing the journal which rotates in the bracket is reduced in diameter as shown. The driving member 112 of the clutch 93 is secured on the hub portion 111 by a set screw or other fastening means 113. The radial face of the member 112 bears against a boss 114 on the bracket 108 and thereby cooperates with the radial face of the hub 110 in maintaining the gear in its desired axial position.

The cam 82 and the ratchet disc 97 are keyed or splined on a stub shaft 116 which is rotatably supported in the hub 110 of the gear 86. In order that these parts may be removed when desired from the shaft 116, a nut and check nut combination 117 is engaged with the threaded end of the shaft 116.

The driven member 119 of the clutch 93 is slidably keyed or splined on the shaft 116, for example by a key 122. Frictional cooperation between the driving and driven members of the clutch is insured by a friction disc 123 pressed between the clutch faces by a compression spring 126. The spring reacts between the clutch member 119 and a disc 129 which is held in position on the shaft by a detachable collar 131. A thrust washer 133 is interposed between the outer radial face of the gear 86 and the inner radial face of the ratchet disc 97 so as to provide the stationary reaction point for the compression spring 126.

By the arrangement of the parts just described, it will be seen that if the ratchet disc 97 and hence the cam 82 are prevented from rotating by means of the detent 92, the gear 86 will rotate the driven member 112 of the clutch 123 but slippage will occur between the clutch members 112 and 119. If the detent 92 is released from engagement with the notch 96, the cam 82 will be driven as a unit with the gear 86.

In operation of the machine of Figs. 1 to 5, the subject copy to be scanned may be placed on the drum 38 on the machine serving as a transmitter while a recording blank will be placed on the drum of a similar machine arranged as shown in Fig. 6 to serve as a recorder. The machines are phased or started simultaneously as previously stated. At the transmitter the cam 82 may be started at any time by a signal generated from a commutator on the cam shaft or by closing a key 136 (Fig. 2) to energize the magnet 102, thereby permitting the cam to rotate and oscillate the frame which carries the scanning head 48. The fixed contact of the key 136 may be connected to any desired source of energy 139, and the one terminal of the magnet 102 may be grounded as shown. A connection 142 leads to the amplifier and transmitter so that the pulse generated on closing key 136 will be transmitted to a receiver or receivers in communication with the transmitter. Each receiver may be arranged as suggested in Fig. 6 so that the pulse signal will be applied to energize the winding of the magnet 191 whereby the clutches at both the transmitter and recorder will be released simultaneously.

The gear ratio of the gear and pinion combination 84 and 86 can be made non-integral so as to give an extended run before a repeat in the scrambled pattern, and the cams and gears can be changed according to a prearranged code.

It will be obvious that when the machine of Fig. 1 is operated as a transmitter with its cam stationary, any recorder of the usual type may be employed for making a record of the subject matter transmitted. If the machine of Fig. 1, arranged as shown in Fig. 6, is employed as the recorder, the regular image signals will be received merely by permitting the detent 92 to remain in engagement with the notch 96.

Figs. 7 and 8 of the drawings show a modified form of machine suitable for use as a recorder of scrambled image signals produced by the machine of Fig. 1. This recorder is of the helical type and comprises a cylinder 144 secured on a rotary shaft 146 which is slidably journaled at one end in a bearing 148 carried by a side frame

member 149. The opposite end 152 of this shaft is squared and is slidably carried in a square hole in the hub 153 of a bevel gear 156. The hub 153 of the gear is journaled for rotation in a frame member 158. The frame members 149 and 158 serve as supports for the entire mechanism of the recorder which may be of any well known type, and therefore, details of construction are omitted for the sake of clearness of illustration.

The portion of the hub 153 which is journaled in the frame 158 is reduced in diameter as shown to provide a shoulder 154 so that the gear 156 is positioned with respect to a meshing gear 162. A worm pinion 163 secures the gear 156 axially in position in the frame 158. The worm pinion 163 is in mesh with a worm gear 164 which may be employed to drive a paper feeding device (not shown) at a speed correlated with the speed of rotation of the cylinder 144.

A compression spring 165 reacting between the end of the cylinder 144 adjacent the frame member 149 and the frame member itself urges the cylinder toward the left as viewed in Fig. 7 of the drawings. This movement is permitted by the slidable mounting of the shaft in the bearing member 148 and the hub 153 of the gear 156.

The cylinder 144 is provided with a helix 166 which projects its peripheral surface. A recording unit is indicated in its entirety by reference character 167, and it may be of the type disclosed in my Reissue Patent No. 20,152, granted October 27, 1936. This recording unit is secured in any suitable manner to the frame members 149 and 158 so that the printer bar 168 cooperates with the helix 166 to produce a record on a web or sheet (not shown) propelled in any suitable manner known to the art.

The recording unit 167 receives image signals from a signal amplifier and detector 171 which is connected to a radio receiver 173. The output of the detector in the unit 171 is fed to the recording unit over a connection 174, and the recording unit is indicated as having a ground connection at 176.

In place of the mechanical recording unit 167, the printer bar 168 may be arranged so that it is urged against the helix 166 by spring pressure or other means. The connection 174 will then supply the image signals directly to the bar 168 so that chemical recordings may be obtained, in which case the cylinder 144 will be effectively grounded, for example, as indicated at reference character 177.

The entire recording mechanism is shown as being driven by a gear 179 which meshes with a pinion 181 on a motor shaft 182. The pinion 181 is shown as being elongated to allow for axial movement of the cylinder 144 which is produced in a manner to be described. The pinion 181 is driven at a speed which is synchronized with the speed of the transmitter in communication with the receiver 173. While a gear and an elongated pinion have been shown illustratively, it will be understood that any other drive for the reciprocable shaft 146 may be employed.

The cylinder 144 is moved axially to vary the scanning speed along a given scanning line by a cam 186 which corresponds to the cam 82 of Fig. 1 of the drawings. The peripheral surface of the cam engages a cam follower roller 188 which is journaled in a channel shaped member 189. The latter is mounted upon a pair of rods 191 and 192 which are slidably received in apertures in the side frame member 158. The channel member 189 is provided with a hardened por-

tion of 194 which is in contact with a hardened ball 196 secured in the end of the shaft 146. As the cam 186 is rotated, the shaft 146 will be reciprocated by irregularities in the surface of the cam.

The cam 186 is mounted upon the reduced end of a shaft 198 along with a latch disc 199. The cam and disc are clamped in position by a nut 201 in threaded engagement with the reduced end of the shaft 198.

The shaft 198 is driven from the bevel pinion 162 through a gear and pinion combination 203 and 204 and a slipping-drive clutch 208. The gear 204 has a reduced portion 206 on its hub 207 which is journaled in a bracket 209. The driving member 211 of the clutch is secured to the reduced portion 206 of the hub. A reduced portion 212 of the shaft 198 is journaled in the hub 207 of the gear and slidably carries the driven member 214 of the clutch which is constrained to turn with the shaft, for example, by the key 216. A compression spring 218 reacts between the driven clutch member 214 and a member 221 which is secured on the end of the reduced shaft section 212 by a collar 222. In the arrangement shown in Fig. 7, the reaction of the spring 218 transmitted through the shaft 212 is taken up by the shoulder on the hub 207 which is in contact with the bracket 209.

A notch 226 (Fig. 8) in the ratchet disc 199 is engaged by a detent member 227 pivotally secured at 228 to a bracket member 229 projecting from the frame member 158. An electro-magnet 232, when it is energized, removes the detent member 227 from engagement in the notch 226. A latch member 234 holds the detent after the electro-magnet has been energized. The latch member may be released by pressing a thumb piece 236.

The electro-magnet 232 may be connected to the output of a pulse signal separator 238, or it may be connected as shown in Fig. 6 of the drawings. The actual arrangement employed will depend upon the method followed at the transmitter for deriving and transmitting the starting pulse.

From the foregoing description of the operation of a secrecy system employing machines of this invention, described in connection with Figs. 1 to 6, it is believed that the operation of the modified machine, shown in Figs. 7 and 8, will be understood.

Various modifications of the system shown and described herein by way of example are possible, without departing from the spirit and scope of the invention described herein, and it is desired that any and all of such modifications be considered within the purview of the present invention defined by the hereinafter appended claims.

Having now described the invention, what is claimed and desired to be secured by Letters Patent is the following:

1. In a facsimile machine for insuring privacy of communication comprising a support for a sheet to be scanned, means to scan said sheet, means for producing relative movement between said scanning means and said sheet supporting means, the combination of means for producing variations in the relative rate of movement between said sheet supporting means and said scanning means, means to render said variation producing means ineffective, and means for causing release of said variation producing means.

2. In a facsimile machine for insuring privacy of communication comprising a support for a sheet to be scanned, means to scan said sheet, means for producing relative movement between said scanning means and said sheet supporting means, the combination of means for producing variations in the relative rate of movement between said sheet supporting means and said scanning means, means to render said variation producing means ineffective, and signal responsive means operable from a remote point adapted to cause release of said variation producing means.

3. In a facsimile machine for insuring privacy of communication comprising a support for a sheet to be scanned, means to scan said sheet, means for producing relative movement between said scanning means and said sheet supporting means, the combination of a movable mounting for said sheet scanning means, a cam together with means for imparting movement to said cam from said support for producing variations in the relative rate of movement between said sheet supporting means and said scanning means, a detent for holding said cam stationary when normal operation of said machine is desired, and means adapted for causing release of said cam when said machine is to be operated for the purpose of insuring privacy of communication.

4. In a facsimile machine for insuring privacy of communication comprising means to propel a sheet to be scanned, a helical scanning member and a printing member to cooperate with said helical scanning member to scan said sheet, and means for producing axial movements of said helical member during a scanning operation in accordance with a predetermined plan whereby to insure privacy of communication.

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