The power required for carrying out the Jebsen treatment at Stangfjorden is derived from five 80-kilowatt dynamos direct coupled to five turbines of equivalent—128 horse power. The power generating installation was provided by Schuckert and Co., of Nuremberg. The wet peat is brought to the factory direct from the bog by water, in lighters of about 100 tons capacity. The boats are discharged by aid of mechanical power, and the peat is submitted to the first drying and pressing operation. This is carried out in a 5 horse power press which can turn out 2,500 pressed blocks of peat, each measuring 80 by 8 by 8 centimeters, per hour. The average weight of dried peat in each of these blocks is 2 kilos.

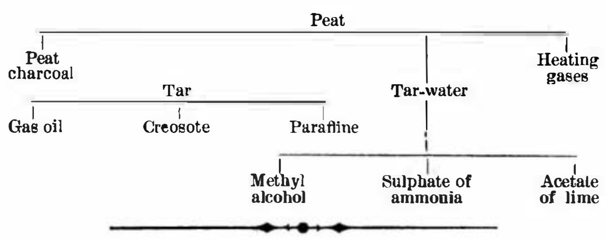
The briquettes of pressed and partially dried peat are next loaded into trolley shelf wagons specially designed for tunnel drying by an American company. Each wagon carries, when fully loaded, 140 of the wet briquettes arranged on ten shelves. The trolley wagons are pushed, when loaded, into the cooler end of the drying tunnel. The air draught which passes through the tunnel is set in motion by fans electrically operated, and is heated by the waste gases from the retorts. The air has a temperature of 90 to 100 deg. C. at the top end of the tunnel where the wagons emerge, and one of 40 to 50 deg. C. at the lower end where they enter. As the wagons pass up the tunnel, the peat is, therefore, submitted to a gradually increasing temperature. The drying plant at Stangfjorden comprises one hot air stove, three electric fans, two tunnels, and 102 shelf wagons; 1,000 of air-dried peat blocks can be produced per day. The wagons with their charges of dried peat are next taken on tram rails direct into the retort house and are emptied directly into the retorts.

The retorts are upright cylindrical vessels of iron, about 2 meters in height and 1 meter in diameter. Each retort has a removable cover, and a discharging hole below, and is in addition provided with gas exit pipes and a pressure gage. The retorts are provided with spiral resistance coils of special construction, and the blocks of peat are built up in actual contact with these, until the retort is entirely filled with a pigeon-holed mass of peat, in the center of which the heating agent lies. The top cover of the retort is now clamped down, and the electric current connections are made. Losses by radiation are minimized by lining the retorts with asbestos. The peat yields three products when submitted to this electrical heating in closed retorts. The gaseous products pass away by openings in the retort cover, and after scrubbing are employed for heating the air used in the drying tunnels. The tarry liquid condensed in the gas pipes and in the scrubbers contains tar oils, ammonia and other compounds, and if the plant and technical skill are available, may be worked up for these products on the spot.

The peat fuel remaining in the retort after the carbonizing operation is completed is allowed to cool down to 130 deg. C. before opening the retort, and is then discharged direct into wagons running beneath the retorts. The peat-fuel produced at the Stangfjorden factory is shipped direct to Bergen, where it is said to meet with a ready sale. The average yield of 100 kilos of the air-dried peat at Stangfjorden is as follows:

	Per cent.
Peat-fuel	33
Peat tar	4
Tar water	40
Gaseous products	23

The diagram below shows the products which are obtained from the peat by dry distillation:



A Scotch Antarctic Expedition.

Although Peary and Sverdrup have returned without having found the pole, and report that nothing unusual is to be discovered in the frozen regions of the earth, the Scotch Antarctic Expedition, under the leadership of William S. Bruce, is to proceed to the Antarctic regions. The province to be explored is situated between the regions now under investigation by the Swedish and German expeditions. The chief object of the expedition is to specialize in oceanography, meteorology and zoology. Six thousand fathoms of sounding line will be carried, chiefly for the purpose of ascertaining whether there is any bottom in the region where Ross reported "no bottom." Aeroplanes and kites are also to be used for the purpose of gathering meteorological data.

FALLER AUTOMATIC TELEPHONE EXCHANGE.

A step into one of the busy New York telephone exchanges is enough to suggest to the inventive mind a great field for invention, and such has evidently been the effect on many a witness of these buzzing centrals, for no small number of patents have been granted on this subject of automatic telephone exchange. In most cases the systems are too complicated to be practicable and comprise a great maze of wires, magnets and contacts which entail a considerable expense for installation and repairs. One man, however, has branched off from his fellow inventors in a very important detail. His system, instead of being electrically actuated throughout, makes use of mechanical means almost entirely in its operations, so that a great many of the contacts and wires necessary even in a manual exchange can be entirely dispensed with in this system. Furthermore, this system can be installed without disturbing the subscriber's telephone or materially interfering with the business of the exchange, and it is a straight, central energy system throughout. An important feature of this machine, and one that distinguishes it from all others, is that the central terminal of each subscriber serves both for calling and for being called. All the subscribers' lines terminate at central in similar terminals which are connected by cord circuits just as in the manual system. This is obviously a great improvement on systems which use separate terminals for the calling and for the called subscriber.

A better understanding of the system can be obtained from the following description. The machine illustrated is designed for a hundred subscribers. The subscriber's outfit consists of the usual apparatus, to which is added an instrument termed the "sender." This consists of a small case in which are a couple of dials, each bearing figures from 1 to 10 along its periphery. The dial on the right is the units dial, and that on the left is the tens dial, so that any number up to a hundred can be made to appear through the window in the casing. For larger exchanges dials are added, so that any desired com-

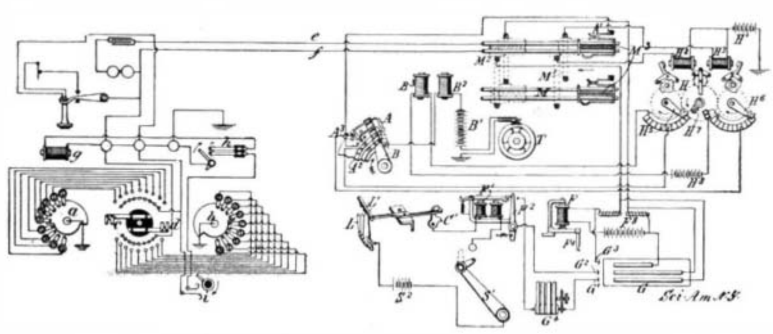


DIAGRAM OF THE CIRCUITS OF THE AUTOMATIC TELEPHONE EXCHANGE.

bination of numerals can be made. To illustrate the operation of the system, we will suppose, throughout the following description, that subscriber No. 55 desires to call up subscriber No. 54. The first act of the calling subscriber is to turn the right thumb nut until the figure 5 appears, and the left until the figure 4 is shown through the window. The operator then turns the central knob, shown in our illustration, to the right. This winds up a coil spring which provides the motive power for sending over the subscriber's wires a series of impulses corresponding in number to the figures on the dials. This is more clearly illustrated by reference to the diagram. The tens and units dials are secured to disks *a* and *b* respectively. These disks are reduced in diameter over a portion of their circumference, so as to clear a number of contacts arranged radially about each disk. In turning the number dials to 54, the tens disk, as shown, is brought into engagement with five of these contacts, and the units disk with four, so that when the motor spring is released the brushes *c* and *d* are operated under control of the escapement mechanism to sweep over a series of contact pins, thus successively grounding the two subscribers' wires. The longer arm, *c*. in passing over the tens contact pins will send five electric impulses over the wire, *e*. and similarly the brush, *d*. will send four impulses over the wire, *f*. On winding up the motor spring, however, it is necessary to delay the sending of these impulses until such time as the machine at central is ready to receive them. For this purpose the escapement is normally held in check by the armature of a magnet, *g*, until central is ready for the signal, when the magnet, *g*. is energized, and its armature withdrawn from engagement with the escapement. When the motor spring of the sender is wound up, the contact at *h* and *i* is automatically made, which grounds the line wire, *e*, and permits a flow of current.

The machine at central is provided with a series of rods, *M*, a pair for each subscribers' pair of wires. A carriage, M^3, is adapted to travel over each pair of rods, and carries the subscriber's terminal springs, which are insulated from each other, but are each in electrical contact with their respective legs of the subscriber's line. Normally these carriages are in the position shown in full lines, so that an unbroken circuit is formed over a wire, *e*. through the carriage and connection, *A'*, to the subscriber's contact or pin 55 on the rotary contact-maker, *A*. This contact-make consists of two sets of circularly disposed contact-pins, each set containing as many pins as there are subscribers. The trailer, *B*, which is normally rotating, sweeps over these contact-pins and connects them successively with two contact-rings. As soon then as the trailer comes into contact with pin 55 of the inner circle of pins, the circuit is closed through ring, A^2, magnet, B^2, battery, B^1, and resetting wheel, *T*, to the ground. The magnet, B^2, being thus energized attracts an armature which stops the rotation of the contact-trailer and trips a clutch which starts the power mechanism. The resetting wheel, *T*, of the power mechanism prevents the call from some other subscriber from being sent in while a switching operation is going on, for the circuit is broken at all times except when the power mechanism is idle. Rotating with the contact-maker is the "busy wheel," *L*, which is very clearly illustrated in one of our views. It consists of a series of resilient, radial fingers, mounted on and disposed about a shaft to form a helix of one turn. These fingers, corresponding in number to that of the subscribers, are so arranged that when the contact-maker stops at pin 55 the finger which is in line with the carriage, M^3, of subscriber 55 will be in vertical position. Parallel with the axis of the busy wheel, and placed just above it, is a rack, *L'*, whose teeth normally lie between the paths of the busy wheel fingers. Now when the busy wheel stops and the power mechanism is started, this rack is moved laterally under action of a cam, thereby bending finger 55 with which it will come in contact. On account of the spiral arrangement of the busy wheel, only a single finger—that in the vertical position—will be engaged by the rack. Adjacent to the path of each finger is a latch which locks a corresponding shuttle in the position of rest. Springing the finger No. 55 axially results in a release of this latch and in the dropping of shuttle No. 55 to its operating position, thus bringing the carriage with which it is connected into the selective position shown in dotted lines in the diagram; the shuttles are shown at *C* in our illustrations. In this position the line spring terminals are brought into contact with the power bars, *M'*, at the same time breaking connection with the rotary contact maker. This done, the power mechanism, having made a partial rotation, automatically throws itself out of operation and restarts the busy wheel. All this is the work of a few seconds. Current now flows over line, *f*, of the calling subscriber, through the magnet, *g*, and springs, *h*, to the ground. Magnet *g* attracts its armature and permits the contact-maker of the sender to rotate, thus sending the series of impulses over wire, *f*, as previously described. This rotation completed, the parts are restored to their normal positions and the circuit through the sender is broken.

The electric impulses sent by the contact-maker are generated in battery, *H'*, and in passing over both legs of the metallic circuit energize the magnets, H^2 and H^3, causing them to oscillate their armatures. These armatures, as shown in the diagram are connected to an escapement mechanism which permits the selector brushes, H^5 and H^6, being operated by a coil spring, to sweep over and short-circuit their respective series of contacts. We will remember that the number of the called subscriber was 54, therefore the tens impulses passing over line, *e*, will cause the armature of the magnet, H^2, to oscillate five times, bringing the brush, H^5, over contact 5 of the tens selector, and similarly the units impulses will permit the brush, H^6, to travel as far as contact 4 of the unit selector. Between these selector brushes is a timing-train, controlled by an escapement, which is released when the brushes begin to move, and rotates the brush, H^7, until it short-circuits the contacts of battery, H^8. The contacts of the tens selector are connected respectively with ten ring segments, A^2, while the units contacts are connected with the outer row of pins, A^3, of the rotary contact-maker, *A*. These pins, A^3, are divided into ten sections corresponding in position to the sections of A^2. The pins in each section, however, which represent the same numbers, are connected with each other, i. e., every first pin of the tens sections is connected to one circuit, every second pin to another, every third pin to still another, etc. Contact 1 of the unit selector is therefore connected to every pin 1, contact 4 to every pin 4, etc. Now as the trailer, *B*, sweeps over these pins it will engage successively several pins, 4, but no current will flow until it enters that section of A^2 which is in connection with contact 5 of the tens selector, and then when pin 4 is reached, the circuit of battery, H^8, is completed. Following out the diagram, it will be seen that the magnet, B^3, is now

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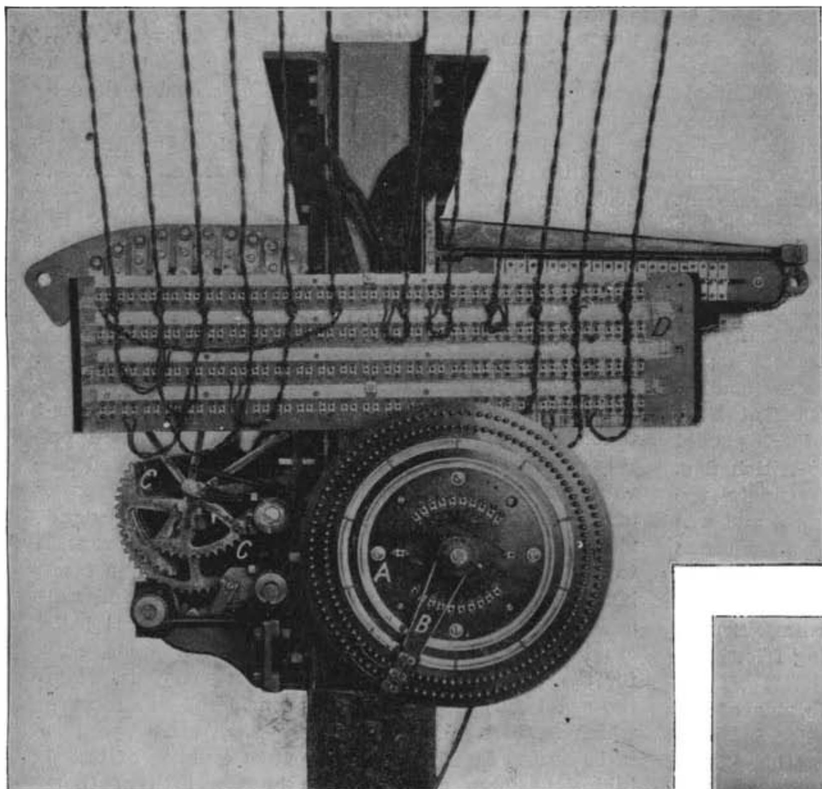
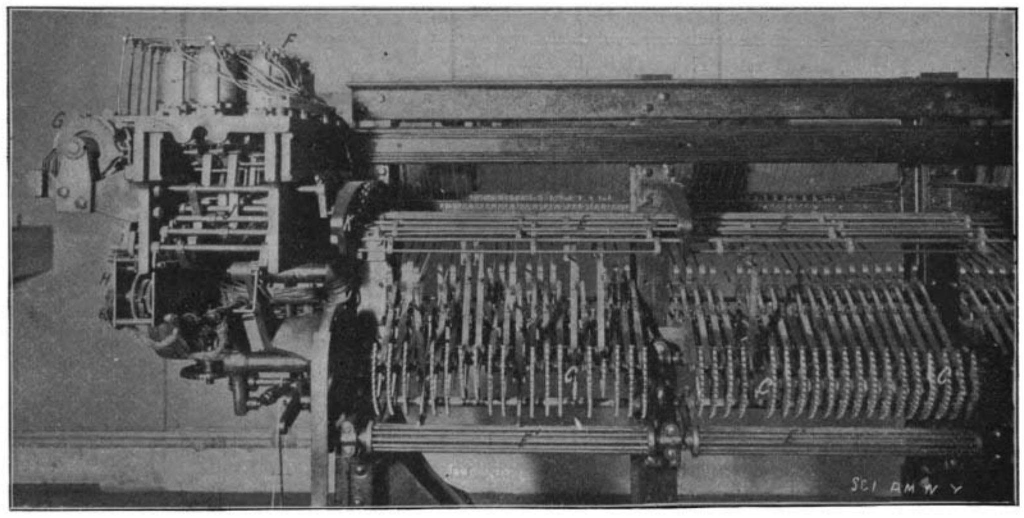
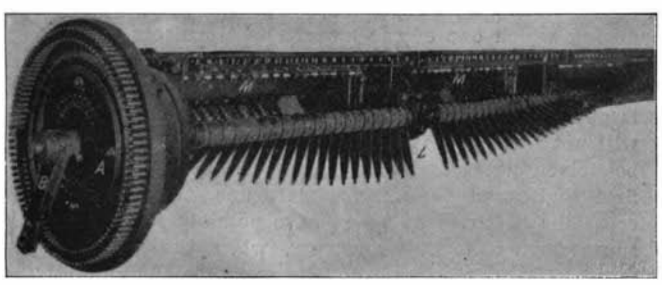


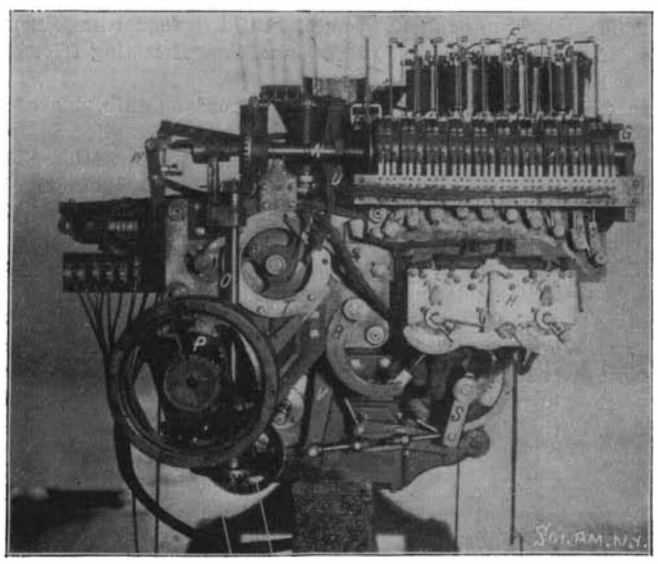
View from the Right—Showing Rotary Contact-Maker.



Front View of Shuttles Showing Several Lifted into Talking Position.

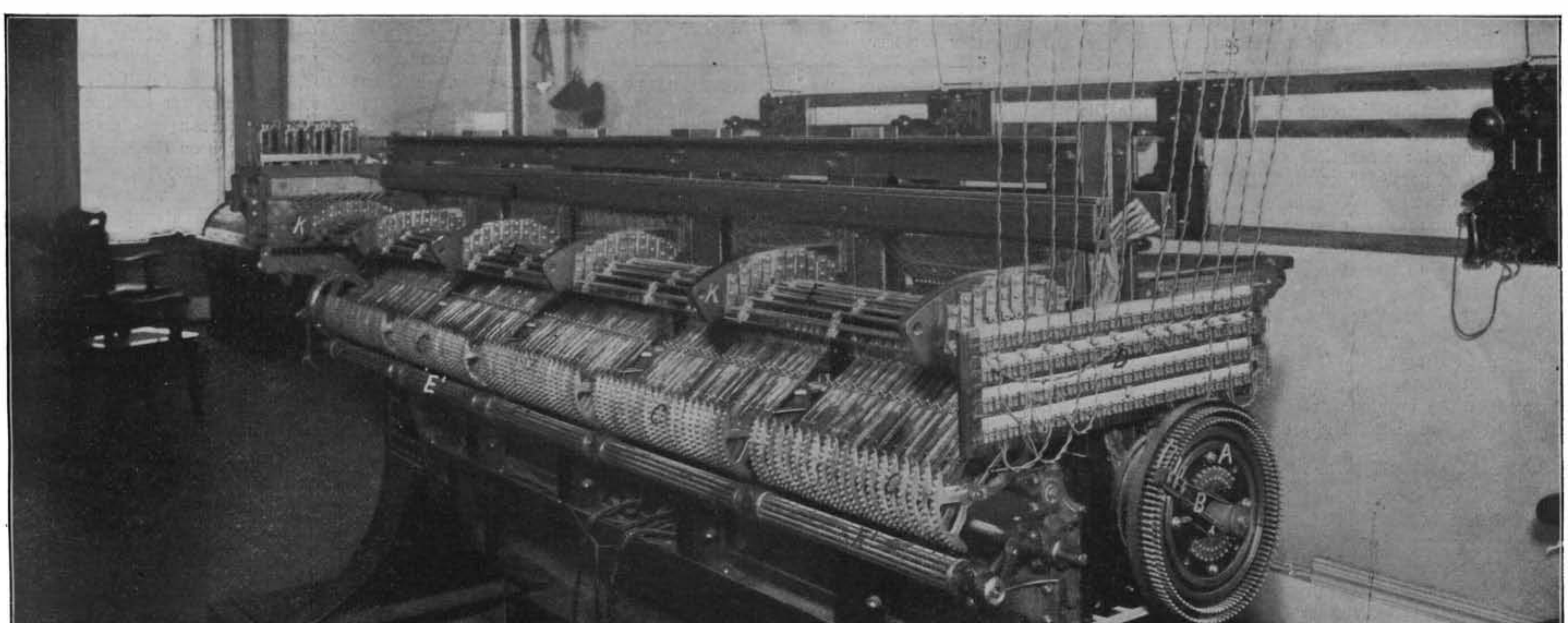


The "Busy-Wheel."



View from the Left.

The Subscriber's Outfit.



GENERAL VIEW OF THE FALLER AUTOMATIC TELEPHONE EXCHANGE.—[See page 238.]

energized, and its armature is raised, together with the armature of B^2, to which it is mechanically connected. This action, just as when B^2 was energized, results in stopping the busy wheel, starting the power mechanism and dropping shuttle 54 into the selective position. It further permits the power mechanism to complete the rotation begun under action of the starting magnet, B^2, and to return to its normal position, when it will auto- tically stop, re-establishing the ground circuit at battery B' through wheel T.

In completing its rotation, the master shaft performs a number of operations which are about to be described. Two shuttles, 55 and 54, have now been dropped. These shuttles, as shown at C in our illustrations, are each provided with a toothed sector which when the shuttle is dropped, engages the pinion, E', at the front of the machine. The opposite ends of the shuttle are connected to the terminal carriages of the subscribers, which, as before stated, are brought into contact with two power bars, M', running at right angles to the bars, M. The power mechanism now permits E' to rotate, thus throwing the upper ends of the shuttles forward under the shuttle-rods, E, the carriages being drawn forward with them along the rods, M. Just above the selector mechanism, shown in the left-hand end view of the machine, a series of oscillating stops may be seen arranged in the arc of a circle. A lever, S', sweeps along this arc, engaging the first stop in its course and throwing it out of its normal sweep. This lever, which is connected by gearing to the pinion, E', is operated in a forward direction by a weight hung from this pinion, and is returned positively by a cam which operates levers V and S, the latter being keyed to the shaft on which lever S' is secured. If the machine had been idle before our signal 54 was sent in, the first stop would be engaged and thrown up and the rotation of pinion E', and the two shuttles engaged would be thereby limited. This act brings the two subscribers' carriages in line with the first pair of conducting rods, M^2, which in this machine take the place of the cord and plug of a manual system. Had the second stop been engaged, the carriages would have been brought into contact with the second pair of rods, M^2. It will be noticed that only ten talking positions are provided for on this machine. This percentage has been found ample in manual exchange practice, for practically never do all subscribers desire to talk at once.

The next act of the power mechanism is to lock the shuttles in position, which is done by lifting them upward until the hooks on their upper extremities engage the rods, E. Our front view shows several shuttles thus locked. In oscillating its stop pins, the lever S' closes the circuit of the battery S^2 through the first of a series of ringer controlling magnets, F'. This circuit contains a shuttle-carrier, C'. Had our subscriber 54 been busy, this carrier would have been dropped so that no signal could be sent. We assume, however, that line 54 is not busy, so the controller magnets will operate to release lever, F^2. By this time the first of a series of controller disks, G, will begin to rotate, bringing their contact strips into engagement with the set of brushes shown in the view at the left-hand end of the machine. The brushes, G' and G^2, connect the ringer, G^4, in multiple with the subscribers' circuits and send each subscriber a signal. The brush, G^3, short-circuits the battery, F^3, through part of the rotation of the disk and permits magnet, F, to be energized, which prevents the clearing-out mechanism from operating. The subscribers now take down their receivers and begin conversation. This act reduces the high resistance of the subscribers' circuit by shunting the ringer of, say, 1,000 ohms and providing a path through the transmitter and receiver of about 75 ohms. A sufficient current therefore flows through magnet, F, to powerfully energize the same. This continues until the subscribers are through talking and hang up their receivers, which act again increases the resistance of the circuit and reduces the flow through the magnet, F, to such an extent that it drops its armature and permits detent, F^4, to drop to its normal position in front of a continually-reciprocating carriage. There are ten clearing-out magnets, F, one for each of the oscillating stops operated by a lever, S'. The detents, F^4, when dropped to their normal positions engage those oscillating stops which have been thrown up by a lever, S', and restore them to their normal positions. The shuttle locks are thus released and return to their positions.

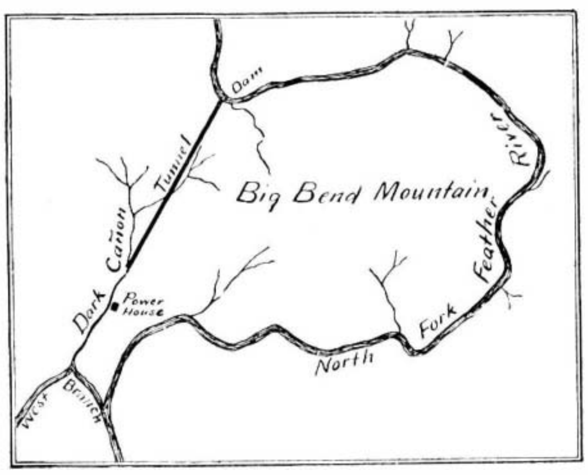
These operations, though seemingly numerous and complicated, are nevertheless automatically taken care of and consume but a few seconds of time. The instructions to the subscriber which are printed on the sender box are very simple, requiring merely the setting of the dials and the turning of the calling knob; it is not necessary to hold the receiver to the ear. In but a few seconds the subscriber's bell will ring and inform him that the connection is made. If the bell does not ring, he will know that the subscriber called is busy. Safety devices are provided in the sender which prevent an incomplete call from going in, and after the call is once set, the instrument is beyond the subscriber's control until the complete signal has been sent. Since the entire mechanism of the exchange is in the main mechanically operated, it requires but small battery power to energize the few magnets employed. A trouble test is provided, whereby any line which is out of order will immediately connect with the telephone of the wireman at the exchange. Any number of subscribers can be accommodated by this system, the requirements being simply an extra machine for every additional hundred subscribers. These machines are all joined to each other in such manner as to permit any two lines in the entire system to be connected together. The limited space at our disposal prevents us from enumerating the many advantages of this machine over the manual system, but these should be readily apparent to anyone acquainted with the tremendous complications of a large telephone exchange.

THE BIG BEND TUNNEL FOR POWER DEVELOPMENT.

BY FRANKLIN RIFFLE.

The recent incorporation of the Feather River Power Company recalls an ill-fated river-bed mining enterprise which for boldness of design, enormous outlay of capital, and barrenness of results, is certainly without a parallel in the annals of river-bed mining in the State of California.

In 1882 the Big Bend Tunnel and Mining Company was organized for the purpose of mining fourteen miles of the bed of that portion of the North Fork of the Feather River known as Big Bend. A careful survey had suggested the construction of a tunnel through Big Bend Mountain 12,000 feet long as the most feasible method of draining the channel. Owing to its precipitous banks, but few attempts (and these on a very small scale) had been made to mine this portion of the river. Both above and below Big Bend, however, mining operations had been carried on for many years wherever the water of the river could be turned from its bed by means of hastily-constructed wing dams and ditches or flumes. Only a portion of the summer season could be employed in actual mining, since much time was necessarily consumed in the construction of the diverting works, which were invariably destroyed by high water in the fall. Yet in spite of these drawbacks, many of the Feather River mining ventures had yielded handsome returns. It is chronicled that in 1857, on the old Cape Claim below Big Bend, the sum of $680,000 in gold was taken from 3,300 feet of the channel during the forty working days that intervened between the date of completing the diverting works and the appearance of high water. The expense of draining the channel and working the gravel amounted to $120,000. It was confidently assumed by the projectors of the Big Bend tunnel that the river-bed at Big Bend was equally rich in gold, and that the construction of a permanent channel sufficiently large to take care of the river flow for six months of the year would enable the company to mine more systematically, and therefore more profitably, than was possible with temporary diverting works, which could be utilized for only a brief portion of the season during which they were constructed.



PLAN SHOWING TUNNEL AND BIG BEND OF NORTH FORK OF FEATHER RIVER.

Active work on the tunnel began in November, 1882, after the completion of the necessary roads, trails and buildings, and the installation of an air compressor plant for operating machine drills. The material encountered proved to be slate, of such a character as to require no timbering; and, although hard and firm, it was excavated without difficulty. Excellent progress was made from the beginning, and the spring of 1886 witnessed the completion of the enterprise as originally planned. The cross-section was 9 feet by 16 feet throughout, except at the entrance, where it was enlarged to 9 feet by 32 feet. The grade was 30 feet per mile. Massive iron gates had been constructed for placing at the entrance of the tunnel, and a substantial diverting dam, 125 feet long and 16 feet high, had been completed simultaneously with the prosecution of the work in the tunnel. At this juncture the enterprise received a serious setback. When it was attempted to drain the channel, the startling discovery was made that the tunnel was much too small to carry the entire volume of water flowing in the river. After computing from accurate measurements the amount of surplus water, it was decided to increase the height of the tunnel from 9 feet, as originally designed, to 16 feet. Plans were made for pushing the work vigorously, with as many men as it was possible to work in three eight-hour shifts. By means of suitable cars drawn by a locomotive, the material was promptly removed as fast as excavated. The work continued without cessation until its completion in the fall of 1887—too late for mining that season.

It was now planned to develop sufficient water power at the lower end of the tunnel to operate the machinery required for excavating the gravel, viz., derricks for removing large bowlders and elevating the gravel to sluice boxes, and pumps for disposing of the seepage. A waterwheel and an electric generator were accordingly installed, and a transmission line was constructed around Big Bend. Fifteen years ago electric power transmission was in its infancy. As the Big Bend line was, therefore, largely experimental, it is not surprising that the results proved far from satisfactory. It may be mentioned as a matter of interest that this was chiefly due to the omission from the plant of an accessory which, in these days of successful power development and transmission, is considered a prime essential, i. e., a waterwheel governor.

The power plant, however, proved to be the least of the company's troubles. When mining was at last begun in the summer of 1888, it was found that the cost of excavating was much greater than had been estimated. This was due to the prevalence of large bowlders that could be handled only with the greatest difficulty. In addition to this obstacle, the bedrock, which had been relied upon to yield the largest values, was either inaccessible on account of the extreme depth of the gravel, or was too hard and smooth where the gravel was shallow to have accumulated gold.

Although the season's operations demonstrated the impossibility of profitably mining the Big Bend channel, the company were reluctant to accept the fact. Operations were resumed during the season of 1889; but the second attempt proving no more successful than the first, it was decided before the close of the season to abandon the enterprise. It is said that more than one million dollars were expended by the company during the eight years that elapsed between the inauguration of the project and its unfortunate termination.

And now comes the sequel. During the past five years the successful transmission of power, generated by water, from distant mountain streams to the towns of the Pacific coast has suggested industrial possibilities that were not even dreamed of fifteen years ago. The amazing success, not merely mechanically but commercially as well, of the Standard Electric and Bay Counties Power Companies in transmitting electric power from the Sierra Mountains to the cities on San Francisco Bay, 200 miles distant, has directed the attention of promoters and investors to all the available sources of water power on the western slope of the Sierras. One of the most promising is that secured by the Feather River Power Company, which has recently come into possession of the Big Bend tunnel property. At the end of the tunnel the water has a drop of 350 feet. It is estimated that this will develop no less than 2,500 horse power, making due allowance for loss in transmission to San Francisco, a distance of approximately 200 miles. The one feature of the Feather River power scheme that will appeal to both the engineer and the investor is the permanent character of the hydraulic portion of the plant. Fully to appreciate the value of this feature, it is only necessary to consider the enormous expense of maintaining the many miles of flume and canal construction that characterize certain large power plants in this State. The estimated cost of the entire plant, including the purchase price of the Big Bend Tunnel and Mining Company's property, is approximately $125 per delivered horse power.

When Big Bend tunnel was abandoned thirteen years ago, probably no one considered the possibility of turning the waste water power to profitable account, much less transmitting this power to the Pacific coast. At that time, as we have seen, the transmission of less than 100 horse power a few miles, and its application to the simplest operations, was attended with greater difficulties than the transmission to-day of many thousand horse power to distant points for distribution.

And so it has come to pass that the remarkable development of electrical science during the past few years has paved the way for transforming a disastrous mining failure into a brilliant commercial success.