Sept. 4, 1923. 1,467,033

W. R. GOODMAN ET AL

ENGINE STARTING DEVICE

Filed Aug. 9, 1921 3 Sheets-Sheet 1

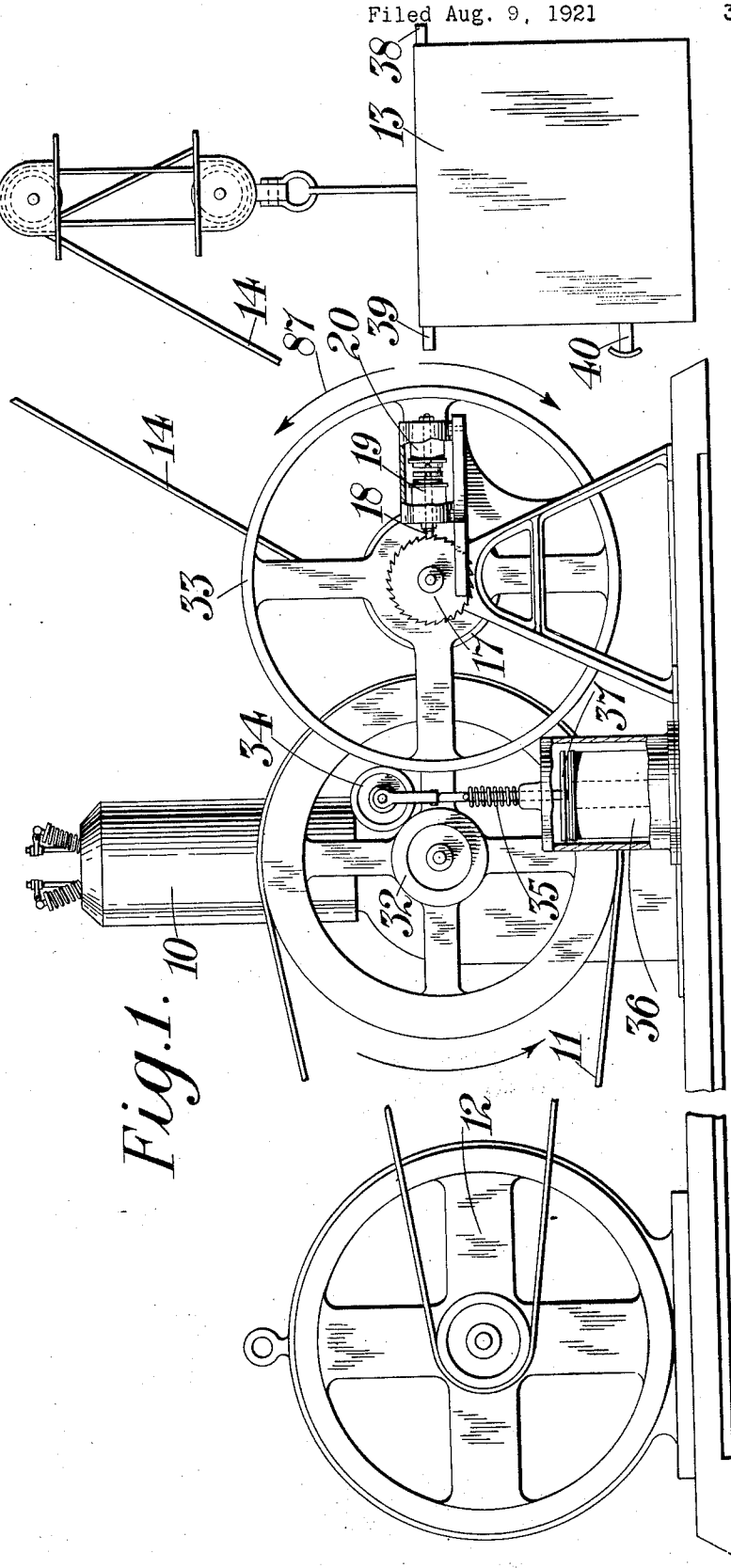


Fig. 1.

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Fig. 3.

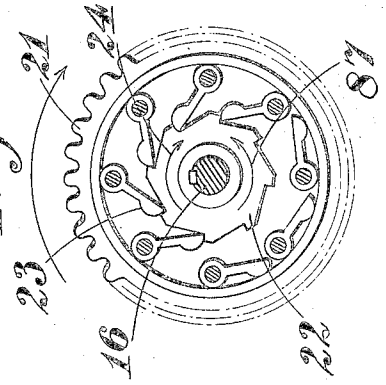
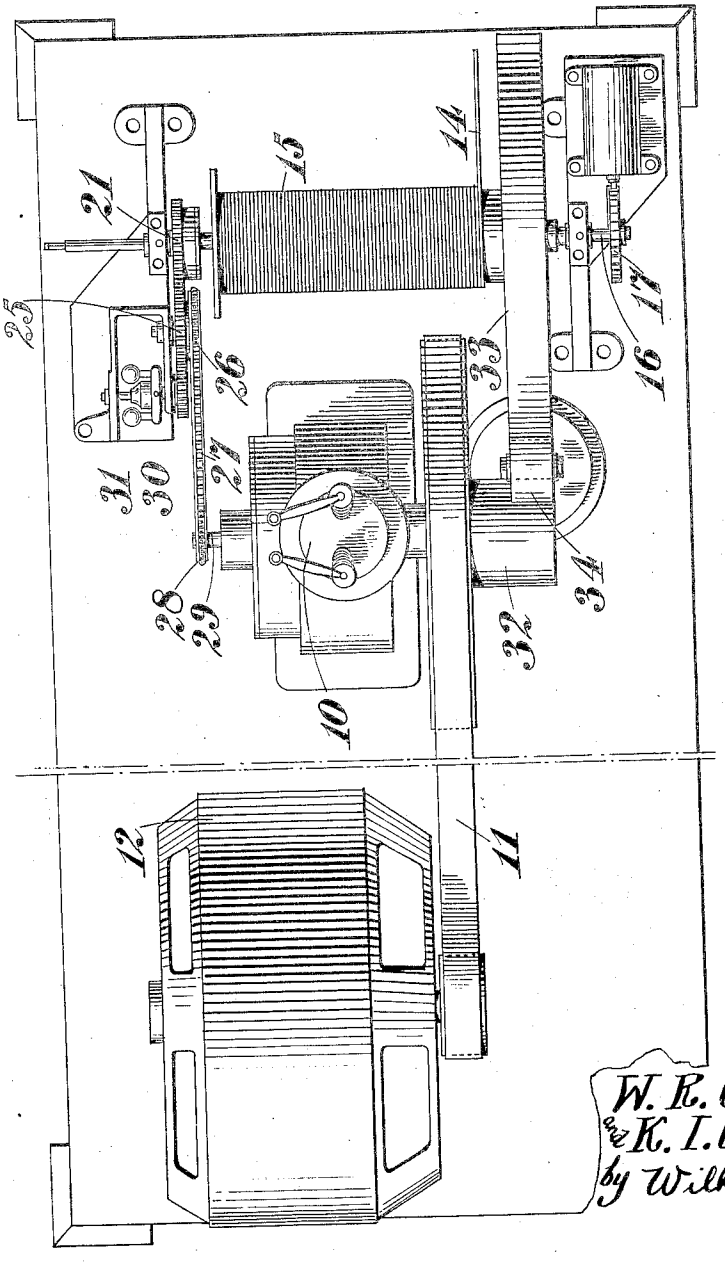


Fig. 2.



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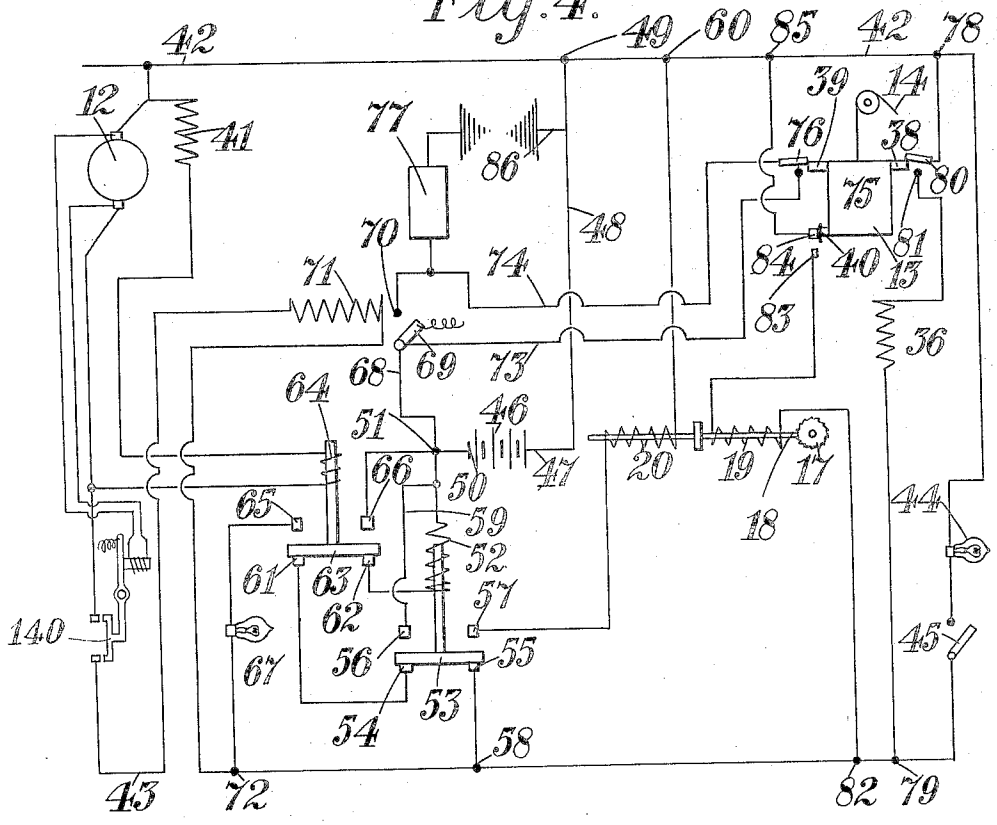
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Fig. 4.



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UNITED STATES PATENT OFFICE.

WALTER RUSSELL GOODMAN, OF WORTHING, AND KEELEY IAN GOODMAN, OF RICHMOND, ENGLAND.

ENGINE-STARTING DEVICE.

Application filed August 9, 1921. Serial No. 491,027.

To all whom it may concern:

Be it known that we, WALTER RUSSELL GOODMAN, a subject of the King of England, and KEELEY IAN GOODMAN, a subject of the King of England, residing, respectively, at Worthing, in England, and Richmond, in England, have invented certain new and useful Improvements in Engine-Starting Devices, of which the following is a specification.

This invention is for improvements in or relating to engine-starting devices such as are used in plants comprising an internal-combustion engine, and an electric generator driven thereby to supply circuits used for example for electric lighting. The object of the invention is to provide an improved construction of starting device whereby the engine is automatically started by the ordinary operation of switching on any of the circuits supplied by the generator when running.

According to this invention there is provided in an electric-power system as above-described, the combination with the engine of a source of mechanical energy, (for example either a weight that can be released to fall, or a spring that can be released to unwind) rotatable means coupling it to the engine to drive it, but permitting the engine to overrun it, an electro-magnetically controlled detent retaining the said source of energy in its energized state; a battery which is of small capacity and small voltage compared with the generator, connected across the mains of the generator so as to form a circuit through any of the branch circuits on the said mains, when said branch circuit or circuits is closed, said battery operating, directly or indirectly, the said electro-magnetically controlled detent to release it when the battery circuit is completed by the closing of the said branch circuit.

According to another feature of the invention, there is combined with the elements above-mentioned, a switch which is closed by the operation of the source of mechanical energy, and circuits connecting the said battery through the said switch to the ignition system of the engine so as to provide for the ignition during the starting period, until the generator has become fully excited. When the source of mechanical energy is a falling weight, the switch is conveniently one that is directly operated thereby, the switch being opened by the weight when it reaches its highest position and automatically closing when the weight is allowed to descend therefrom.

There may also be provided in connection with the ignition circuit of the engine an electro-magnetic switch which is operated by the main line current to disconnect the battery from the ignition circuit and to connect such circuit to the mains supplied by the generator. The whole plant therefore becomes independent of the battery as soon as the engine has attained its normal speed and the generator has become fully excited.

According to another feature of the invention, there may be provided in the first-mentioned circuit of the battery a gap or break which is normally closed by a switch, and an electro-magnet operative on said switch, and energized by the generator to open the switch when the generator is fully excited. The said electro-magnet is conveniently arranged in series with the shunt field winding of the generator.

According to another feature of the invention there is provided mechanism whereby the source of mechanical energy is automatically re-energized by the engine when the latter has attained its normal running conditions; such means comprises a switch which is automatically closed by the operation of the source of mechanical energy and opened when said source is fully energized, and controls a circuit energized by the generator, the circuit containing an electro-magnet which, when energized, causes or permits a reversing gear to be brought into action to couple the engine to the said source of mechanical energy to re-energize it.

According to yet another feature of the invention there is provided in combination with the detent above-mentioned, which releases the source of mechanical energy, an electro-magnet which is operative on the detent to return it to its engaging position to maintain the source of mechanical energy in its energized state, and this electro-magnet is controlled by a switch which is automatically operated from the said source to complete the circuit and operate the detent when the said source of energy has been fully energized. This switch may, if desired, be arranged to operate only momentarily, the detent being so constructed that it does not need to be held in its engaging position.

According to yet another feature of the invention, means are provided for charging the battery after the engine has been started and the generator has been fully excited, such means comprising a switch which connects the battery in series with a suitable resistance across the mains, the switch being electro-magnetically operated from the generator; it may for example be arranged in series with the shunt field-winding of the generator, and this operation moreover may be effected by the same switch which, as above-mentioned, opens the battery circuit after the engine has attained its normal running speed.

In the accompanying drawings which illustrate one embodiment of this invention as applied to an electric power plant,

Figure 1 is a side elevation of the complete plant.

Figure 2 is a plan of Figure 1.

Figure 3 shows a detail of construction, and

Figure 4 is a wiring diagram for the complete plant.

Like reference characters indicate like parts throughout these drawings.

Referring to these drawings, the plant comprises an internal-combustion engine, indicated generally by the reference character 10, which is coupled by a belt 11 to an electric generator 12. The source of mechanical energy which is used for starting the engine 10 is a suitably heavy weight 13 suspended by a cable 14 which is wound on a drum 15.

The shaft 16 of the drum carries a ratchet wheel 17, which is engaged by a pawl or detent 18 to hold the drum from rotation under the action of the weight 13. This detent 18 is controlled by two magnets 19, 20, being mounted on an armature conveniently situated coaxially with and between the magnets. The magnet 20 when energized withdraws the detent 18 from engagement with the ratchet wheel 17 to release the drum and the magnet 19 acts in the reverse direction to bring the detent 18 into engagement with the ratchet-wheel 17.

The shaft 16 aforesaid also carries a gear-wheel 21 (see Figure 2) and an operative engagement between the shaft and the wheel is provided by a ratchet wheel 22 fast on the shaft engaging pawls 23 which are pivotally mounted on the wheel 21. The arrangement is such that the shaft 16 can drive the wheel 21 in the direction indicated by the arrow 24, Figure 3, but the wheel can overrun the shaft in the same direction. When the wheel 21 attains a sufficient speed the pawls 23 become disengaged from the ratchet 22 by the centrifugal force exerted on them and the device is silent running.

The gear-wheel 21 aforesaid meshes with another gear-wheel 25 mounted on a suitable bracket, and the gear-wheel 25 is rotatively connected with a sprocket-wheel 26 which drives by a chain 27 a sprocket-wheel 28 on the crank-shaft 29 of the engine 10. The gear-wheel 25 also engages another gear-wheel 30, which in turn drives the governor 31 which controls the running of the engine by operating on the throttle, or ignition, or in any other desired manner.

The crank-shaft 29 of the engine 10 carries a friction-wheel 32, which is aligned with a similar wheel 33 on the shaft 16 of the drum 15, and an adjustable friction-wheel 34, (see Figure 1) is mounted so that it can be brought into engagement with the two wheels 32, 33 to couple them together. This wheel 34 is controlled jointly by a spring 35 which tends to maintain it in its disengaging position, and by an electro-magnet 36 which is operative on an armature 37 secured to the spindle carrying the wheel 34. When this electro-magnet 36 is energized it draws the wheel 34 into engagement with the two wheels 32, 33 so as to couple them together.

As previously stated the operation of starting the plant is automatic, and certain of the operations are controlled by switches which are operated by the weight 13. There are indicated diagrammatically in Figures 1 and 4, two arms 38, 39 on the weight for the operation of switches as hereinafter described, and also a contact-piece 40 which operates as hereinafter described. It will be understood that the constructional details of these switches and their operating mechanism may be of any desired type, and that the representations in the drawings are merely diagrammatic.

Referring now to Figure 4, which shows the electrical connections for the complete plant, certain parts which have already been referred to are illustrated diagrammatically therein, these being the generator 12, the ratchet-wheel 17, detent 18, electro-magnets 19, 20, 36, switch-operating arms 38, 39, and contact-piece 40 on the weight 13.

The generator 12 may be a compound wound or shunt wound machine, and the shunt winding is indicated at 41. The generator is connected in the ordinary way to the two supply mains 42, 43, and the load of these mains is indicated by a lamp 44 controlled by a switch 45. The main circuit of the generator indicated in heavy lines in the drawing is controlled by a main circuit-breaker 40 described hereinafter.

A battery 46, which is conveniently a secondary or storage battery, is connected on one side 47 by a wire 48 to the main 42 at 49. The other side of the battery 50 is connected through 51 to the magnet-coil 52 of a relay switch 53. This switch 53 normally bridges a pair of contacts 54, 55, and when the coil 52 is energized the switch 53 is

moved to bridge a pair of contacts 56, 57. The contact 55 is connected directly to the main 43 at 58; the contact 56 is connected through 59 and 51 direct to the battery at 50; the contact 57 is connected to one end of the detent releasing magnet 20 aforesaid, the other end of this magnet winding being connected to the main 42 at 60; the contact 54 is connected to a contact 61 which is normally connected with a second contact 62 by a switch 63, the contact 62 being connected to that end of the magnet winding 52 which is not connected to the battery 46.

The switch 63 is arranged to be operated to open the circuit between the contacts 61 and 62 whenever the generator 12 becomes fully excited after starting up the plant. This is conveniently effected by using a magnet coil 64 which is in series with the shunt winding 41 of the generator. This switch 63 is also used for another pair of contacts 65, 66 so as to connect them when the generator is fully excited. The contact 65 is connected to the main 43 through a resistance 67, such as a lamp, and the contact 66 is connected through 51 to the battery 46 at 50. The usual type of automatic switch is shown at 140 in the generator circuit.

The battery 46 is also connected from 50 through 68 to a switch 69 whereof the co-operating contact is shown at 70. This switch is arranged to be operated by an electro-magnet 71 which is in series with the main 43 aforesaid, being connected across a gap therein at 72. The switch 69 and its contact 70 are connected through 73, 74 respectively to a contact 75 and switch 76 which is operated by the arm 39 on the weight 13 aforesaid, the arrangement being such that when the weight is in its uppermost position the switch 76 is moved away from its contact 75, but as soon as the weight descends the switch 76 makes contact with 75 and thereby short-circuits the switch 69. An induction coil is indicated at 77, being connected on one side to the conductor 74 and earthed on the other side, this coil supplying in the usual way a sparking plug (which is not shown) for the engine.

The electro-magnet 36 which operates the wheel 34 aforesaid is connected across the mains 42, 43 at 78, 79 respectively, and is in series with a switch 80 whereof the co-operating contact is shown at 81. This switch 80 is similar to the switch 76 and is operated by the arm 38 of the weight 13 so as to be opened when the weight reaches its uppermost position. The magnet 19 which operates to move the detent 18 into engagement with the ratchet 17 is connected on one side to the main 43 at 82, and on the other side to the contact 83 of a pair of contacts 83, 84, which are arranged to be bridged by the contact-piece 40 aforesaid on the weight 13 when the weight is just below its topmost position. The contact 84 is connected to the main 42 at 85.

The operation of this starting device will now be described. Assuming that the weight 13 is in its uppermost position, and the engine is stationary, all the switches will occupy the positions shown in Figure 4. The only operation that is required is to close the switch 45 which controls part of the load connected across the mains 42, 43. When this switch is closed a circuit for the battery 46 is completed through 47, 48, 49, 42, load 44, 45, main 43, 58, 55, 53, 54, 61, 63, 62, relay-coil 52, 51 to the battery at 50. The coil 52 is thereby energized and lifts the switch 53 from the contact 54, 55 on to the contacts 56, 57 and a fresh circuit for the battery 46 is thereby completed from 47 through 48, 49, 60, detent-releasing coil 20, 57, 53, 56, 59, 51 back to the battery at 50. The coil 20 is thereby energized to withdraw the detent 18 from engagement with the ratchet wheel 17 and release the weight 13. The weight commences to move downwards and in so doing drives the engine through the gearing 21, 25, 26, 28, as shown in Figure 2. As soon as the weight moves, the switch 76 moves on to its contact 75 and completes a circuit for the battery 46 from 50 through 51, 68, 69, 73, 75, 76, 74, to the induction coil 77 thence to earth and back to the battery from an earth connection 86 on the conductor 48, to 47.

The engine is thereby set in rotation and a current supplied to its igniting device, and the engine commences to run under its own power. When the field of the generator 12 is built up to full excitation the electro-magnet 64 which is in series with the field-winding 41 becomes energized, closes the circuit-breaker 140 and simultaneously moves the switch 63 away from the contact 61, 62, thus providing a break in the first-mentioned circuit for the battery 46 between these two contacts. The switch 63 is moved to engage the contacts 65, 66 so that a circuit is provided from the main 43 through the resistance 67 to 65, 63, 66, 51, 50, battery 46, 47, 48 to the other main 42, at 49; the resistance 67 is selected so as to permit sufficient current to pass on this circuit to charge the battery. Further, when the normal running conditions are maintained, the load current in the main 43 energizes the magnet 71 and causes the switch 69 to move on to its contact 70; the ignition current for the engine is thereupon supplied from the mains, the induction coil 77 being in parallel with the battery 46 and supplied from 43 through 67, 65, 63, 66, 51, 68, 69, 70, 77, to earth, and from the earth 86 to 49 on the main 42. As soon as the weight 13 started to descend, it allowed the switch

80 to close on to its contact 81 and thereby complete a circuit from the main 42 at 78 through the electro-magnet 36 to the main 43 at 79. This winding is so designed that when the supply voltage reaches its normal maximum the coil becomes fully energized and moves the wheel 34 into contact with the wheels 32 and 33. The wheel 32 is now being driven by the engine, and a drive is therefore transmitted from it to the wheel 33 on the drum shaft 16. Owing to the interposition of the wheel 34, the drum is driven in the direction indicated by the arrow 87 in Figures 1 and 3 so as to wind up the weight again. This winding-up continues until the weight reaches its topmost position, and in so doing its contact 40 bridges the contacts 83, 84, so as to complete a circuit between the mains from 82 through the electro-magnet 19 to the main 42 at 85. The magnet is thereby energized and moves the detent 18 into engagement with the ratchet wheel 17 so as to retain the drum against rotation in the reverse direction and hold the weight in its uppermost position. The weight on reaching its uppermost position has opened the switch 80 so that the wheel 34 is released from its driving engagement with the wheels 32, 33, and the weight therefore remains stationary ready for starting the engine again. The switch 76 has also been opened, but this does not affect the ignition of the engine since the switch 69, as above-described, has been moved on to the contact 70 to provide for a supply of current to the induction coil 77.

The relay coil 52 is no longer energized owing to its circuit being broken between the contacts 61, 62, so that the switch 53 returns to the contacts 54, 55. The circuit for the magnet 20 is broken between the contacts 56, 57.

This arrangement of the switches is maintained so long as the engine is running and current is being supplied. As soon as the load is all switched off, there is no current in the main 43 and the switch 69 being no longer held by its magnet 71 leaves its contact 70 thereby opening the ignition circuit of the engine. The engine therefore stops, and when the excitation of the field winding 41 of the generator 12 falls, the magnet 64 releases the switch 63 so that it returns to its original position on the contacts 61, 62, and the circuit-breaker 140 opens the main circuit. All the switches therefore return automatically to their original position when the generator ceases to supply current, and everything is ready for restarting the engine by closing the switch 45 in the manner hereinbefore described.

It should be pointed out that when the weight 13 starts to descend, its contact 40 bridges the contacts 83, 84, and completes a circuit for the magnet 19. The generator however, has not had time to build up its field and supply the mains at its normal voltage so that the magnet 19 is not energized, and the detent 18 remains disengaged from the wheel 17 until the contact 40 becomes operative on the upward movement of the weight when the generator is supplying at its normal voltage. It will also be seen that the switch 80 for the magnet 36 is closed as soon as the weight moves downwards, but here again the voltage across the mains is not sufficient to energize the magnet and move the wheel 34 until the engine is running under its own power and the mains are being supplied at a voltage approximating to their normal pressure. It is found in practice that this arrangement is very satisfactory as the wheel 34 is gradually brought down into engagement with the wheels 32, 33 as the generator voltage builds up, so that there is no sudden application of load (for rewinding the weight 13) before normal running conditions have been obtained. What happens is that when rewinding of the weight 13 commences, if the engine slows down owing to this load, the voltage drops and the magnet 36 releases the wheel 33 from driving engagement so that the engine gets an opportunity to speed up again.

It will be seen that this invention provides a starting device for an engine which operates automatically on closing the switch of a circuit supplied by the generator, and which automatically resets the source of mechanical energy which is used to start the engine ready for another start and finally automatically shuts down the plant as soon as all the electrical load is taken off the supply mains.

What we claim as our invention and desire to secure by Letters Patent is:—

1. In an electric power system the combination of an internal combustion engine, an electric generator driven thereby, a source of mechanical energy, rotatable means coupling it to the engine to drive it, but permitting the engine to overrun it, a battery which is of small capacity and small voltage compared with the generator, a switch closed by the operation of the source of mechanical energy when released and circuits connecting said battery through said switch to the ignition system of the engine.

2. In an electric power system the combination of an internal combustion engine, an electric generator driven thereby, a main circuit for said generator, a source of mechanical energy, rotatable means coupling it to the engine to drive it, but permitting the engine to overrun it, a battery, a switch closed by the operation of the said source of mechanical energy when released, circuits connecting said battery through said switch to the ignition system of the engine, and an

electromagnetic switch operated by current in the said main circuit of the generator to short-circuit the said switch operated by the source of mechanical energy.

3. In an electric power system, the combination of an internal combustion engine, an electric generator driven thereby, a main circuit for said generator, a source of mechanical energy, rotatable means coupling it to the engine to drive it, but permitting the engine to overrun it, a battery, a switch closed by the operation of the source of mechanical energy when released, circuits connecting said battery through said switch to the ignition system of the engine, and an electromagnetic switch operated by the said generator when fully excited to connect the ignition circuit of said engine to the said main circuit of the generator.

4. In an electric power system, the combination of an internal combustion engine, an electric generator driven thereby, a main circuit for said generator, a source of mechanical energy, rotatable means coupling it to the engine to drive it, but permitting the engine to overrun it, a detent for retaining said source of mechanical energy in its energized state, means for releasing said detent, a reversing gear, electro-magnetically controlled means whereby said reversing gear can be coupled to the engine and the said source of energy to re-energize the latter when the engine is running, said electro-magnetic means being arranged in a circuit controlled by a switch which is closed by the operation of the source of mechanical energy and opened when the said source is fully energized, the said circuit being energized by the generator to be operative when the generator is fully excited.

5. In an electric power system the combination of an internal combustion engine, an electric generator driven thereby, a main circuit for said generator, a source of mechanical energy, rotatable means coupling it to the engine to drive it, but permitting the engine to overrun it, an electromagnetically controlled detent retaining the said source of energy in its energized state, a battery which is of small capacity and small voltage compared with the generator and is connected across the mains of the generator so as to form a circuit through any of the branch circuits on the said mains when said branch circuit is closed, said battery effecting the operation of the said electromagnetically controlled detent to release it when the battery circuit is completed by the closing of the said branch circuit, a circuit across the mains of the generator, containing an electro-magnet (19) operative on the said detent to return it to its engaging position to maintain the source of mechanical energy in its energized state, and a switch automatically operated by the said source of energy to complete the circuit and operate the detent when the said source of energy has been fully energized.

6. In an electric power system, the combination of an internal combustion engine, an electric generator driven thereby, a main circuit for said generator, a source of mechanical energy, rotatable means coupling it to the engine to drive it, but permitting the engine to overrun it, an electromagnetically controlled detent retaining the said source of energy in its energized state, a battery which is of small capacity and small voltage compared with the generator and is connected across the mains of the generator so as to form a circuit through any of the branch circuits on the said mains when said branch circuit is closed, said battery effecting the operation of the said electromagnetically controlled detent to release it when the battery circuit is completed by the closing of the said branch circuit, a circuit across the mains of the generator, containing an electro-magnet operative on the said detent to return it to its engaging position to maintain the source of mechanical energy in its energized state, and a switch automatically operated by the said source of energy to complete momentarily the circuit when said source of energy approaches its state of being fully energized.

7. In an electric power system, the combination of an internal combustion engine, an electric generator driven thereby, a main circuit for said generator, a source of mechanical energy, rotatable means coupling it to the engine to drive it, but permitting the engine to overrun it, an electromagnetically controlled detent retaining the said source of energy in its energized state, a battery which is of small capacity and small voltage compared with the generator, and is connected across the mains of the generator to form a circuit through any of the branch circuits on the said mains when said branch circuit is closed, said battery effecting the operation of the said electromagnetically controlled detent to release it when the battery circuit is completed by the closing of the said branch circuit, a switch closed by the operation of the said source of mechanical energy when released, circuits controlled by said switch connecting said battery to the ignition system of the said engine, an electromagnetically controlled two-way switch connected across said generator and energized by it when it is fully excited to move it to its second position and effect the opening of the said detent controlling-circuit of the battery, an electromagnetically-controlled switch operated by the current in the said generator mains to short-circuit the switch operated by the release of the source of mechanical power and to connect the ignition system of the engine in parallel with

the said battery across the generator mains, a reversing gear, electromagnetically controlled means whereby it can be coupled to the engine and to the said source of energy to energize the latter when the engine is running, said electromagnetic means being arranged in a circuit across the generator mains and controlled by a switch which is closed by the operation of the source of mechanical energy when released and opened when the said source is fully energized, a second electromagnet operative on the said detent to return it to its engaging position to maintain the source of mechanical energy in its energized state, said electromagnet being connected across the mains of the generator and controlled by a switch which is automatically operated by the said source of energy to complete said circuit momentarily when said source of energy approaches the state of being fully energized, substantially as set forth.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

WALTER RUSSELL GOODMAN.
KEELEY IAN GOODMAN.

Witnesses:
L. E. GREENACRE,
T. J. OSMAN.