Aug. 14, 1962 G. W. PARKES 3,049,208

LOCKING MECHANISMS

Filed Dec. 29, 1958 3 Sheets-Sheet 1

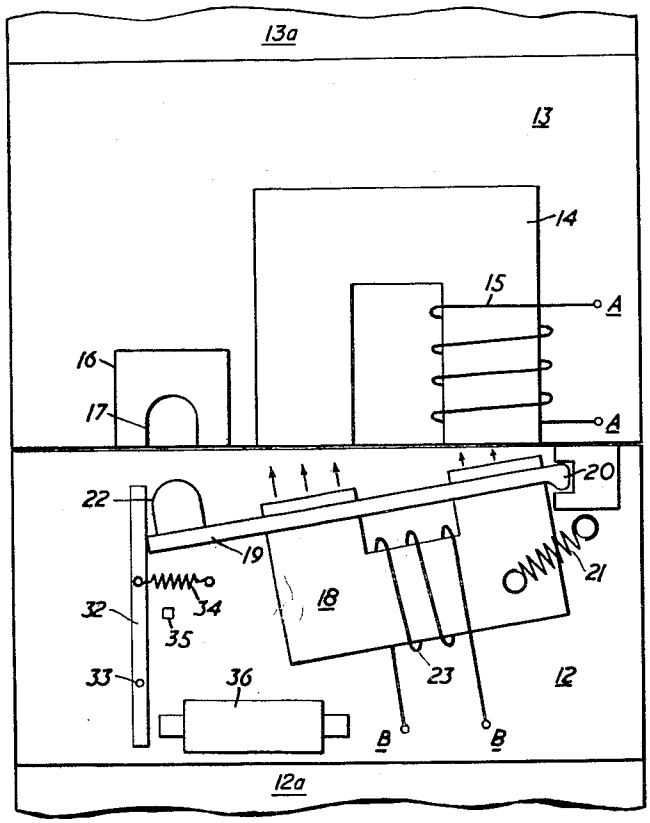


FIG. 1.

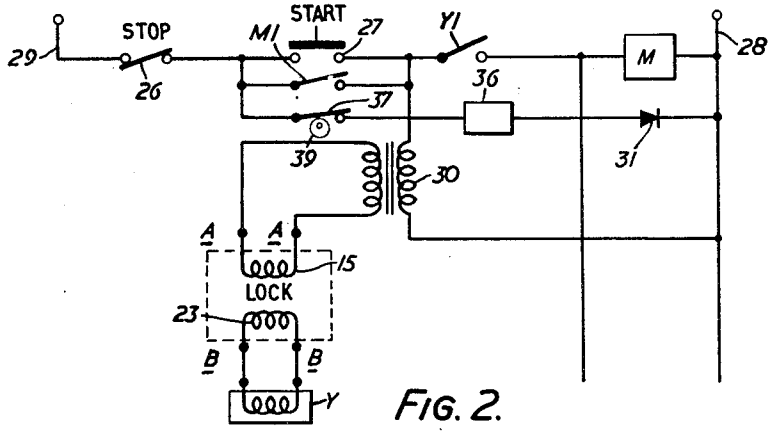


FIG. 2.

INVENTOR
Gregory Wilson Parkes
BY
Pierce, Scheffler & Parker
ATTORNEYS

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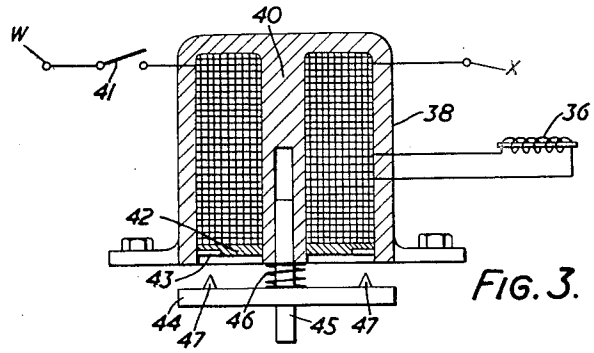


FIG. 3.

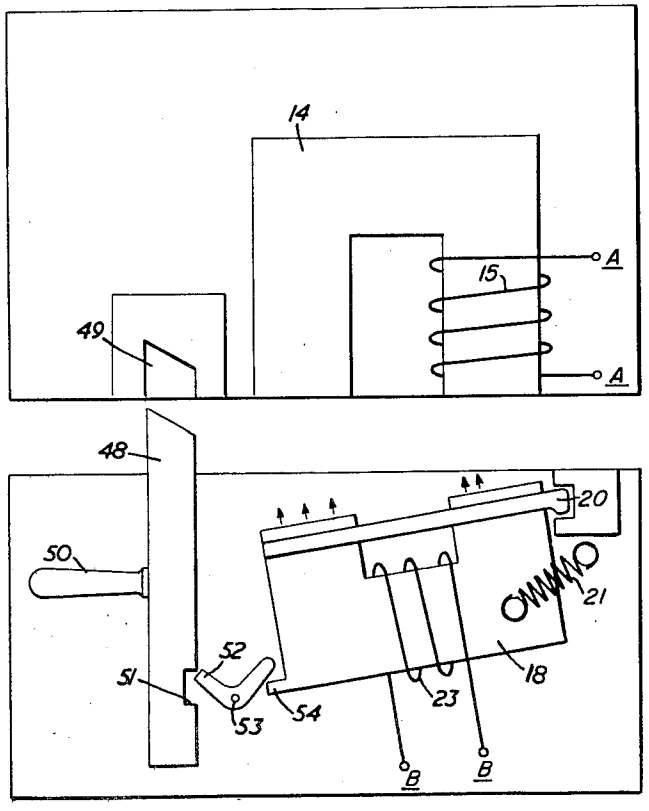


FIG. 4.

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FIG. 5.

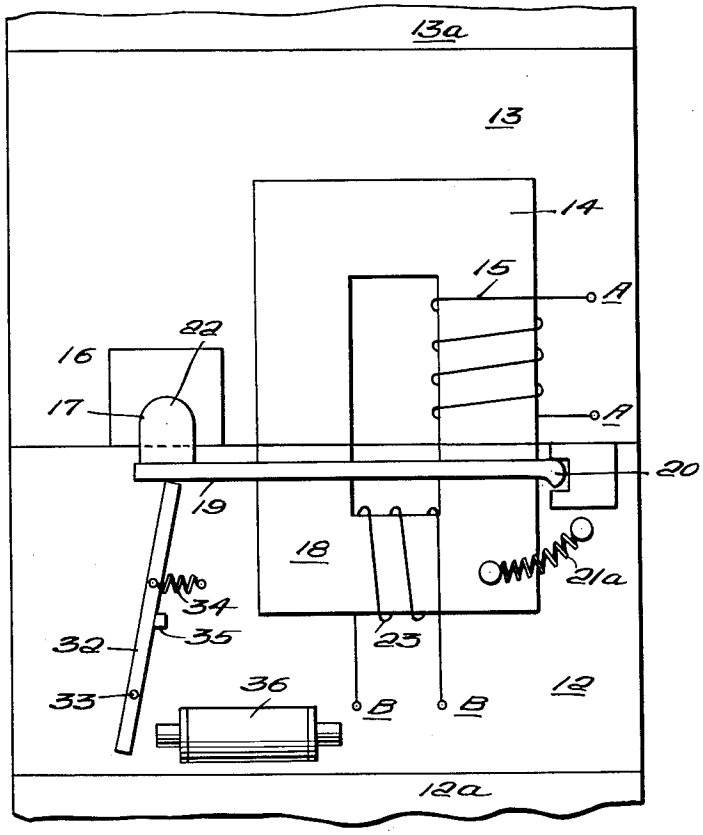
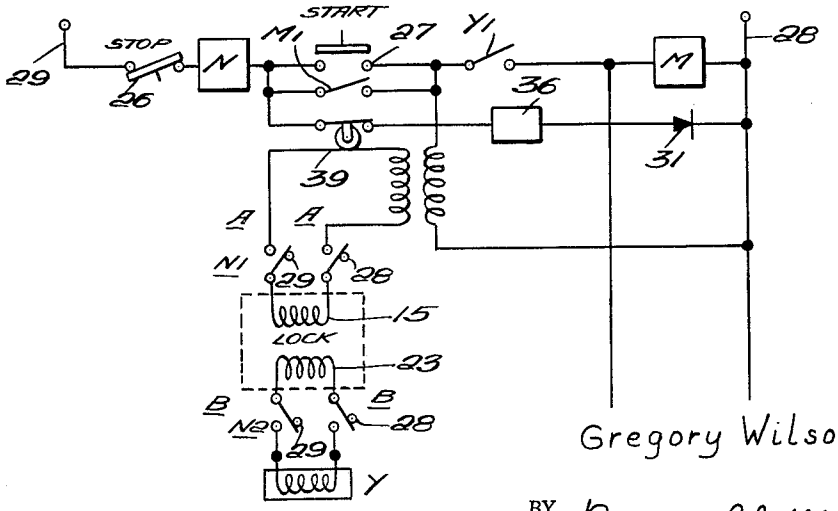


FIG. 6



INVENTOR

Gregory Wilson Parkes

BY Pierce, Schiffler & Parker

ATTORNEYS

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LOCKING MECHANISMS

Gregory Wilson Parkes, 129 Davies Road,
West Bridgford, England

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22 Claims. (Cl. 192—135)

This invention relates to safety devices and is particularly concerned for locking mechanisms employed to prevent access to a machine during operation thereof.

Previous locking mechanisms have suffered from the disadvantage that, although they have been designed to become actuated automatically on starting of the machine, they are liable to become broken or capable of being rendered inoperative, so that access to the machine can be obtained during operation of the machine, to the danger of the operator.

In accordance with the present invention, a safety device for an electrically operated machine comprises a safety member which when in a predetermined position provides protection from the machine, a transformer so arranged that a voltage of prescribed magnitude is induced in a winding only when the safety member is in the predetermined position, and means operated by the voltage of prescribed magnitude in the winding for completing an electrical circuit for the machine.

In a preferred form of the invention, a safety device for an electrically operated machine or the like comprises a movable safety member which when in a predetermined position provides protection from the machine, a locking mechanism which when operated with the safety member in the predetermined position locks the member in that position, a core having a first part in a fixed position and a second part movable with the safety member, the magnetic circuit through the core being completed only when the safety member is in the predetermined position, a primary winding on one of the core parts, a secondary winding on the other core part, an energising circuit for the primary winding, the arrangement being such that a voltage of prescribed magnitude is induced in the secondary winding only when the safety member is in the predetermined position, and means operated by that prescribed voltage for completing an electrical circuit for the machine.

The invention will be more readily understood by way of example from the following description of a locking mechanism in accordance therewith reference being made to the accompanying drawings, in which:

FIGURE 1 illustrates the mechanism,

FIGURE 2 is a circuit diagram showing the electrical connection of the mechanism,

FIGURE 3 shows a device for operating a release solenoid,

FIGURE 4 illustrates a modification of FIGURE 1,

FIG. 5 illustrates a further modification of FIG. 1, and

FIG. 6 illustrates a modification of the electrical control circuit of FIG. 2.

Referring to FIGURE 1, the mechanism consists of two relatively moving parts **12**, **13**, one of which is to be mounted on a stationary part of the machine and the other of which is to be mounted on a part of a machine which is movable relative to the stationary part. For example, part **12** may be attached to a stationary part of the machine indicated at **12***a* such as the machine housing, while part **13** may be attached to a movable guard member indicated at **13***a*, such as a door or other similar safety guard member which, when open, allows access to the machine and the working parts thereof and, when closed, prevents such access.

On part **13**, there are mounted an electromagnet consisting of a core **14** and an energising winding **15**, and

a block **16** containing a recess **17**. The part **12**, on the other hand, carries an armature **18** to which is secured a plate **19**. This plate **19** has at one end a blunt knife edge which is held in a slot **20** by a pair of springs **21**. The armature **18** can pivot about the knife edge although some degree of float is permitted by the nature of the pivotal connection. At the other end, the plate **19** carries a bolt **22** adapted to engage in the recess **17**. The armature **18** has also a winding **23**, the ends of which may conveniently be connected to the springs **21** which then provide the external connections to the coil. This has not been shown in the drawing.

The parts **12**, **13** are so mounted on the stationary part **12***a* of the machine and the guard member **13***a* that, when the guard member is in the closed or safety position, they take up the relative positions shown in FIGURE 1, and, when the bolt **22** is received in the recess **17**, the said elements **17** and **22** constituting the locking mechanism, the guard cannot be moved.

On the supply of alternating current to the winding **15** and provided the guard is in the closed or safety position, the armature is attracted causing the bolt **22** to enter the recess **17**. At the same time, a secondary current is induced in the winding **23**. On de-energisation of winding **15**, springs **21** pull the armature into the position shown, thereby unlocking the guard.

Referring now to FIGURE 2, the start contactors M for the machine are connected in series with normally closed stop contacts **26**, normally open start contacts **27** and normally open contacts Y1 of relay Y, across A.C. supply lines **28**, **29**. The primary winding of a transformer **30** is also connected between start contacts **27** and line **28**. The secondary winding of this transformer **30** is connected across winding **15** of electromagnet **14** and winding **23** of armature **18** is connected to relay Y. Hold contacts M1 of the start contactors M are connected in parallel with start switch **27**.

When start contacts **27** are closed by hand, the electromagnet winding **15** is energised causing the armature **18** to be attracted and locking to take place. As the armature **18** approaches the core of the electromagnet, the flux passing through the armature core and therefore the voltage of winding **23** increases and relay Y is only operated when the armature is fully attracted and bolt **22** enters recess **17**. When relay Y operates, contacts Y1 close and complete a circuit to the start contactors M, which when operated complete a holding circuit through contacts M1. The machine will then continue to operate until stop contacts **26** are opened when the start contactors M open and stop the machine, the electromagnet becomes de-energized, and unlocking takes place. It will therefore be seen that the machine cannot be started until the guard is in the safety position, the start contacts **27** are closed, and the guard is properly locked.

The floating action of the armature **18** permitted by its pivotal connection enables the pole faces of the cores of the electromagnet and armature to seat properly against one another and thereby avoids buzz and chatter. There is also little likelihood of seize up due to corrosion or accumulated dirt.

Covers may be provided for the parts **12**, **13** such that the plane of contact between the faces of the two parts is completely masked on all four sides and it is impossible to insert anything between the faces to jam the lock.

Particularly when the machine is of a kind having moving parts of high inertia and a long run-down time after the current is cut off, it is desirable that the locking mechanism should remain locked after the contactors M are de-energised and until the machine comes to rest. For this purpose, there is illustrated in FIGURE 1 an interlocking means comprising a digit member **32** which is pivoted at **33** and which is biased in a clockwise direc-

tion by spring 34. When the armature 18 is moved into the locking position, the digit member 32 is drawn by spring 34 behind the plate 19 and prevents the lock releasing. Stop 35 limits the clockwise movement of member 32.

Release of the locking member is effected by a slow-to-operate solenoid 36 which is energised when and only when the machine is moving slowly enough and which when energised attracts the lower end of member 32 against the action of spring 34, causes member 32 to move anti-clockwise and frees plate 19 for unlocking movement under the action of springs 21.

Referring to FIGURE 2, the solenoid 36 is connected in series with spring closed contacts 37 and a rectifier 31 across the A.C. supply lines 28, 29. A cam 39 driven by the machine periodically opens contacts 37 so that, so long as the machine continues to move, direct current is supplied only intermittently to the solenoid. While the machine and the cam 39 are moving relatively quickly, the supply of direct current to the solenoid 36 is interrupted by the contact 37 too frequently to allow the slow-to-operate solenoid 36 to become energized. When, however, the machine is put out of operation, it slows down and, when it is moving slowly enough, the solenoid 36 will become energized to permit the unlocking movement described.

In place of the energising circuit for solenoid 36 shown in FIGURE 2, the device illustrated in FIGURE 3 may be employed. In this figure, a pot type magnetic core 38 has a primary winding and a secondary winding wound on to the central limb 40. The primary winding is connected in series with a switch 41 across the D.C. supply lines W and X, while the secondary winding is connected to the solenoid 36 which, in this case, is quick-operating. The centre limb 40 and the outer annular wall of the core 38 are bridged by a plate 42 of non-magnetic material having teeth 43 on its lower face. A rotary armature 44 is carried on a spindle 45 and is held away from core 38 by a compression spring 46. The armature is driven by the machine and has projecting pins 47 on its upper face designed to cooperate with the teeth 43.

When the operator requires to obtain access to the machine, he closes switch 41 which completes the circuit through the primary winding. If the armature 44 is stationary, it is attracted towards the core 38, the pins 47 are received between the teeth 43 with the result that the armature 44 seats on the core 38 and completes the magnetic circuit. On release of switch 41, the stored flux in the magnetic circuit collapses causing a current to pass through the secondary winding and the solenoid 36. The digit member 32 is operated and the locking mechanism released. If, on the other hand, the machine is still moving, the pins 47 ride over the teeth 43 and the armature 44 is prevented from seating on core 38. The magnetic circuit remains incomplete and insufficient magnetic energy is stored in the circuit to operate solenoid 36, when switch 41 is released.

As the energisation of solenoid 36 depends in all cases on the supply of direct current from lines W and X, the failure of the electrical supply ensures that the machine remains safely locked. As a result, access to the machine during running down is prevented, even following de-energisation of the machine caused by a power failure.

In the arrangement of FIGURE 1, the armature 18 is biased into the unlocked position by springs 21. It is also possible to have the locking mechanism biased into the locking position, the bolt 22 then taking the form of a spring lock, of the "Yale" type for example, to permit closing of the guard. FIGURE 5 illustrates such a modification of FIGURE 1, in which modification springs 21*a* are under compression to bias the armature into the locked position, as shown. In this case, it is unnecessary to have an electromagnet to attract the locking member into locking position. However, core 14, armature 18, and associated windings 15, 23 are still provided to ensure that the contactors M are not operated until the guard is properly locked in position, although the core and armature may now be smaller since no spring bias has to be overcome.

Unlocking may be effected manually, in which case premature unlocking may be prevented by a mechanism such as the digit member 32 and solenoid 36 shown in FIGURE 5 for this purpose. Alternatively, the armature may be with drawn against the action of springs 21*a* by a solenoid energised when contactors M are de-energised, or when the machine slows sufficiently. Again, opening of the lock may be obtained by passing current through the windings 15, 23 in such relative phase that the armature 18 is driven away from core 14.

FIGURE 6 shows a modification of FIGURE 2 for effecting the latter operation. In this modification, a further relay N connected between the stop and start contacts 26, 27 and having two pairs of contacts N1, N2, as shown. On closing the start contacts 27, relay N is energised and contacts N1, N2 adopts the other positions from those shown so that the circuit is of the form of FIGURE 2 to initiate the machine if the guard member is closed. On opening the stop contacts 26, relay N is immediately de-energised and contacts N1, N2 adopt the positions shown in which they connect windings 15, 23 across A.C. supply lines 28, 29 in appropriate sense to magnetise core 14 and armature 18 for mutual repulsion against the bias of springs 21*a*.

It will be noted that unlocking will not be effected until energisation of solenoid 36 if the digit member 32 mechanism is employed, but in any event the arrangement, when unlocked in this manner is maintained unlocked until subsequent closure of start contacts 27 with the guard in its closed position.

Operation of the locking member may be effected manually both for locking and unlocking the guard. In this case the armature 18 is interlocked with the locking member so that the armature cannot mate with the core 14 and cause energisation of the contactor M until locking has occurred. An example of such an arrangement is shown in FIGURE 4 where the locking member takes the form of a bolt 48 slidable in one of the two parts to be locked together and receivable in a slot 49 in the other part. The bolt 48 has a handle 50 and a recess 51 which can receive one arm of a cranked lever 52 pivoted at 53. The pivoted armature 18 has a projecting part 54 which engages the other arm of lever 52 when the armature moves towards the core 14. Provided that the two parts to be locked are in the required position and the bolt in the locking position, the armature 18 can pivot clockwise, the lever 52 pivoting into recess 51, and the contactor M is operated by the voltage induced in winding 23, as described in relation to FIGURES 1 and 2. If however the bolt 48 is not in locking position, pivoting of the armature 18 is prevented by the engagement of lever 52 with an unrecessed part of bolt 48. Similarly, withdrawal of the bolt 48 into unlocking position is prevented by the engagement of lever 52 with one end of recess 51 until armature 18 is released by the operation of stop contacts 26.

I claim:

1. A safety device for use with a machine having a stationary member and a guard member movable relative to said stationary member between a closed position in which access to at least a part of the machine is prevented and an open position permitting such access, and having also an electrical control circuit so arranged that the machine can be put into operation only when the electrical control circuit is electrically energised, said safety device comprising a first transformer core portion adapted to be carried by said stationary member of the machine, a second transformer core portion adapted to move together with the movable guard member and adapted to move into close flux-carrying relationship with

said first transformer core portion to form a substantially closed magnetic circuit only when said movable guard member is in its closed position, a transformer primary winding wound upon one of said transformer core portions, an A.C. supply connectable to said transformer primary winding, a transformer secondary winding wound upon one of said transformer core portions and so arranged that an alternating voltage of prescribed magnitude is induced in that winding from said transformer primary winding only when said transformer core portions are in said close flux-carrying relationship, and energization means connected to said transformer secondary winding and adapted to electrically energize said electrical control circuit to put said machine into operation only when said alternating voltage of prescribed magnitude is induced in said transformer secondary winding.

2. A safety device according to claim 1, which includes a locking mechanism adapted to operate automatically, whenever said movable guard member is moved to its closed position, to lock said movable guard member in that position.

3. A safety device according to claim 2, in which said locking mechanism includes two co-operating locking members, and one of said transformer core portions is arranged to be relatively movable into and away from said close flux-carrying relationship with the other transformer core portion together with one of said co-operating locking members.

4. A safety device according to claim 3, which includes pivoting means whereby said relatively movable transformer core portion is made pivotally movable relatively to said other transformer core portion.

5. A safety device according to claim 4, in which said pivoting means pivotally connects said relatively movable transformer core portion to said stationary member of the machine.

6. A safety device according to claim 5, which includes spring means operatively connected to said relatively movable transformer core portion and arranged to tend to cause that core portion to move away from said close flux-carrying relationship with the other transformer core portion.

7. A safety device according to claim 6, which includes an electro-magnet constituted by one of said transformer core portions and by said transformer primary winding which is wound upon that core portion, and which includes a co-operating armature constituted by the other transformer core portion and capable of being attracted by the electro-magnet whereby said transformer core portions can be drawn into said close flux-carrying relationship by the action of said electro-magnet.

8. A safety device according to claim 5, which includes spring means operatively connected to said relatively movable transformer core portion and arranged to tend to cause that transformer core portion to move into said close flux-carrying relationship with the other transformer core portion.

9. A safety device according to claim 1, in which one of said transformer core portions is arranged to be relatively movable into and away from said close flux-carrying relationship with the other transformer portion, the safety device including a locking mechanism adapted to lock said movable guard member in it closed position, and including interlocking means operably connected to said relatively movable transformer core portion and to said locking mechanism so as to prevent unlocking of said locking mechanism until operation of the machine has substantially terminated.

10. A safety device according to claim 9, in which said interlocking mechanism is also arranged to prevent said relatively movable transformer core portion from moving into said close flux-carrying relationship with the other transformer core portion unless said locking mechanism is first operated.

11. A safety device according to claim 9 and wherein said interlocking means includes a release solenoid arranged, when electrically energized, to permit release of the locking mechanism.

12. A safety device according to claim 11 which includes a main electrical supply by means of which the machine is put into operation, and which includes an auxiliary electrical supply capable of electrically energizing said release solenoid, the arrangement being such that said auxiliary electrical supply is derived from said main electrical supply, whereby, if said main electrical supply fails while said locking mechanism is operated, said auxiliary electrical supply also fails so that the release solenoid cannot be electrically energized to permit release of the locking mechanism.

13. A safety device according to claim 11, which includes an auxiliary electrical supply connected to and capable of electrically energizing said release solenoid, and contact means for interrupting the connection of said auxiliary electrical supply to the release solenoid, the contact means being adapted to be operated in response to the putting into operation of the machine, and the arrangement being such that the contact means permits operation of the release solenoid by the auxiliary electrical supply only when the operation of the machine has substantially terminated.

14. A safety device as claimed in claim 11, which includes a transformer-like device including primary and secondary windings and an associated magnetic circuit, the magnet circuit comprising a stationary core member and a rotary bridging member for the stationary core member, the rotary bridging member being adapted to be driven by the machine and being movable between two positions in only one of which the rotary bridging member co-operates with the stationary core so as to complete the magnetic circuit, the safety device also including means preventing the bridging member from taking the said one position while the bridgeing member continues to be rotated by the machine, the secondary winding of the transformer-like device being connected to the release solenoid, and the primary winding of the transformer-like device being connected to a further electrical supply through manually operable contacts .

15. A safety device as claimed in claim 14, in which the said further electrical supply is a D.C. supply.

16. A safety device as claimed in claim 11, which includes means adapted to be operated by the said electrical control circuit, and which is arranged to electrically energize the release solenoid to permit release of the locking mechanism only when the electrical control circuit is not electrically energized.

17. A safety device as claimed in claim 9, which includes electrical circuit means which is connected to at least one of said transformer primary and secondary windings and which is arranged when operated to cause electrical currents in anti-phase to pass through said transformer primary and secondary windings whereby release of the locking mechanism is effected.

18. A safety device as claimed in claim 2, in which said locking mechanism comprises a projection and a co-operating slot.

19. A safety device as claimed in claim 2 in which said locking mechanism comprises a spring lock.

20. A safety device according to claim 1, in which one of said transformer core portions carries said transformer primary winding, and the other of the transformer core portions carries said transformer secondary winding.

21. A safety device according to claim 1, in which said energization means comprises relay means operable by said alternating voltage of prescribed magnitude.

22. A safety device according to claim 21, in which said relay means comprises a starting contactor for the machine.

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