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SOUND RESPONSIVE CODED SIGNAL MINE

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FIG. 1.

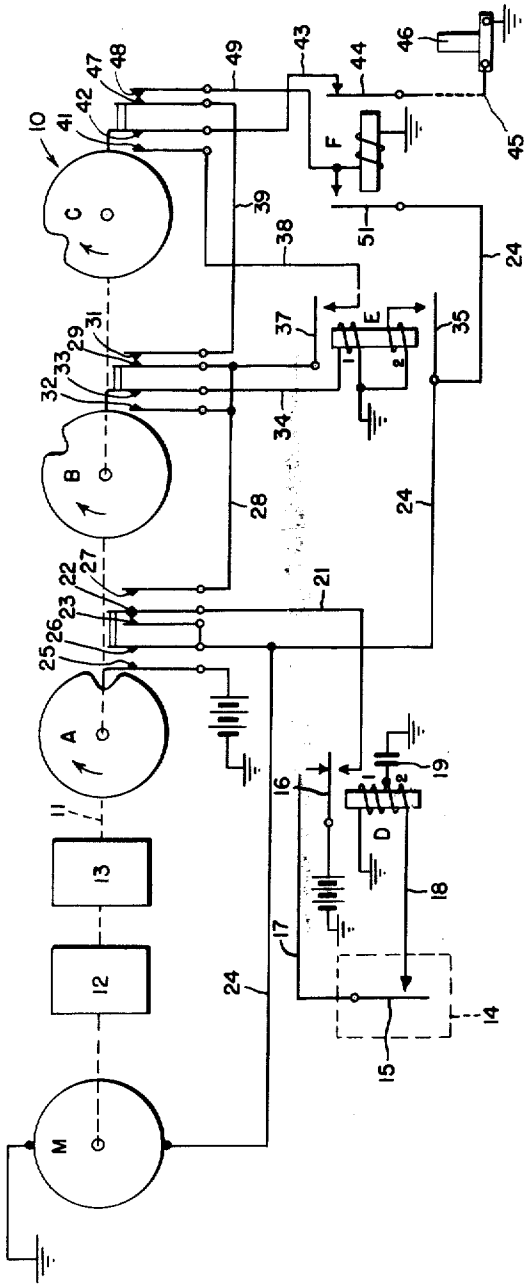
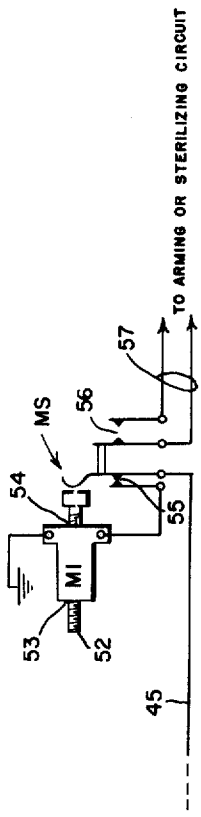


FIG. 2.



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SOUND RESPONSIVE CODED SIGNAL MINE

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This invention relates to a demolition device and more particularly to a demolition device adapted to be used as a component in a mine in which the device is employed to fire or sterilize the mine, as the case may be, in response to a coded signal comprising a series of impulses received in predetermined time spaced relation from underwater explosions or signals such as may be produced by the use of hand grenades, depth charges, sonar signaling devices or any other suitable signal device adapted to produce or initiate the production of underwater noise.

In devices of this character heretofore devised for use with mines employing ship counters and delayed arming devices, considerable difficulty has been experienced in sweeping such mines within short periods of time by reason of the fact that, in the case of mines employing ship counters, the mine sweeping operation must be repeated until the ship counter has been actuated to a predetermined firing position and, in the case of mines employing delayed arming devices, the mines can not be swept until the mine is armed at the completion of the arming period.

The foregoing difficulties are obviated by the demolition device of the present invention which is arranged to fire the mine instantly when a predetermined coded signal comprising a plurality of impulses in predetermined time spaced relation with respect with one another, has been received from any suitable signal generating source. The arrangement of the present invention also prevents the mine from being swept by impulse signals which do not correspond to the predetermined coded pattern.

One of the objects of the present invention is to provide a new and improved demolition device for use as a component of a mine for arming, sterilizing or firing a mine selectively in response to underwater coded signals which may be initiated at a remote distance from the mine.

Another object is to provide means for firing a marine mine immediately in response to coded signals received through the water regardless of the armed condition of the mine.

Another object is to provide a new and improved device for controlling a plurality of circuits in predetermined time delayed relation after a starting impulse has been received in which a control circuit is closed selectively in accordance with the time spaced characteristics of a plurality of additional impulses received by the device.

A still further object is to provide a timing mechanism operable in unit cycles adapted to close a control circuit for a mine in response to a pair of impulses received by the mechanism in time coded relation during one of said cycles.

A still further object is to provide a new and improved demolition device for a mine selectively responsive to coded impulses which will be economical to manufacture, reliable in operation and which possesses all of the qualities of ruggedness and durability in service.

Still other objects, advantages and improvements will be apparent from the following description, taken in connection with the accompanying drawings, of which:

FIG. 1 is a circuit diagram of the complete device according to a preferred embodiment thereof as employed for firing a mine; and,

FIG. 2 is a circuit arrangement in which the device of FIG. 1 is employed to arm or sterilize a mine, as the case may be.

Referring now to the drawings for a more complete understanding of the invention and more particularly to FIG. 1 thereof, there is shown thereon a timing or demolition device indicated generally by the numeral **10** comprising a plurality of cams A, B and C secured to a shaft **11** and adapted to be rotated through one revolution from an initial starting position during a cycle of operations of the device. The cams are operated by an electric motor M through a reduction gearing **12** to which the shaft **11** is connected, a governor **13** of any type suitable for the purpose, preferably being employed to control the rate of movement of the shaft **11** whereby the cams A, B and C make one revolution during a predetermined period of time such, for example, as 60 seconds.

Each of the cams A, B and C controls the operation of a plurality of switching elements comprising pairs of electrical contacts adapted to be moved into engagement or disengagement with each other, as the case may be, during a revolution of the cams. The contact elements associated with cam A, for example, are operated within two seconds after cam A moves away from the initial home position thereof and are restored to their initial settings as the cam A returns to the home position. The contact elements of cam B are closed for a short period of time, such as 5 seconds, when an interval of 10 seconds has elapsed after the device has been set in operation. The contact assemblies of cam C are operated for a short period of time such as 5 seconds when the device has been in operation for a period of 20 seconds. The purpose of the operation of the switching assemblies of cams A, B and C in predetermined time delay relation in the order named, will be more clearly apparent as the description proceeds.

The device of FIG. 1 is well adapted for use with a marine mine to control the firing of the mine or arming of the mine or such other function as may be desired in response to a series of impulses or waves of pressure received through the surrounding water by the vibration responsive sound pickup device **14** which may be of any type suitable for the purpose and preferably secured to the casing of the mine in which a pair of normally open contacts **15** are brought into engagement with each other in response to a pressure signal or a shock received through the surrounding water. The contacts **15** are connected to a relay D adapted to be operated as the contacts **15** are closed and apply a control signal to the demolition device in response to each impulse of predetermined character received by the sound pickup device **14**. There are also provided a pair of relays E and F having the operating windings thereof connected to the contact assemblies controlled by cams B and C respectively, the purpose of which will be clearly apparent as the description proceeds.

When a series of impulses are received in predetermined time delayed relation by the device **14**, a circuit is closed by way of a pair of normally closed contacts on baffle relay F during a cycle of operations of the demolition device which was set in operation by the first one of these impulses. In FIG. 1 is shown an arrangement of this circuit which causes the mine to be detonated. It will be understood, however, that if the series of impulses are not received in predetermined time coded relation, this circuit will not be closed. The manner in which this is accomplished will be more clearly apparent by a consideration of the following example.

Let it be assumed, by way of example, that it is desired to explode a mine field just prior to the passage of a fleet of vessels which it is desired to move across the mine area without injury to the vessels as a result of the explosion of the mines and that each of the mines is provided with a demolition device of FIG. 1. This may

be accomplished by setting off a series of underwater explosions within the vicinity of the mines in predetermined time spaced relation such that, in the example, the second explosion will occur 10 seconds after the first explosion and the third explosion will occur 20 seconds after the first explosion. Each of the aforesaid explosions may be produced by a hand grenade, a depth charge or other underwater shock producing devices adapted to initiate an impulse or pressure signal within the water of sufficient strength to operate the vibration responsive sound pickup device **14**.

The closure of contacts **15** of the device **14** in response to the first coded signal received, closes a circuit from positive battery at armature **16** and break contact of relay D, conductor **17**, contacts **15** of the sound pickup device, conductor **18** and thence through windings **2** and **1** of relay D to ground thereby causing relay D to operate and condenser **19** to charge. As armature **16** of relay D moves away from its break contact, condenser **19** discharges through winding **1** of relay D thereby preventing the release of relay D until condenser **19** has discharged to a predetermined value through winding **1** of the relay which is of a high resistance. Relay D is thus slow releasing while retaining a quick operating characteristic whereby the relay is operated in response to a momentary closure of the contacts **15** of the sound pickup device.

As armature **16** of relay D moves into engagement with its make contact, positive battery is applied to conductor **21**, normally closed contacts **22** and **23** of cam A, conductor **24**, to the motor M and thence to ground thereby setting the motor into operation and causing the device to start a cycle of operations. As cam A moves away from its initial home position, contact **25** controlled thereby is moved into engagement with contact **26** thereby maintaining battery on conductor **24** until a cycle of operations has been completed. As contact **22** moves away from contact **23**, conductor **21** is disconnected from conductor **24** and as contact **22** moves into engagement with contact **27**, conductor **21** is connected to conductor **28**. The condenser **19**, it will be understood, is of such size as to cause relay D to release before contact **22** engages contact **27**.

When the device has been in operation for 10 seconds, the contact assemblies of cam B are operated, contact **29** moving away from contact **31** and contact **32** being engaged by contact **33**. As relay D operates in response to the closure of contacts **15** of the sound pickup device as the second signal is received, positive battery is applied to conductor **21**, contacts **22** and **27** of cam A, conductor **28**, contacts **32** and **33** of cam B, conductor **34**, winding **1** of relay E and thence to ground thereby causing relay E to operate. As armature **35** of relay E moves into engagement with its make contact, a circuit is closed from battery on contacts **25** and **26** of the cam A contact assembly, conductor **24**, armature **35** and make contact of relay E, winding **2** of relay E and thence to ground thereby causing relay E to lock until the cycle of operations of the device has been completed. As armature **37** of relay E engages its make contact, conductor **28** is connected to conductor **38** but this circuit performs no useful function at this time for the reason that conductor **38** is connected to an open contact of cam C.

Fifteen seconds after the cycle of operations of the device has been initiated, the contact assemblies of cam B are restored to the positions shown on FIG. 1. As contact **33** moves away from contact **32**, conductor **28** is disconnected from conductor **34** and as contact **29** of cam B engages contact **31**, conductor **28** is connected to conductor **39**. Armature **16** of relay D, in the assumed example, has moved away from its make contact thereby removing battery from conductor **21** before contacts **29** and **31** of cam B are engaged at the completion of the fifteen second interval whereby relay F is not operated at this time.

When a period of 20 seconds has elapsed after the cycle of operations has been initiated, the contact assemblies of cam C are operated and let it be assumed also, for the purpose of description, that concurrently therewith the sound pickup device **14** operates in response to the third signal received through the surrounding water. The operation of relay D at armature **16** and make contact thereof now applies battery to conductor **21**, contacts **22** and **27** of cam A, conductor **28**, armature **37** and make contact of relay E, conductor **38**, contacts **41** and **42** of cam C contact assemblies, conductor **43**, break contact and armature **44** of relay F, conductor **45**, electroresponsive detonator **46** and thence to ground thereby operating the detonator and firing the mine as the third impulse is received.

In the event that the enemy should attempt to fire the mine by a series of random explosions, the device would be set in operation in response to the first one of these explosions and perform at least one unit cycle of operation. If the second explosion should be received before the 10 second interval of the assumed example has elapsed, contact assemblies A will be operated and contact assemblies B and C will be unoperated. The operation of relay D in response to this second explosion applies battery to conductor **21**, contacts **22** and **27** of cam A, conductor **28**, contacts **29** and **31** of cam B, conductor **39**, contacts **47** and **48** of cam C, conductor **49**, to the winding of relay F and thence to ground thereby causing relay F to operate and lock by way of its make contact and armature **51** to battery on conductor **24**. Relay F thus remains operated until contact **25** of cam A is disengaged from contact **26** at the completion of the cycle of operation of the device. As armature **44** of relay F moves away from its break contact, the firing circuit to the detonator **46** is interrupted and the mine is thus prevented from being fired by explosive signals during the remainder of the cycle of operations of the device regardless of whether a subsequent explosion should occur at the completion of the 10 second interval and thereby operate relay E.

Let it now be assumed that the second explosion initiated by the enemy occurred during the time the cam B contacts were operated thereby causing relay E to operate and lock to battery on conductor **24** and, furthermore, that the third explosion occurs before the cam C contacts operate. In such a case the operation of relay D would cause relay F to operate and interrupt the firing circuit. Relay F locks until battery is removed from conductor **24** at contacts **26** and **25** of cam A as the cam moves into its home position thereby baffling the firing circuit and preventing firing of the mine in response to any additional explosions which the enemy might initiate during the remainder of the cycle of operations of the device.

In the event that the second explosion should occur after the cam C contacts had been restored to their initial settings and during the remaining portion of the cycle of operations of the device, the operation of relay D in response to the signal caused by this explosion would not cause the mine to be fired for the reason that the firing circuit is open at contacts **41** and **42** of cam C.

On FIG. 2 is shown an arrangement whereby the device of the present invention may be employed to arm or sterilize a mine, as the case may be, the arrangement comprising a motor driven switch MS adapted to close a pair of contacts in response to a flow of current received over conductor **45**. The switch mechanism comprises an electric motor MI having a shaft **52** in threaded engagement with a pair of bearing surfaces at **53** and **54** respectively whereby the shaft is moved axially as the motor operates sufficiently to operate the switch contact assemblies **55** and **56**. When battery is applied to conductor **45** by relay D at armature **16** and make contact thereof, FIG. 1, a circuit is closed by way of contacts **55** of switch MS and the winding of motor MI to ground thereby setting the motor

in operation and causing the shaft **52** thereof to be moved rotatably and axially in a direction to disengage contacts **55**. When this occurs the circuit to the motor MI is interrupted but the motor armature conductor continues to rotate by reason of the inertia thereof sufficiently to cause contacts **56** to close. The closure of contacts **56** establishes an electrical connection between the pair of conductors **57**. When the device is used to arm a mine the contacts **56** may be conveniently arranged in series with the battery of the mine whereby closure of these contacts causes the mine to be armed.

When it is desired to employ the arrangement of FIG. 2 for sterilizing a mine, the conductors **57** may be connected to the terminals of the battery whereby the operation of the motor switch MS causes the battery to be short circuited and the mine to be rendered sterile. Whereas in FIG. 2 is shown a pair of normally open contacts **56** adapted to be closed in response to the operation of the motor MI, it will be understood that, if desired, the motor MI may be employed to open a normally closed pair of contacts to arm the mine, in which case the conductors **57** would be connected to the terminals of the electroresponsive detonator and the detonator would be short circuited by the contacts **56** at all times prior to the operation of motor MI. It will now be clearly apparent that the arrangement of FIG. 2 is well adapted to arm or sterilize a marine mine in response to a series of pressure waves or impulses received in predetermined time spaced relationship through the surrounding water by the sound pickup device **14** employed with the device of FIG. 1.

Whereas the invention has been described in particularity in reference to a timing mechanism operable in unit cycles of 60 seconds in which cam B causes its contact assemblies to operate 10 seconds after a starting impulse has been received and cam C causes its contact assemblies to operate 20 seconds after a starting impulse has been received, it will be understood that this has been done for the purpose of description and that the cams B and C may be adjusted on the shaft **11** to operate their associated contacts when any desired intervals of time have elapsed after the starting impulse has been received thereby to vary the coded signal required for actuation of the electroresponsive device connected to conductor **45**. Furthermore, the time of rotation of the shaft **11** through one complete revolution thereof may be varied by varying the ratio of the speed reduction gearing **12**.

Briefly stated in summary, the invention discloses a new and improved timing mechanism and circuit means controlled thereby adapted to explode a mine in response to a plurality of impulses received through the water in predetermined time spaced relationship and which is also suitable for arming or sterilizing a mine, as the case may be.

The invention may be advantageously employed in a mine field in which the mines comprising the field are provided with demolition devices having different time periods during which the coded signals are effective to demolish the mine. For example, the mines comprising the mine field may be arranged in three groups and the mines of group 1 may be demolished by a coded signal comprising two intervals of 10 and 20 seconds respectively after the first signal has been received, the mines of group 2, 15 and 25 seconds and the mines of group 3 may be demolished by a coded signal having intervals of 18 and 45 seconds respectively. With this arrangement, the accidental demolition of a group of mines in response to a fortuitous coded signal initiated by the enemy might lead the enemy to believe that all mines in the field had been swept in response to his sweeping operations whereas the waters would in fact be fatal to his shipping by reason of the remaining unexploded mines within the mined area. To accomplish this result it is merely necessary to adjust the cams B and C of the timing device on the shaft **11** to different settings corresponding to the desired intervals between the impulses comprising the coded signals.

While the invention has been described with reference to two particular examples thereof which give satisfactory results, it will be understood by those skilled in the art, after understanding the invention, that various changes and modifications may be made without departing from the spirit and scope of the invention and it is intended, therefore, that the appended claims cover all such changes and modifications.

The invention herein described and claimed may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. In a system of the character disclosed for firing a mine selectively in response to a plurality of signals received through the surrounding water in consecutive order and in predetermined time spaced relation, a signal receiving circuit including a control relay, a timing mechanism connected to said relay and operated thereby as the first of said signals is received, a circuit closing device on said timing mechanism connected to said control relay, means on said mechanism for operating said circuit closing device momentarily while the timing mechanism is in operation, a second relay connected to said circuit closing device for operation by the control relay while the circuit closing device is momentarily operated, a second circuit closing device on the timing mechanism and electrically connected to said second relay, means on said mechanism for operating said second circuit closing device momentarily in predetermined time delayed relation with respect to the time of operation of the first named circuit closing device, means including a pair of normally open contacts on said second relay for establishing an electrical connection between said second circuit closing device and the control relay while the second relay is operated, and an electroresponsive detonating device operatively connected to said second circuit closing device for operation by the control relay while the second circuit closing device is operated.

2. In a mine firing system adapted to be controlled by signals received in predetermined time sequence through the surrounding water, in combination, a signal receiving circuit including a relay, a control circuit connected to said relay and closed as each of the signals is received, a cyclic timing device, said control circuit electrically connecting the relay to said timing device for setting the timing device in operation as the control circuit is closed in response to the first one of the signals received by the signal receiving circuit, a second relay, means on the timing device for momentarily switching the control circuit into connection with said second relay to momentarily connect the second relay to the first named relay in response to a second signal received by the receiving circuit during a cycle of operations of the device, means on the timing device for maintaining the second relay operated until said cycle of operations has been completed, additional switching means on the timing device, means on the timing device for momentarily operating said additional switching means during the remainder of the cycle of operations, means on said second relay for connecting the control circuit to said additional switching means as the second relay operates, and electroresponsive detonating means connected to said second circuit closing means for operation by the first named relay over said control circuit in response to a third signal received by the receiving circuit while the additional circuit closing means is operated.

3. In a system for firing a mine in response to a plurality of signals received in consecutive order through the surrounding water in predetermined time spaced relation, in combination, a cyclic timing device comprising a driving means, a plurality of cams connected in driven relationship with said means, two cam controlled contact assemblies operatively connected to said cams for momentary operation in predetermined successive order dur-

ing a cycle of operations of the device, a signal receiving circuit including a relay, a control circuit connected to said relay for closure of the control circuit as each of said signals is received, means connecting said driving means to the control circuit for setting the device in operation as the control circuit is closed in response to the first signal received, means for switching the control circuit to a first one of said contact assemblies during said cycle of operations, means effective when a second signal is received while the first contact assembly is operated for switching the control circuit to the second one of said contact assemblies, and an electroresponsive detonating device momentarily connected to said control circuit by the second contact assembly whereby the detonating device is operated as the control circuit is closed by the relay in response to a third signal received while the second contact assembly is operated.

4. In a system of the character disclosed for arming a mine in response to a plurality of signals received in succession through the surrounding water in predetermined time delayed relation, in combination, signal receiving means including a relay adapted to close a control circuit as each of the signals is received, a cyclic timing device, means for setting the device in operation as the control circuit is closed in response to the first signal received, a pair of circuit closing devices on said timing device adapted to be operated momentarily in successive order during a cycle of operations of the device, means for switching the control circuit to the first one of said circuit closing devices as the timing device is set in operation, means effective when a second signal is received while the first circuit closing device is operated for switching the control circuit to the second circuit closing device, an output circuit connected to the second circuit closing device and adapted to be momentarily connected to said control circuit as the second circuit closing device operates, a motor switch connected to said output circuit and adapted to be operated as the control circuit is closed by the first named relay in response to a third impulse received while the second circuit closing device is operated and means on said motor switch for closing an arming circuit for the mine as the motor switch is set in operation.

5. In a system for sterilizing a mine by shorting the battery thereof in response to a plurality of signals received in predetermined time delay sequence through the surrounding water, a control circuit, a signal responsive circuit including a relay for receiving said signals and for closing said control circuit concurrently therewith, a cyclic timing device connected to the control circuit for operation as the control circuit is closed in response to the first one of said signals received, a pair of switching devices on said timing device and connected thereto for momentary operation in successive order during a cycle of operations of the timing device, means for switching the control circuit to the first one of said switching devices as the timing device is set in operation, means effective while the first one of the switching devices is operated for connecting the control circuit to the second one of said switching devices in response to a second signal received while the first switching device is operated, a motor driven switch connected through said second switching device to the control circuit for operation as the control circuit is closed by said first named relay in response to a third impulse received while the second switching device is operated, a normally open sterilizing circuit for starting said battery as the circuit is closed, and means on said motor driven switch for closing said sterilizing circuit as the motor switch is set in operation.

6. In a device of the character disclosed for operating a mine system in response to a predetermined number of signals received in succession through the surrounding water in predetermined time spaced sequence, in combination, a signal circuit including signal responsive means and a relay controlled thereby, a control circuit connected to said relay for closure thereof when the relay is energized in response to a signal received by said signal responsive means, unit cycle means connected to the control circuit for operation during a predetermined time interval, a plurality of circuit closing devices operatively connected to said unit cycle means for operation thereby in said predetermined time spaced sequence, and an output circuit closed progressively from said control circuit by said circuit closing devices as the circuit closing devices are sequentially closed in said predetermined time spaced sequence whereby the output circuit is closed when the final signal of the sequence is received.

7. In a system for firing a mine selectively in response to a plurality of signals received through the surrounding water in consecutive order and in predetermined time spaced relation, signal receiving means including a pair of normally open contacts adapted to be closed as the signal is received, a control relay connected to said contacts for operation as the contacts are closed, said relay having a pair of normally open control contacts thereon, a source of electrical power connected to one of said control contacts, a timing mechanism connected to the other one of said control contacts and adapted to be set in operation by the control relay as the contacts are closed in response to the first of said signals received by said signal receiving means, means including a cam operated switch on said timing mechanism for causing the timing mechanism to continue operation until a cycle of operations thereof has been completed, a pair of normally open cam actuated contacts on the timing mechanism adapted to be closed momentarily when a predetermined period of time has elapsed after the timing mechanism has been set in operation, a control circuit connected between one of said cam actuated contacts and said other control contact, a second relay connected to the other one of said cam operated contacts for operation as the last named contacts are closed and the control relay is operated in response to a subsequent signal concurrently received by the signal receiving means, means for maintaining said second relay operated until the timing mechanism has completed said cycle of operations, a second pair of cam actuated contacts on the timing mechanism adapted to be momentarily closed in predetermined time delayed relation with respect to the time of closing of the first named cam actuated contacts, means including a pair of normally open contacts on said second relay for establishing an electrical connection between said second cam actuated contacts and the control relay while the second relay is operated, and an electroresponsive detonating device connected to said second cam actuated contacts whereby the detonating device is operated by power from the contacts of the control relay should the control relay be operated in response to a signal received by the signal receiving means while said second cam actuated contacts are closed.

8. In a system for selectively firing a mine, a signal receiving means having a pair of signal actuated normally open contacts, a signal responsive circuit connected to said contacts and including a relay provided with a pair of normally open control contacts, a unit cycle timing mechanism having a plurality of sequentially operated switch closing means and a plurality of normally open switches connected to the switch closing means for actuation in a predetermined time spaced sequence, and an output circuit connected through said normally open switches for progressive closure of the output circuit when the signal receiving means receives a plurality of signals through the surrounding water in said predetermined time spaced sequence.

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