

June 26, 1928.

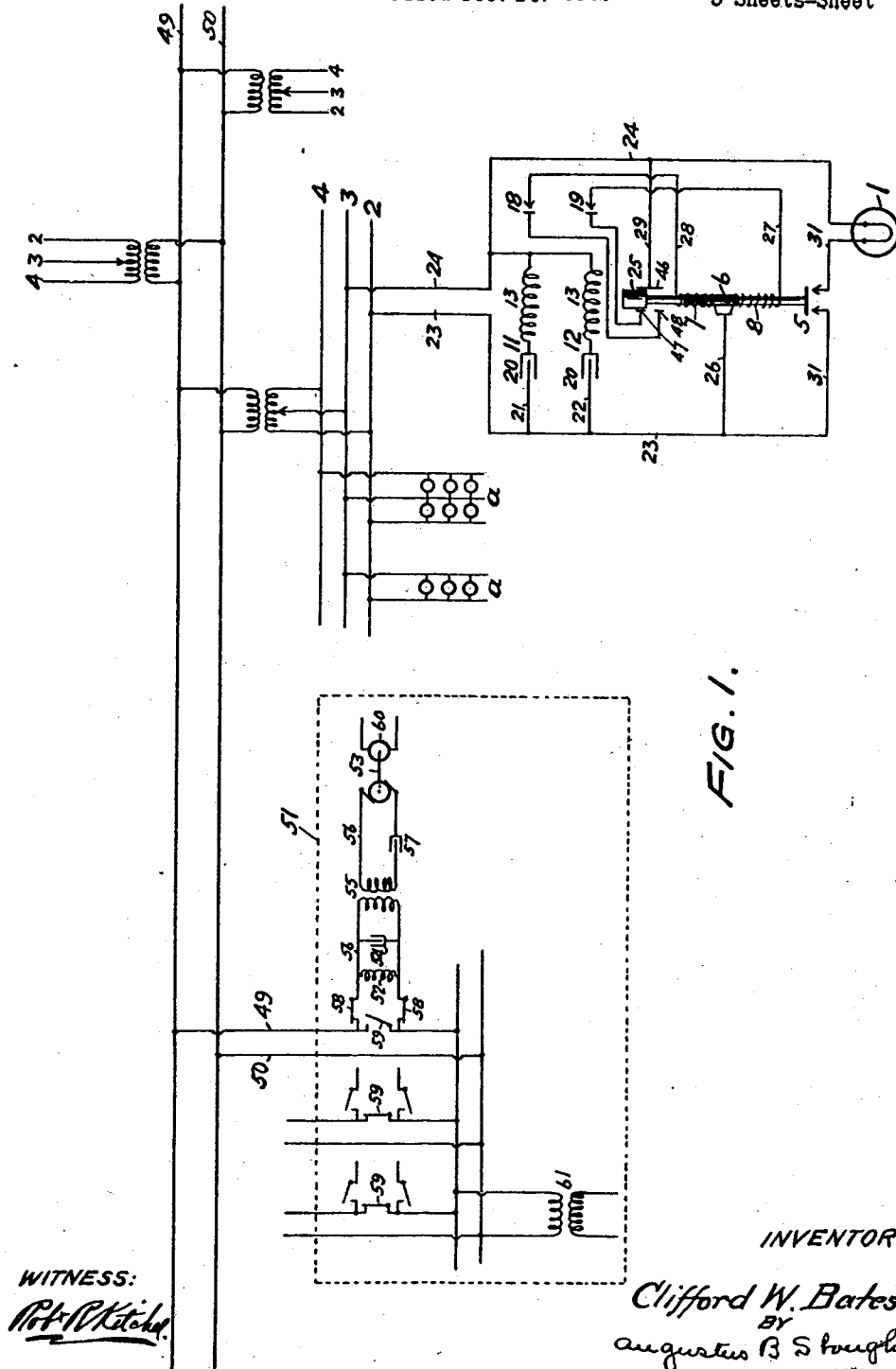
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REMOTE CONTROL SWITCH APPARATUS

Filed Dec. 14, 1922

3 Sheets-Sheet 1



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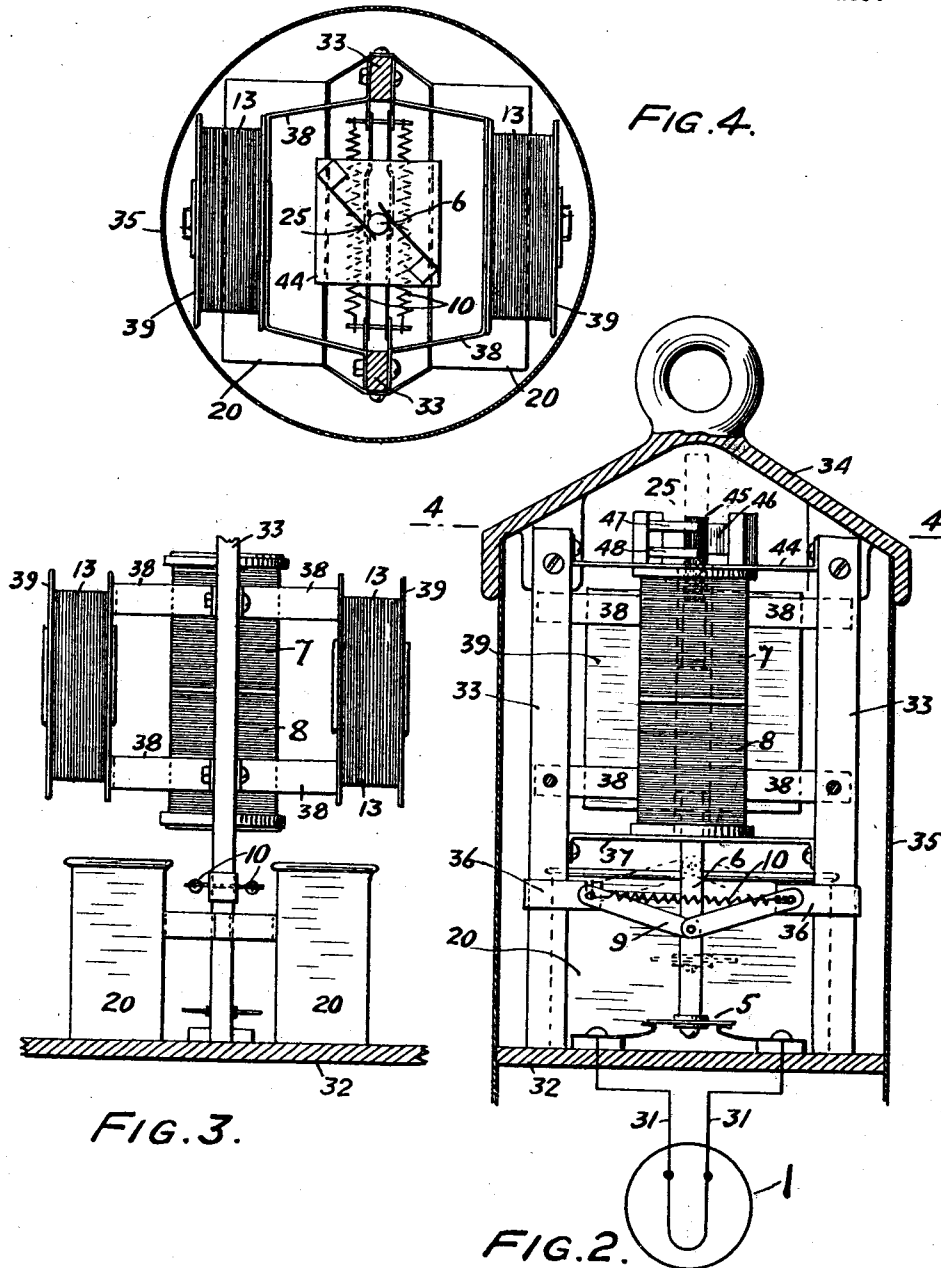
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REMOTE CONTROL SWITCH APPARATUS

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3 Sheets-Sheet 2



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REMOTE CONTROL SWITCH APPARATUS

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3 Sheets-Sheet 3

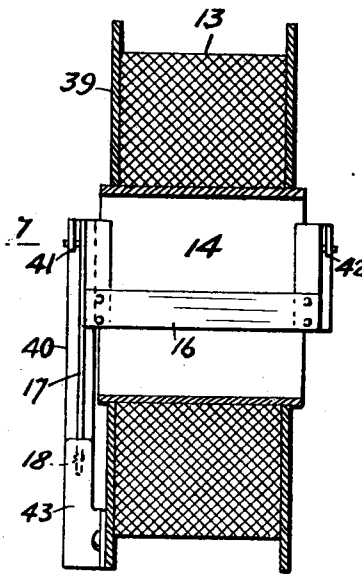
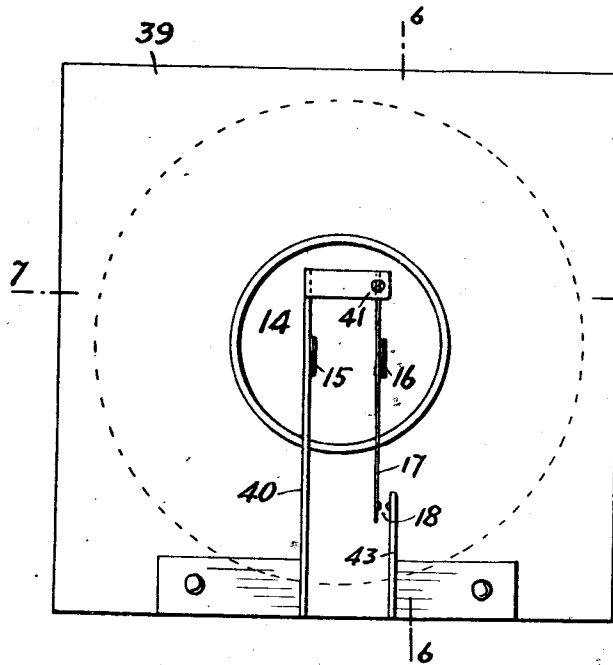
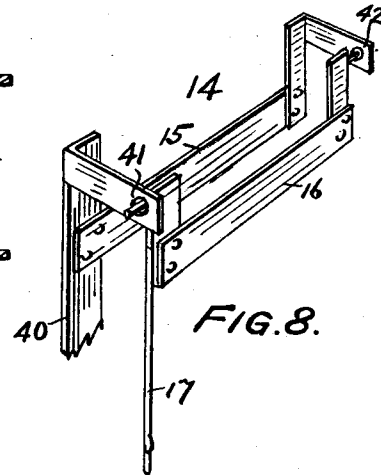
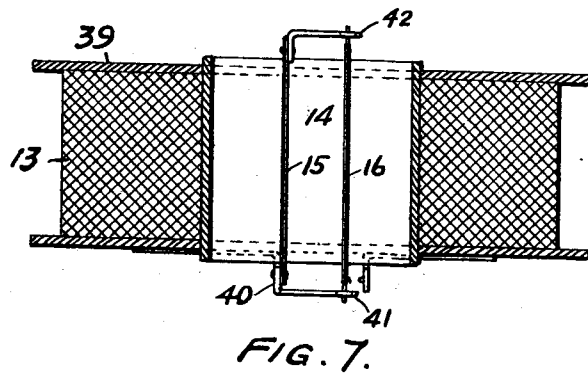


FIG. 5.

FIG. 6.

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## UNITED STATES PATENT OFFICE.

CLIFFORD W. BATES, OF NARBERTH, PENNSYLVANIA.

## REMOTE-CONTROL SWITCH APPARATUS.

Application filed December 14, 1922. Serial No. 606,801.

In a remote control switching system which has been proposed, use is made of a resonant relay which operates only when a voltage of a predetermined frequency is impressed on the relay, thus avoiding the necessity of pilot wires for the operation of the switch.

The object of my invention is to provide a satisfactory remote control switch apparatus including one or more resonant relays, switches operated by the relays, and means for impressing a suitable operating voltage of the required frequency upon the electrical distribution system to which the relays are connected.

My invention will be claimed at the end hereof but will be first described in connection with the embodiment of it chosen from other embodiments for the sake of illustration in the accompanying drawings forming part hereof and in which

Figure 1 is a diagrammatic and schematic view of apparatus embodying features of the invention.

Fig. 2 is an elevational view with the housing broken away of the apparatus diagrammatically illustrated at the lower right-hand corner of Fig. 1.

Fig. 3 is a view of some of the structure shown in Fig. 2, looking in a direction at right angles to the plane of Fig. 2.

Fig. 4 is a sectional view taken on the line 4-4 of Fig. 2.

Fig. 5 is an elevational view drawn to an enlarged scale and illustrating the contact apparatus shown in plan at the right and left in Fig. 4.

Fig. 6 is a sectional view taken on the line 6-6 of Fig. 5.

Fig. 7 is a sectional view taken on the line 7-7 of Fig. 5, and

Fig. 8 is a perspective view of a part of the mechanism shown in Figs. 5, 6 and 7.

My invention will be described as applied to the operation of individual street lights 1, supplied from the general service secondary mains 2, 3 and 4, of a sixty-cycle system, but the application of the invention is not limited to street lights, nor to sixty-cycle systems.

In my invention use is made of a switch 5 which in the embodiment of the invention selected for illustration in the drawings is operated by means of a plunger 6 actuated by two solenoids 7 and 8, one being used for opening the switch and the other for

closing it. A quick action is provided by a toggle joint 9 having a spring 10 arranged to force the toggle into the bent or collapsed position. This also holds the switch firmly closed or positively open. The application of current to the solenoids is controlled by two relays generally indicated at 11 and 12, each of which responds to the application of an alternating voltage of a particular frequency or rather of a particular limited range of frequency, one range being used for opening and another for the closing relay.

The frequency which can be used for the relays is subject to some limitations which will be discussed later. I have found the sixth and eighth harmonics of a sixty-cycle fundamental to be desirable, that is 360 and 480 cycles. It is immaterial which of these frequencies is used with the opening relay but it will be assumed that the opening relay is made to respond to 360 cycles.

There are relays having mechanical resonance and there are relays having electrical resonance and I have illustrated one form of the latter and I will proceed with a description of that form for the sake of an explanation of the invention and without intending any limitation of the invention.

Each relay consists of a coil 13 of wire wound so as to obtain the maximum inductance without regard to the small amount of iron, generally indicated at 14, used with it. Within this coil are two groups of laminated iron 15 and 16, one, 15, fixed and the other, 16, movable, the latter carrying a contact arm 17. When current passes through this coil like poles are induced at the ends of the iron which are at the same side of the coil. These poles then repel and cause the movable core 16 to move closing the relay contacts 18 and 19.

The adjustment of the relay to respond to any desired frequency is obtained by connecting a condenser 20 in series with the coil 13, the inductance of the coil with its small iron cores 14, and the capacity of the condensers being so chosen as to resonate at the desired frequency.

It is necessary that the relay should operate at a high frequency voltage of not to exceed 10% of the voltage of the circuit to which the relay is connected and this voltage should preferably not exceed 5%, in order that the high frequency current passed through the normal load *a* of the circuit shall be inappreciable, but this voltage

should not be much lower, on account of the possibility of the occurrence of harmonics in the line voltage which would cause false operation of the relay. It is also necessary that the range of frequency within which the relay will respond shall be neither too large nor too small. If this is too large, the relays will not be sufficiently selective and if too small, the accuracy of adjustment must be so great that manufacturing expense will be unduly high. This may be controlled by a proper choice of the losses in the relay circuit, for which purpose the coil resistance is the most suitable variable. The losses should be so adjusted that the voltage across the combination at resonant frequency is approximately 10% of the voltage across either the coil 13, or the condenser 20.

The frequencies of 360 and 480 cycles are chosen for the following reasons: (1) The frequency should be moderately high so as to avoid false operation due to the passage of a large current by the normal frequency voltage or by low harmonics of the voltage of large magnitude, (2) since the size of the relay necessary to close with a desired force increases directly with the frequency, the frequency must not be extremely high in order to avoid unduly large relays, (3) even harmonics are normally absent from the voltage waves of alternating voltages, and hence false operation should never occur when the resonant frequency approximates an even harmonic. The frequencies chosen seem to be the best compromise between these more or less conflicting requirements but other frequencies between the limits of about 300 to 1000 cycles may be used if desired.

The two relay circuits 21 and 22 are connected permanently across the supply terminals 23 and 24, the switch solenoids 7 and 8 are each connected across the same terminals in series with their respective relay contacts 18 and 19 and preferably with a switch 25, which will open the solenoid circuit 26, branch 27, or branch 28 and lead 29, at or near the end of the stroke of the switch plunger 6, and the lamp 1 or other utilization device controlled by the switch 5 is also connected across the terminals by 31 through the switch.

Referring more particularly to Figs. 2 to 6, 32 is a base shown as circular and from it rise a pair of spaced and diametrically arranged standards 33, surmounted by a cap 34 between which and the base extends an enclosing shell 35. On the base are mounted the fixed contacts of the switch 5 and the condensers 20. The movable contact of the switch 5 is shown in the form of a disc. Lugs 36 on the standards 33 properly support the toggle links 9 which are arranged in pairs between the springs 10. A rest 37 carried by and between the standards sup-

ports the coils 7 and 8, and arms 38 extending from the standards 33 carry the spools 39 upon which the coils 13 are wound and these spools are shown as equipped with square heads, Fig. 5. From one of the square heads of the spools extends a bracket 40 to which one end of the fixed mass of iron 15 is attached and which is provided with one element 41 of a knife edge pivot. To the other end of the part 15, Fig. 7, is attached another element 42 of a second knife edge pivot. The movable mass of iron 16 is pivoted to these elements 41 and 42 for which purpose the part 16 is provided with knife edge pivot elements. The support 43 for the fixed element of the contact 18 is also carried by the spool head. The standards 33 carry a rest 44 which carries the fixed contacts of the switch 25 of which the movable bridge element 45 is carried by the plunger 6, and these fixed contacts are the one, 46, relatively wide, and the other in two parts 47 and 48 each relatively narrow, and they are spaced apart. When relay 11 closes the contact 18 the path of the circuit is from 24, 29, 46, 45, 48, 18, 28, 7 and 26 to 23, so that the switch 5 is open and in opening has broken the path between 45 and 48, the springs 10 serving to keep the switch open. When relay 12 closes the contact 19, the path of the circuit is from 24, 29, 46, 45, 47, 19, 27, 8 and 26 to 23, so that the switch is closed and in closing has broken the path between 45 and 47, the springs 10 serving to keep the switch closed.

The high frequency impulses by means of which the relays and hence the switch are operated are impressed upon the distribution mains 49 and 50 at any desired central point but preferably at the sub-station 51 from which the mains are supplied. This is done by superposing upon the voltage of normal frequency a high frequency voltage of the proper magnitude and of the frequency necessary for operating the desired relay. This superposition is accomplished by the temporary insertion of an inductance 52 into one of the wires 49 of the circuit to be controlled. The value of this inductance should be as large as possible but small enough so that at full load of the circuit the normal frequency drop across the inductance will not cause an excessive disturbance of the normal circuit voltage. This drop may be 5% of the line voltage causing a 2 to 3 1/2% fluctuation depending on the load power factor. A suitable high frequency voltage is then impressed across the terminals of this inductance. This inductance and the high frequency generator 53 with suitable control form the essential parts of the apparatus, but economy and safety require additional elements. The high frequency current absorbed by the inductance will be large but since it is a lagging current absorbed mainly

by the inductance as magnetizing current it may be neutralized by connecting a suitable condenser 54 in parallel with the inductance, the leading current absorbed by the condenser being just sufficient to supply the lagging current of the inductance. The net current supply from the high frequency generator will then be that required to supply the losses in the inductance 52, and in the condenser 54, and to supply the high frequency current to the devices connected to the distribution mains including the relays 11 and 12 of such switches as are used on the circuit. Since the circuits leaving substations usually operate at voltages which are dangerous, it is necessary to insert an insulating transformer 55 in the circuit 56, the preferable location for this transformer being between the inductance 52 with its condenser 54 and the high frequency generator 53. This transformer may have any ratio desired in order to adapt the voltage of the high frequency generator to the requirements of the control system.

When the primary distribution mains 49 and 50 operate at 2300 volts, a ratio of one to one will be found suitable. It is also desirable to insert a condenser 57 in series with the high frequency supply in order to prevent the low or normal frequency current from passing through the high frequency generator while allowing the passage of high frequency currents. This may be placed in either the high tension or the low tension side of the transformer 55, but is preferably located on the low tension side for the sake of safety. The magnitude of the condenser capacity is not important but is preferably such as to approximately neutralize the inductance of the transformer windings. In its preferred form therefore the complete high frequency source consists of an inductive reactor of about 5% drop (based on full load normal frequency) inserted into one of the supply lines with suitable switches 58 and 59 for short-circuiting the inductance and for removing it from the circuit, a condenser 54 adjustable to resonance at all relay operating frequencies connected in parallel with the inductance 52, an insulating transformer 55, a series condenser 57 whose capacity will approximately neutralize the inductive drop of the transformer at the average relay frequency and a high frequency generator 53 with a variable speed drive 60 to adapt it to the various frequencies necessary together with suitable control switches 58 and 59, rheostats and instruments, not shown because too well understood to require illustration.

The high frequency voltage thus superposed on the normal frequency voltage will pass currents corresponding to the high frequency voltage and impedance through all devices connected across the mains including

the relay coils of the switches. This current will return to the high frequency generator through the other wire or wires of the circuit and through the transformers or other source of normal frequency power. These utilization devices may be connected to the primary mains through transformers, in which case the high frequency voltage will be transformed in a manner similar to the transformation of the power supply except that the drop in the transformer will be somewhat larger in proportion. As described above, the application is made to a single phase circuit or one phase of a polyphase circuit, but if the power is distributed by means of some polyphase method having a common neutral grounded at not more than one point, all of the phases may have the high frequency voltage superposed simultaneously by introducing the high frequency voltage into the common neutral. The high frequency may be applied as described above to one of the circuits leaving the substation and then to another and so on or the entire group of circuits leaving the station may be energized simultaneously by introducing the high frequency voltage into the wires supplying the station bus on either the primary or secondary side of the substation transformers 61.

As described above my invention is applied to the control of a single utilization device but its application is not limited to the control of a single utilization device but it may be used to control any number of such devices by duplication as, for example, all of the street lights in a given territory may be controlled by individual switches for which purpose my invention is particularly suited.

Also this group of devices may be subdivided by using control relays selectively responsive to various ranges of frequency so that certain subdivisions of the group may be operated or controlled independently thus for instance enabling the number of lamps to be adapted to the requirements for illumination.

While my invention has been described as applied to devices supplied from alternating current mains, it is not limited to this form of supply and may be applied to direct current mains with a few obvious changes in the method of introducing the relay operating current. In this case it will not be necessary to use such a high frequency, approximately sixty cycles being suitable in this case.

I claim:

1. In resonant remote control switching apparatus adapted to be operated from customary constant potential mains by superimposed currents of proper frequency and voltage, means for impressing said superimposed currents upon the mains which means

include in sub-combination an inductance inserted in series in one of the mains, a high frequency generator for impressing high frequency voltage across the inductance, a transformer between the inductance and generator, and condensers of which one is connected in parallel with one of the windings of the transformer and of which the other is in series with the generator.

17 2. In resonant remote control switching apparatus adapted to be operated from customary constant potential mains by super-

imposed currents of proper frequency and voltage, means for impressing said super-imposed currents upon the mains which 15 means include in sub-combination an inductance inserted in series in one of the mains, a high frequency generator for impressing high frequency voltage across the inductance, a transformer between the inductance 20 and generator, and a condenser connected in parallel with one of the windings of the transformer.

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