A. S. ANDERSON.

GOVERNING MECHANISM FOR TURBINES.

APPLICATION FILED OCT. 29, 1906.

963,110. Patented July 5, 1910.

Fig. 1.

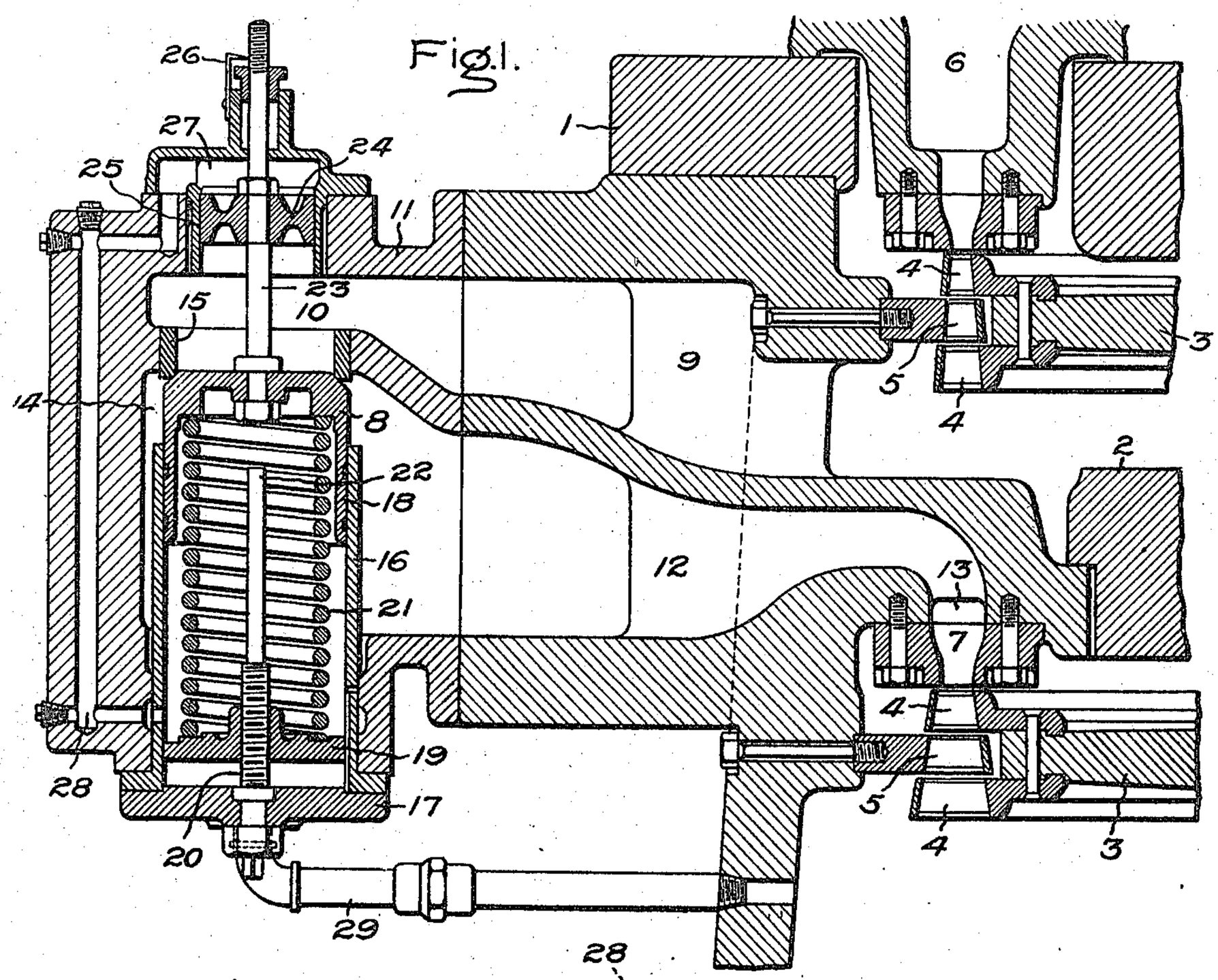


Fig. 2.

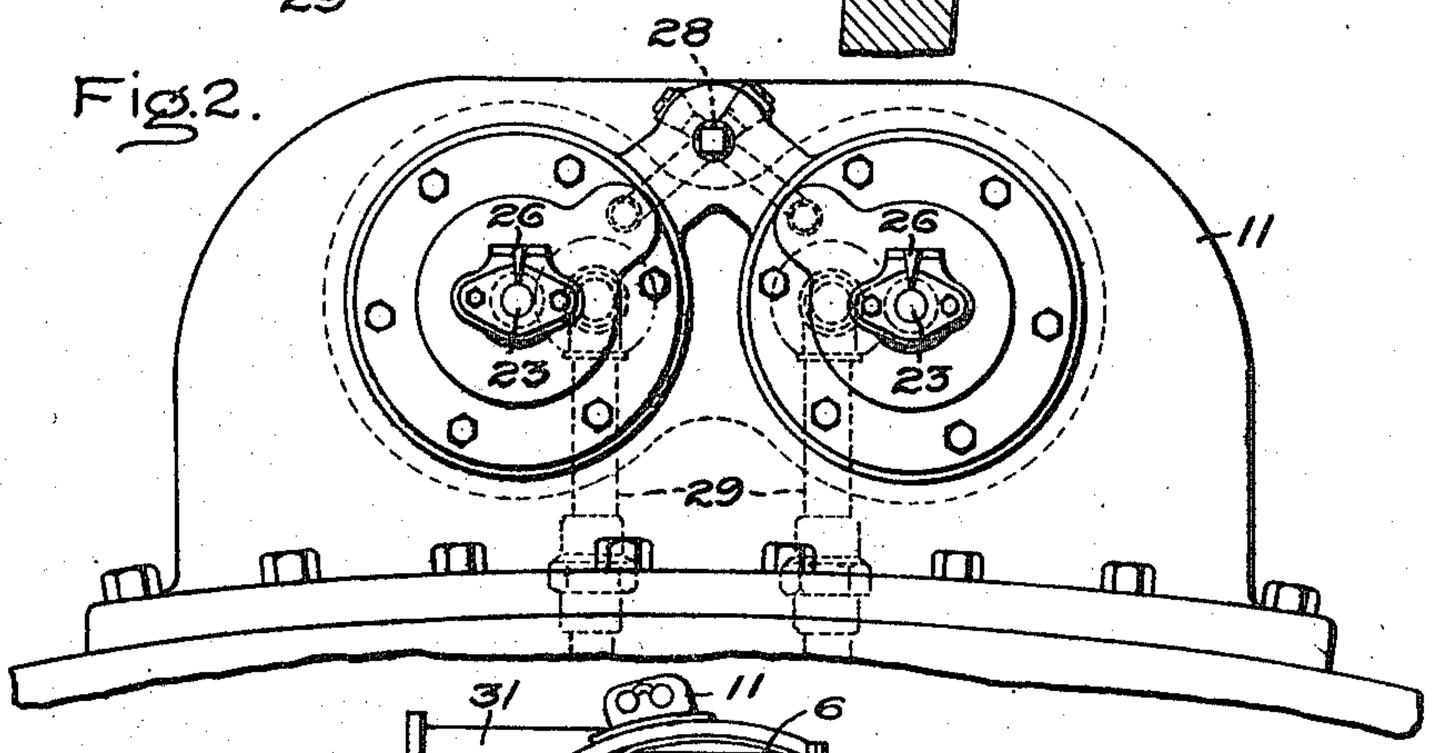
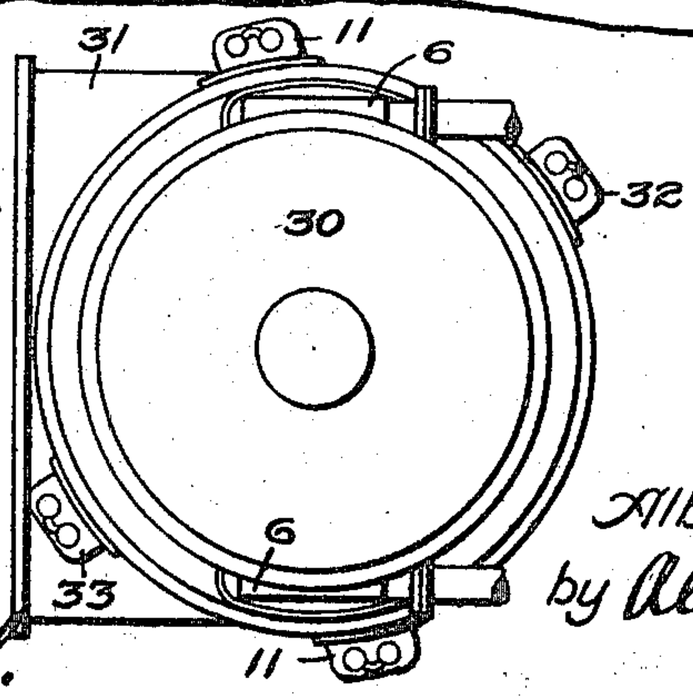


Fig. 3.



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UNITED STATES PATENT OFFICE.

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GOVERNING MECHANISM FOR TURBINES.

963,110. Specification of Letters Patent. Patented July 5, 1910.

Application filed October 29, 1906. Serial No. 340,996.

To all whom it may concern:

Be it known that I, ALBERT S. ANDERSON, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Governing Mechanism for Turbines, of which the following is a specification.

The present invention relates to governing mechanism for elastic-fluid turbines, and is directed more specifically to the valves which control the passage of motive fluid between stages in response to changes in fluid pressure.

The object of the invention is to improve the construction and operation of these stage valves, whereby they will operate within narrower limits than heretofore, and this with smaller opposing springs and parts of decreased size.

In the accompanying drawing which illustrates one of the embodiments of my invention, Figure 1 is a partial axial section of an elastic-fluid turbine; Fig. 2 is a plan view of the valve casing showing two valves mounted therein; and Fig. 3 is a plan view of a vertical-shaft turbine.

1 represents the casing of a turbine which is divided into wheel compartments or stages by one or more diaphragms 2. In each stage is a wheel 3 having one or more rows of buckets. Between each two rows of wheel buckets 4 are intermediate buckets 5. Steam or other elastic fluid is admitted to the machine by a valve chest 6 containing one, two, three or more admission valves (not shown) that operate in response to any suitable form of speed governor. The motive fluid is admitted to the second stage, as well as to the subsequent stages where the turbine is provided with more than two stages, by stage nozzles 7. Of these nozzles or nozzle sections there may be one, two or more for each stage. Some of these nozzles are or may be normally open while the remainder are controlled by stage valves 8 responding automatically to changes in stage pressure. Where two or more valves are provided for a given stage they preferably and usually operate successively, but they may operate simultaneously under certain conditions.

For convenience the specific construction of a valve will be described in connection with one stage, but it is to be understood that the invention is not so limited. Extending outwardly from the wheel chamber through the casing is a passage 9 which communicates with a chamber 10 in a valve casing 11 bolted or otherwise secured to the wheel casing. It is desirable but not essential to make the casing removable, since it reduces the cost of manufacture and renders the parts of the turbine more accessible.

Extending parallel or substantially so to the passage 9 is a second passage 12 one end of which discharges into a segmental chamber 13 that supplies steam or other motive fluid to the sections of a stage nozzle or other fluid-discharging devices, while the other end communicates with a chamber 14 in the valve casing located below the valve seat 15. The valve seat is made removable so that it can readily be replaced. Engaging the under side of the seat is the valve 8 having a double area, that is to say, when the valve is closed a certain definite area is exposed to the pressure of the fluid in the first stage and the said area plus a certain additional area when the valve is open. The object of this feature is to prevent wire drawing of the motive fluid.

In the valve casing is a sleeve or lining 16 held in place by the head 17 bolted to the under side of the casing. Located within the sleeve is the guide 18 of the valve and an adjustable abutment 19, the latter being carried by the adjusting screw 20 extending through the head 17. Between the valve and the abutment is a compression spring 21 or equivalent means which, by reason of the balancing piston to be referred to later, is shorter and of less power than heretofore used for this purpose under like conditions of operation. The adjusting screw is extended up into the interior of the valve to form a stop 22 to limit the extent of opening of the valve.

Mounted on top of the valve is a stem 23 and carried thereby is a balancing piston 24, the latter being located in a removable cylinder 25 mounted on the valve casing. The cylinder is extended to form a head through which the end of the stem projects. Mounted on the head is a pointer 26 which by comparison with suitable marks on the stem will show the position of the stage valve.

In a turbine of the character described there are changes in pressure due to fluctua-

tion in load and also to a certain extent by reason of changes in pressure of the source of supply. In order that the effect of these variations may be minimized the cylinder space on the side of the balancing piston away from the stage valve is connected by a passage or passages with the under side of the stage valve. This is accomplished by forming a chamber in the head 27 communicating with the vertically extending passage 28, the latter communicating with the space below the abutment and the pipe 29 tapped into a stage of lower pressure. Since the valve under discussion controls the passage of fluid between the first and second stages, I prefer to connect the pipe to the second stage. It will be noted that the passage 28 is common to both valves in the casing as shown in Fig. 2. This simplifies the construction. The arrangement of the parts just described has been found to be a suitable one and for that reason has been illustrated, but the invention is not to be understood as being specifically limited thereto unless so stated in the claims.

Considering for the moment the action of one valve, its action is as follows: When fluid is admitted to the turbine it flows through the inlet nozzles or other devices and buckets of the first stage and in so doing produces rotation of the wheel and the supporting shaft. The fluid under pressure in the first stage immediately fills the passage 9 and the chamber 10 communicating therewith, thus subjecting the under side of the balancing piston and the upper surface of the stage valve 8 to the same pressure. The fluid which enters the second stage through the unvalved nozzles or other discharging devices rotates the second stage wheel and also fills the wheel compartment with motive fluid at a pressure somewhat lower than that in the first stage. This pressure is immediately communicated by the pipe 29 and the passage 28 to the chamber above the balancing piston and also to the under side of the stage valve so that changes in pressure in the second stage correspondingly affect the piston and the valve. The area of the piston is somewhat less than that of the top of the valve, so that while there is a certain tendency for the piston to seat the valve there is a greater tendency due to the greater area of the top of the valve for the latter to open. This tendency for the valve to open is counterbalanced by the compression spring 21 under it until the pressure in the first stage increases to a point where it overcomes the effect of the spring and the valve opens. As soon as this happens the valve presents an increased area sufficient to compensate for the drop in pressure in the first stage caused by increasing the number of active nozzles or devices discharging into the second stage. So long as the first stage pressure remains above a certain predetermined point the valve will remain open, but as soon as it falls below this point the spring will seat the valve.

By the use of the balancing piston I am enabled to use a spring for seating the valve which is materially shorter and lighter than would be the case if the piston were omitted. This piston not only introduces a saving in the cost of manufacture, for it is difficult to wind the heavy springs and get them exactly alike, but it permits of the valves working within narrower limits than where the spring alone is employed to oppose the pressure. Moreover, in some cases the conditions are such that it would be impractical to use springs alone owing to excessive length. Reducing the size of the spring also enables me to reduce the size of the valve casing and other parts. The area of the balancing piston can be made to bear any relation that is desired to the area of the end of the valve and in this manner relieve the spring of any desired amount of work. By reason of the connection from the upper side of the piston to the under side of the valve, the effects of fluctuation in stage pressure on the valve or valves are reduced to a minimum. In other words, instead of being effective on the whole area of the valve, it is only effective on a percentage, *i. e.*, the difference in area between the balancing piston and the stage valve.

In Fig. 3 is shown in plan view a turbine of the vertical shaft type, but it is to be understood that the invention is also applicable to horizontal shaft machines. In this figure 30 represents the top head of an electric generator having a centrally located dome over the upper end of the shaft. Steam or other elastic fluid is admitted to the turbine by the valve chests 6 located on opposite sides. The exhaust issues through the conduit 31. The turbine shown is of the multi-stage type, and between the first and second stages are located stage valves 8, each pair of valves being contained in a common casing. The valves of each stage are preferably set by the springs 21 or the relation of the balancing pistons to the valves or both so that they will open and close successively under predetermined pressure changes. In casings 32 and 33 are other pairs of stage valves which may be arranged to control the passage of motive fluid through the first and second stage or second and third or third and fourth, etc., as desired. One pair of valves may be arranged between the second and third stages and another pair between the third and fourth and so on. The number of valves can be increased or decreased as desired and also the number of stages provided with these valves.

I have shown the invention in connection

with a Curtis turbine but it is to be understood that the invention is not limited thereto since it can be used with other types of turbines.

In accordance with the provisions of the patent statutes I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. An elastic-fluid turbine having stages working at different pressures, each stage comprising relatively rotatable parts, in combination with a stage valve automatically responding to changes in stage pressure for controlling the passage of motive fluid, a device opposing the opening of the valve, and a means responsive to fluid pressure for assisting said device and thereby relieving it of a certain amount of work.

2. An elastic-fluid turbine having stages working at different pressures, each stage comprising relatively rotatable parts, in combination with a stage valve automatically responding to changes in stage pressure for controlling the passage of motive fluid, a device opposing the opening of the valve, and a balancing piston responsive to fluid pressure which coöperates with the said device to prevent the valve from opening.

3. An elastic-fluid turbine comprising stages wherein a difference in pressure exists, rotary buckets, and fluid-discharging devices, in combination with a stage valve that opens in response to changes in pressure in one of the stages, a device opposing the action of fluid pressure on the valve, a balancing means coöperating with the said device, and a conduit for partially balancing the pressures to which the valve and balancing means are exposed.

4. An elastic-fluid turbine comprising stages wherein a difference in pressure exists, rotary buckets, and fluid-discharging devices, in combination with a stage valve that opens in response to changes in pressure in one of the stages, a balancing piston attached to the valve and coöperating with the said device, the valves and piston being exposed to high pressure on one side and low pressure on the other, and a conduit connecting the low-pressure sides of the valve and piston so that changes in pressure will correspondingly affect both.

5. An elastic-fluid turbine which is divided into stages working at different pressures, each stage comprising relatively rotatable parts and fluid-discharging devices, in combination with a plurality of successively operating stage valves controlling the passage of fluid through said devices, each of said valves being provided with a device opposing the action of stage pressure tending to open it, and a balancing means for each valve which is acted upon by the same pressure which tends to open the valve.

6. An elastic-fluid turbine of the multistage type, in combination with a valve which controls the passage of motive fluid from one stage to another, a balancing piston for the valve whose effective action in opposing its opening is less than the effective action of the fluid on the valve itself, and a device which coöperates with the piston to prevent the valve from opening until the effective pressure of the fluid on the valve exceeds a certain amount, said device also assisting in closing the valve when the pressure falls.

7. An elastic-fluid turbine of the multistage type, in combination with a valve which controls the passage of motive fluid from one stage to another, a balancing piston for the valve that is exposed on opposite sides to a difference in fluid pressure, a balancing piston attached to the valve that is exposed on opposite sides to the same difference in fluid pressure as the piston, a spring opposing the opening of the valve and which assists in closing it, and a conduit which connects the low-pressure sides of the balancing piston and valve.

8. A turbine, in combination with a valve that controls the passage of motive fluid from one part of the turbine to another, the said valve comprising a casing to receive the valve, the latter having a double area, a balancing piston attached to the valve, the effective area of the valve being greater than that of the piston, a spring coöperating with the piston to resist the action of motive fluid on the valve, and a means for connecting the low-pressure sides of the valve and piston with that part of the turbine into which the fluid passing through the valve discharges.

9. A turbine, in combination with a valve which tends to open under a predetermined increase in pressure, a casing therefor, a balancing piston that is exposed to the same pressures as the valve and exerts at all times a tendency to close said valve and thus reduce the load on the spring, a means mechanically uniting the valve and piston, a spring coöperating with the piston to seat the valve, an indicator to show the position of the valve within its casing, and a conduit for equalizing the pressures on opposite sides of the piston and valve.

In witness whereof, I have hereunto set my hand this 27th day of October, 1906.

ALBERT S. ANDERSON.

Witnesses:

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HELEN ORFORD.