Nov. 7, 1961 A. SÜSS 3,007,675

ADJUSTING DEVICE FOR WATER TURBINE GUIDE APPARATUS

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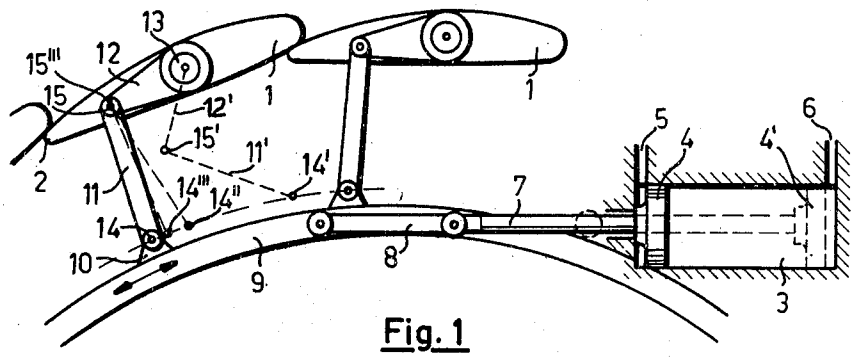

Fig. 1

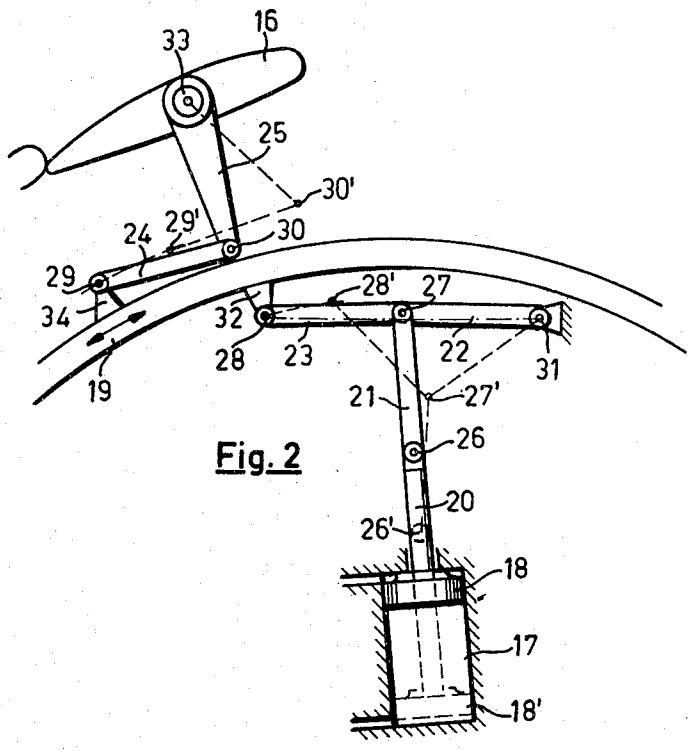

Fig. 2

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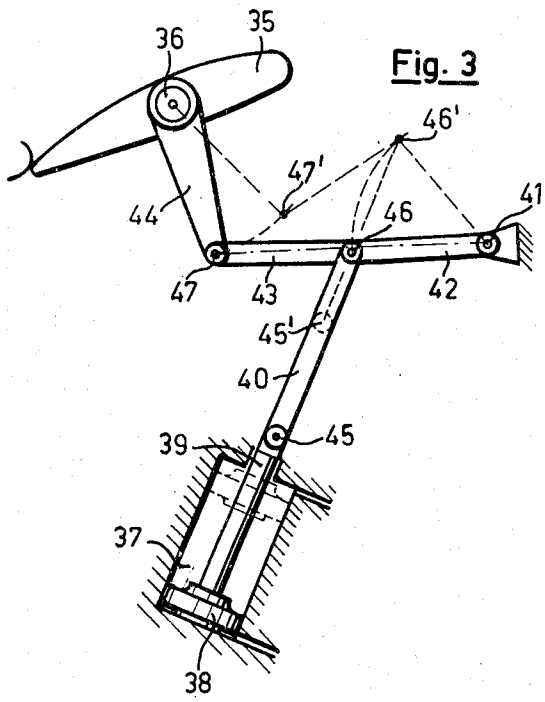
Fig. 3



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ADJUSTING DEVICE FOR WATER TURBINE GUIDE APPARATUS

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As a rule, no special shut-off members are provided in front of large low-pressure water turbines, that is to say, more particularly in front of Kaplan turbines, since such members are relatively expensive, due to their size. From the beginning of the construction of large Kaplan turbines, therefore, their adjustable guide apparatus has been provided with a lock which, when the servomotor is without pressure, holds the guide apparatus fast in its closed position against the vane restoring forces developed by the water. For simplification of the control, however, it is desirable to dispense with this lock.

This invention now relates to the adjusting device for the servomotor-operated guide apparatus of a water turbine and the aforesaid simplification is made possible according to the invention by the fact that the adjusting linkage between the servomotor and the guide vanes has a toggle lever mechanism which, in the closed position of the guide apparatus, attains at least the dead-centre position, so that the guide apparatus remains in its closed position when the servomotor is without pressure.

Constructional examples of the subject of the invention are illustrated in simplified representation in the drawing, wherein:

FIGURE 1 shows an adjusting device with a central regulating ring operating the guide apparatus.

FIGURE 2 shows another constructional form of an adjusting device with regulating ring, and

FIGURE 3 shows an adjusting device, in which each vane of the guide apparatus is adjusted by a separate servomotor.

FIGURE 1 shows two adjustable vanes **1** of the guide apparatus of a water turbine, which is intended to feed a whirling body of water to the turbine runner (not shown). In the closed position, each guide vane bears against the adjacent guide vane in the vicinity of its trailing edge **2**. The guide apparatus is operated by a pressure-fluid actuated servomotor with cylinder **3** and piston **4**. The pressure fluid supply lines are indicated at **5** and **6**. The movement of the piston **4** is transmitted by a piston rod **7** and a connecting rod **8** to a regulating ring **9** mounted coaxially with the turbine. In the region of each guide vane, this regulating ring is provided with a projection **10**, to which is pivoted one end of a link **11**. The other end of the link is pivoted to a lever **12** for operating the guide vane. The vane has a pivot **13** to which said lever **12** is rigidly connected. **14** and **15** are hinge points between regulating ring projection **10** and link **11**, and between link **11** and lever **12**, respectively. The parts **7**, **8**, **9**, **10**, **11**, **12**, **13** form the adjusting linkage between the servomotor **3**, **4** and the guide vanes **1**.

In the open position of the guide apparatus, the piston **4** of the servomotor is in a position **4'**, the link **11** in a position **11'**, the lever **12** in a position **12'**, and the pivots **14**, **15** are in positions **14'** and **15'**, respectively. To bring the guide vanes **1** to their closure position, pressure medium is admitted through the supply line **6** to the cylinder **3** of the servomotor. The piston **4** then moves from its end position **4'** to the left, until due to the rotation of the ring **9** on its axis, the hinge points **14** has passed from its position **14'** to a position **14''**, in which the hinge point **15** assumes the position shown

and the vane **1** is in the closed position. Due to the vane **1** bearing on the adjacent vane, the vane can no longer rotate beyond this position.

In the position **14''** of the hinge point **14**, the link **11** is almost in its dead centre position. The servomotor, however, is moved still farther to the left. The dead centre position of the link **11** is attained when the hinge point **14** has reached the position shown at **14'''**. The hinge point **15**, however, then reaches a position **15'''** displaced outwardly by a small amount, which since the vane **1** can no longer rotate is possible only with elastic deformation of the lever **12** or the blade pivot **13**.

The parts **10**, **11** of the adjusting linkage between the regulating ring **9** operating the guide apparatus and the guide vane **1** form a toggle lever mechanism. Each of the other guide vanes of the guide apparatus has a corresponding toggle lever mechanism associated with it. In the dead centre position **14'''**, **15'''** of the hinges **14**, **15**, the link **11** is in a radial direction with reference to the axis of the regulating ring. Water pressure, acting on the vanes **1**, develops vane restoring forces which tend to move each vane in a counterclockwise direction about its pivot **13** to an open position. However, since these forces are transmitted to ring **9** through links **11**, and since these links are now in radial positions with respect to the ring, the forces do not exert any torque on the ring. The guide apparatus thus remains in its closed position even when the servomotor is without pressure.

In the adjusting device shown, however, the end position of the piston **4** of the servomotor on closure of the guide apparatus is so selected that the hinge point **14** lies beyond its dead centre position **14'''**. Vane restoring forces transmitted by the link **11** then produce a torque acting on the regulating ring **9** in the closing direction, so that the piston **4** is held fast in its end position and hence the guide apparatus in its closed position. If the resiliency in any event already present in the adjusting members is not sufficient to permit the dead centre position of the toggle lever mechanism to be reached, a special resilient member may also be provided in the toggle lever mechanism.

In the device according to FIGURE 2 the vanes of the guide apparatus of the water turbine, of which only one is shown at **16**, are operated by a servomotor with cylinder **17** and piston **18** via a regulating ring **19** mounted coaxially with the guide apparatus. The adjusting linkage consists of a piston rod **20** rigidly connected to the piston **18**, a link **21**, a radius link **22**, a link **23**, a further link **24** and a lever **25**, **26**, **27**, **28**, **29**, and **30** denote hinge points and **31** is a fixed pivot, to which the radius link **23** is pivoted. The link **21** is connected at the hinge point **26** to the piston rod **20** and at the hinge point **27** to the outer end of the radius link **22** and one end of the link **23**. By its other end, the link **23** is connected at the hinge point **28** to a projection **32** of the regulating ring **19**. The guide vane **16** has a pivot **33** on which is mounted the lever **25**. The link **24** connects at the hinge points **29** and **30** a projection **34** of the regulating ring **19** to the outer end of lever **25**.

The guide vane **16** is shown in its closed position. In the open position of the guide apparatus, the hinge points **26**, **27**, **28**, **29**, **30** are in the positions denoted by **26'**, **27'**, **28'**, **29'**, **30'**, and the piston **18** is in its rear end position shown at **18'**. If now pressure medium is admitted behind the piston **18'**, a closing movement of the guide apparatus is initiated and the radial link **22** and the link **23** approach the extended position, that is to say, the position in which the hinge point **27** lies on the straight line connecting the hinge point **28** and the fixed pivot **31**. Shortly before, however, the closure position of the vane **16** is reached. Before, however, the piston **18** has reached the front end position shown, the

hinge point 27 will be forced beyond the straight line connecting the points 28 and 31, so that restoring forces originating from the guide apparatus will no longer be able to move the piston 18 from its end position and open the guide vanes, even when the servomotor 17, 18 is without pressure. The parts 22, 23 of the adjusting linkage between the servomotor 17, 18 and the regulating ring 19 operating the guide vanes here form a toggle lever mechanism, the extended position of these parts representing its dead centre position.

According to FIGURE 3, it is assumed that each guide vane has a separate servomotor associated with it. Only a single guide vane 35 with vane pivot 36 is shown. It is operated by a servomotor with cylinder 37 and piston 38. The adjusting linkage is formed by a piston rod 39, rigidly connected to the piston 38, a link 40, a radius link 42 turning on a fixed pivot 41, a link 43 and a lever 44 mounted on the pivot 36 of the vane 35. The link 42 is connected at a hinge point 45 to the connecting rod 39 and at a hinge point 46 to the radius link 42 and one end of the link 43. The other end of the link 43 is connected at a hinge point 47 to the lever 44.

In the open position of the guide vane, the hinges 45, 46, 47 assume the positions denoted by 45', 46', 47'. The radius link 42 and the link 43 form a toggle lever mechanism. Shortly before reaching the closure position shown of the servomotor piston 38, the parts 42, 43 reach their dead centre position, that is to say, hinge point 46 reaches the straight line connecting the hinge 47 and the fixed pivot 41. Before the piston 38 reaches the end position, the hinge point 46 passes the said connecting line. Restoring forces originating from the vane and counteracting the closure movement are in this case also unable to cause a displacement of the piston 38 from its end position, even when the servomotor 37, 38 is without pressure, so that the guide vane remains closed.

What is claimed is:

1. In combination, a water turbine having a guide apparatus including adjustable vanes, each vane being movable between closed and open positions and being urged toward the latter position by vane restoring forces developed by the water pressure acting on it; at least one fluid pressure actuated servomotor; and an adjusting linkage operatively connecting the servomotor with the vanes to move them between the closed and open positions, the adjusting linkage including at least one toggle lever mechanism arranged so that it reaches at least its dead centre position as the vanes reach closed position, whereby the toggle lever mechanism prevents the vane restoring forces from moving the vanes.

2. The combination defined in claim 1 in which the adjusting linkage includes a resilient member arranged to be deformed when the toggle lever mechanism is in the region of its dead centre position.

3. The combination defined in claim 1 in which the adjusting linkage includes a regulating ring that is operatively connected with the vanes; and in which the toggle lever mechanism is interposed between the servomotor and the regulating ring.

4. The combination defined in claim 1 in which the adjusting linkage includes a regulating ring that is operatively connected with the servomotor; and in which there are a plurality of toggle lever mechanisms, one of said mechanisms forming an operative connection between the regulating ring and each vane.

5. The combination defined in claim 1 in which there are a plurality of servomotors, one for each vane; and in which there are a plurality of toggle lever mechanisms, one interposed between each servomotor and its associated vane.

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