Jan. 22, 1963 J. CALDWELL ETAL 3,074,236

MULTI-CYLINDER CONDENSING STEAM TURBINES

Filed July 3, 1961 3 Sheets-Sheet 1

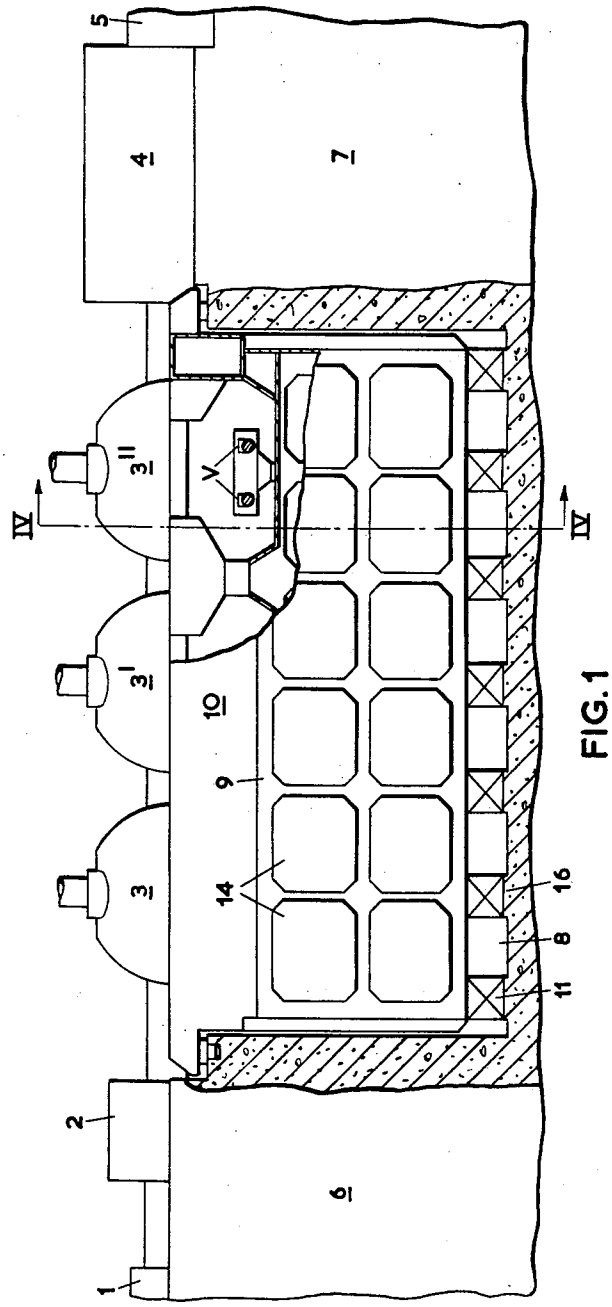

FIG. 1

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Filed July 3, 1961 3 Sheets-Sheet 2

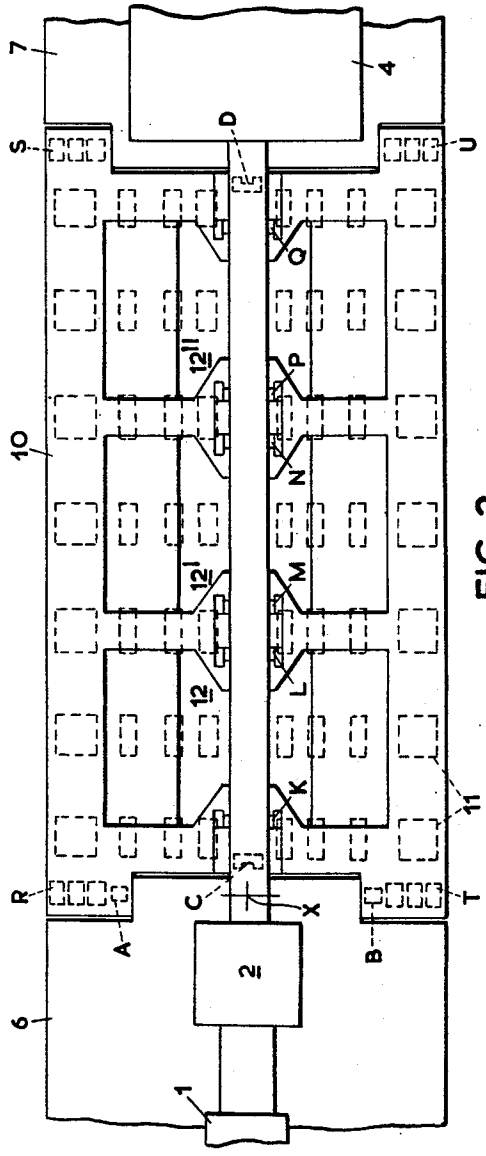

FIG. 2

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Filed July 3, 1961 3 Sheets-Sheet 3

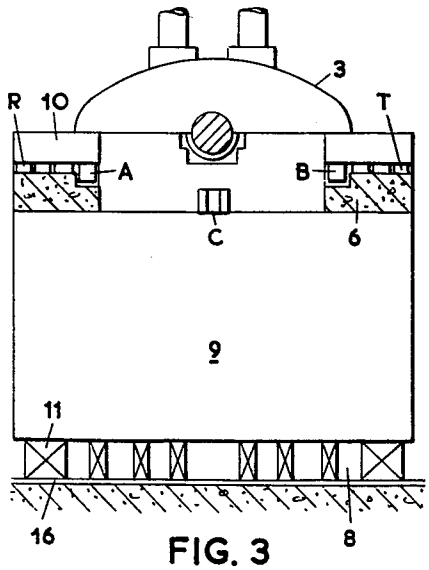

FIG. 3

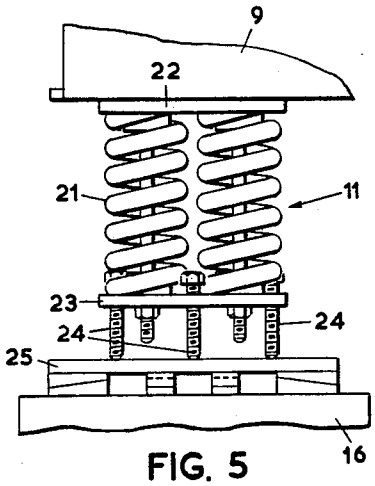

FIG. 5

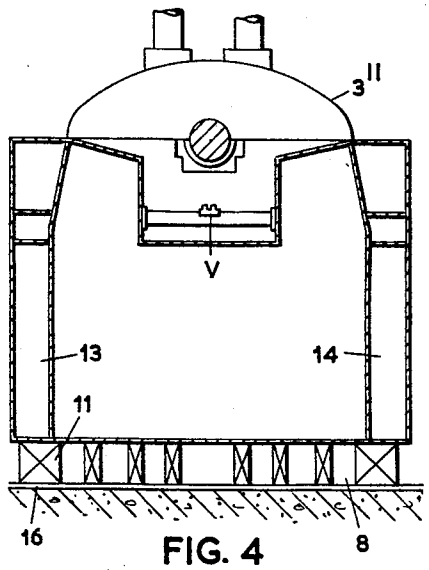

FIG. 4

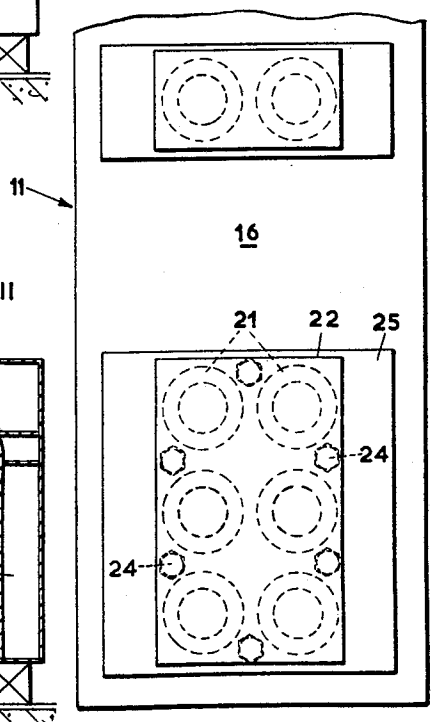

FIG. 6

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MULTI-CYLINDER CONDENSING STEAM TURBINES

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5 Claims. (Cl. 60—95)

The present invention relates to multi-cylinder condensing steam turbines, for example to large types of these machines wherein several low-pressure turbine cylinders are arranged in alignment with one another and with the high pressure and intermediate pressure cylinders, all of these turbines driving directly the alternator and exciter.

According to the invention, the low pressure cylinder exhaust chambers of the turbine and the condenser are connected directly to one another and form a bridge structure resting at its ends on the reinforced concrete block or steel structure supporting the high pressure and intermediate pressure cylinders at one end, and on the corresponding support for the alternator and exciter at the other end. By thus combining the condenser and low pressure cylinder exhaust chambers a strong bridge-like structure is formed, in which the critical clearances of rotating parts are insensitive to forces applied to the bridge. Also, the compactness of the arrangement of support eliminates some of the concrete foundation work and makes the station smaller.

Preferably the said bridge structure is also supported by springs carrying a considerable proportion of the weight of the assembly of low pressure cylinder hoods, exhaust chambers and condenser, the said springs being arranged between the underside of the condenser and the concrete floor of the condenser pit. The spring loading can be adjusted initially.

Thermal expansion of the unit comprising the said bridge structure, the low pressure cylinder exhaust chambers and the condenser is accommodated by its sliding with one end of the bridge structure on the foundations, the other end thereof being keyed in position.

In order that the invention may be clearly understood and readily carried into effect, an embodiment thereof will now be described by way of example with reference to the accompanying drawings in which:

FIG. 1 is a diagrammatic side elevation,

FIG. 2 is a diagrammatic plan view, and

FIG. 3 is a diagrammatic end elevation of the new arrangement.

FIG. 4 is a section on the line IV—IV of FIG. 1,

FIG. 5 is an elevation, and

FIG. 6 a plan view of a set of springs supporting the condenser from underneath, FIGS. 5 and 6 being on a larger scale.

The high pressure cylinder 1, intermediate pressure cylinder 2, and three double-exhaust low pressure cylinders 12, 12', 12'', are arranged in alignment with one another and in direct driving connection with an alternator 4 and exciter 5. The high pressure cylinder 1 and intermediate pressure cylinder 2 are supported by one concrete block 6, while the alternator 4 and the exciter 5 are supported by another concrete block 7, the said two concrete blocks leaving a pit 8 between them wherein the condenser 9 is accommodated directly under the three low pressure cylinders 12, 12' and 12'' and their hoods 3, 3' and 3'' and combined exhaust chambers 10.

The exhaust ducts of the low pressure cylinders 12, 12' and 12'' form a strong bridge-like structure 10 which, when joined to the condenser, bridges the pit between the

high pressure and intermediate pressure cylinder foundations 6 and the alternator and exciter foundations 7. The bridge structure rests with its ends on both these supports 6 and 7.

The bridge structure is keyed at A and B to the concrete block 6 in a manner allowing expansion in the direction transversely of the turbine axis and on pads R and T, but locating the bridge structure on the concrete block in the axial direction. The bridge structure is moreover keyed on its centre line at C and D in a manner locating its centre line against lateral displacement. The point of intersection X of the centre line C—D of the bridge structure with the line of the keys A and B is accordingly a fixed datum point of the bridge structure.

The other end of the bridge structure is supported freely slidable on the pads S and U fixed to the concrete support 7.

The rest of the turbine, such as high pressure, intermediate pressure and low pressure cylinders are all connected to the end of the bridge structure adjacent the point X, so that they can thermally expand away from this point. They are, however, kept on the true centre line of the turbine set by conventional systems of keys such as V.

A considerable proportion of the strength of the bridge structure is derived from the waterboxes 13 and 14 of the condenser. Since these are water-cooled, any tendency to hogging or other thermal distortions is reduced. The cooling effect of the water also extends to the upper part of the bridge structure 10 by conduction from the waterboxes 13, 14 or by local circulation of water through this structure.

The construction is arranged so that the fine clearances between rotating and static parts are not unduly affected when variable forces act on the structure. An extreme example of this is when water is lost from the condenser during an emergency in turbine operation. This reduces the gravity force on the beam by as much as 25% and, consequently, the centre of the beam rises relative to its ends by an amount appropriate to beam flexure.

When such a condition occurs the danger to beware of is upwards movement, of such parts as glands, relative to the shaft, and an eventual take-up of rotational clearances and serious rubbing of the shaft. The structure is inherently insensitive to this because the turbine shaft is supported by several bearings K, L, M, N, P, Q along the length of the bridge. These bearings move upwards by the same amount as the bridge flexes, so that the shaft adopts the same flexure as the bridge, and rotational clearances remain almost unaffected. The stresses imposed in both shaft and bridge by this flexure are quite acceptable, the structure being designed accordingly.

Part of the working weight of the low pressure turbines and condensers is taken by springs denoted 11 as a whole. These springs are situated in the condenser pit 8 and rest on floor plinths 16. The spring load can be adjusted.

An arrangement 11 of these springs is shown in more detail in FIGS. 5 and 6; compression springs 21 are arranged between a plate 22 resting against or fixed to the underside of the condenser 9 and an adjustable plate 23. Jacking screws 24 screwed through the plate 23 bear on a base plate 25 resting on the concrete plinth 16.

By tightening the screws 24 the proportion of weight taken by the springs 21 is increased.

The invention offers simplicity in the internal arrangements of the low pressure turbines, condenser and supporting foundations of multi-flow machines, for example the six-flow exhaust machine illustrated. It also eliminates the concrete support structure which normally runs

along the sides of the condenser, and thereby makes possible a lower and shorter machine as a whole with ultimate reductions in the size of foundations and turbine-house buildings and of their cost.

What we claim as our invention and desire to secure by Letters Patent is:

1. A multi-cylinder condensing steam turbine plant comprising in combination: a high pressure casing, an intermediate pressure casing and several low pressure casings arranged in alignment with one another, shafts of all said casings coupled to one another, an alternator and an exciter arranged in alignment with said casings and coupled to the free end of the shaft of the last of said low pressure casings, said low pressure casings having each a removable upper hood portion and a lower exhaust chamber portion, a condenser fixedly connected to said exhaust chamber portions and forming a beam structure with them extending in a direction parallel to said shafts, a first permanent support structure supporting said high pressure and medium pressure cylinders and a second permanent support structure supporting said alternator and exciter, sad beam structure being supported at each end by one of said permanent support structures forming a bridge between them.

2. A multi-cylinder condensing steam turbine plant as claimed in claim 1, comprising keyways on top of one of the said permanent support structures, said beam structure being supported slidably in said keyways at one end and fixedly connected to the other parmanent support structure at the other end.

3. A multi-cylinder condensing steam turbine plant as claimed in claim 1, wherein said condenser has laterally arranged water boxes forming a major load-carrying component of said beam structure.

4. A multi-cylinder condensing steam turbine plant as claimed in claim 1, comprising in addition: a condenser pit having a concerete floor arranged between the said two permanent support structures, and compression springs arranged between the underside of said beam structure and said concrete floor and transmitting part of the weight of said beam structure to said concrete floor.

5. A multi-cylinder condensing steam turbine plant as claimed in claim 4, wherein said springs are adjustable initially in strength.

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