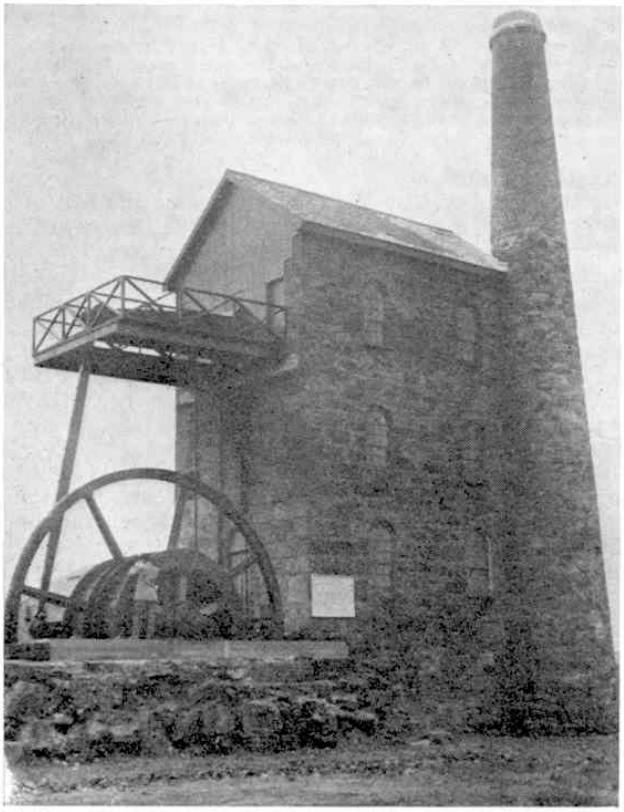
CORNISH BEAM ENGINES

A brief survey of these monsters of the steam era, a few of which can still be seen in preservation

By Richard Angove



SUMMER tourists traversing the undulating, mist-enshrouded moorlands of Cornwall are intrigued by the number of derelict chimneys and engine-houses standing, like gaunt sentinels, along the hilly backbone of the Duchy. These are the remains of Cornwall's long mining and engineering heritage, when not only most of the World's copper and tin, but much of the engineering equipment needed for its recovery, was shipped from neighbouring harbours.

Once scenes of export activity, they are now backwaters of leisure where children explore the decayed jetties and the only commercial activity is that of a few small fishing craft.

From the middle ages, when the quantity of metals recovered from alluvial deposits by the traditional washing or 'streaming' methods began to diminish, miners were forced to excavate.

This led to the inevitable ingress of water, the elimination of which, from earliest times, has been a challenge to their ingenuity.

Shallow workings could be drained by 'adits' or horizontal tunnels which emerged at lower levels; these were satisfactory and also afforded a degree of ventilation to shallow shafts dug into gently sloping hillsides, but as depths increased the need for some mechanical means of water removal become evident.

Endless chains carrying swabs were probably among the earliest innovations. These were later enclosed in crude wooden pipes, and small buckets replaced the swabs which, later still, were propelled by horses.

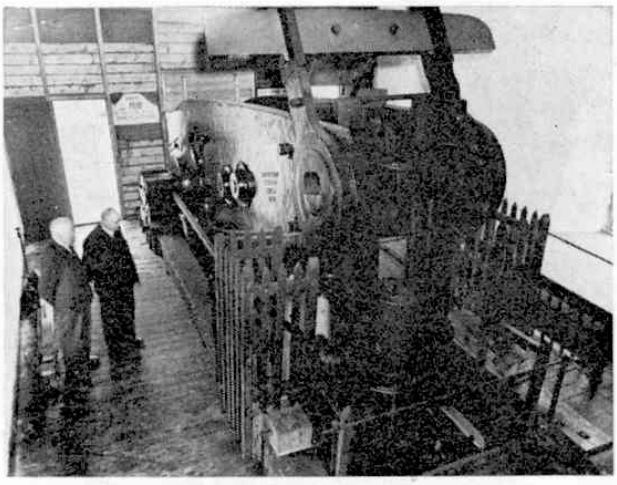
The first dramatic engineering break-through was by Thomas Savery, who, working on principles tried out by the Naples engineer Giovanni Battista della Porta in the early 17th century, ejected steam into a cylinder and condensed it by applying water. The resultant vacuum was used to raise the water; by operating two cylinders Savery was able to maintain a continuous stream and he patented the idea.

Coincident with these experiments, Thomas Newcomen, working on similar lines, produced an improved pump which, by an arrangement of rods actuated in conjunction with a rocking beam, manipulated valves to admit steam and water appropriate to the movements; the device thus became self-acting and the first of its kind. Because the initiating power was that of the atmosphere it was known as an 'Atmospheric Engine.'

James Watt, then an instrument technician at Glasgow University, had a model of one of these machines sent to him for repair, and so intrigued was he by the novelty of its operation that he developed the basic principles and subsequently produced, in conjunction with a colleague, Matthew Boulton, the first really practical rotative steam engine.

Looms, mills and factories in the Midlands and north of England were, until this time, mostly operated

Top, the East Pool winding engine which ceased work in 1921 lifted ore and miners from a depth of 1300 feet. Left, Trevithick's cottage at Camborne. Trevithick was one of the greatest engineers of his day.



The top chamber of the East Pool pumping engine, showing the 52 ton beam. Taken on the day of closure, at the left of the picture stands Mr. Tregonning Hooper, Hon. Sec. of the Cornish Engine Preservation Society (now the Trevithick Society). Nearest the beam is Mr. William Jelbert who helped to build this great machine 62 years before this date (26.10.54).

by water-wheels, which necessitated their location near rivers or other reliable water sources. The introduction of steam as a prime mover changed this. Factories could now be more conveniently located and industrial cities developed near collieries, ports, and other more economically desirable sites. Steam engines thus automatically increased country-wide coal consumption and a great boom in coal mining accompanied their introduction into every branch of social and commercial life, resulting in the great industrial revolution to which steam was probably the biggest single contributory factor.

Readers may recall some of the technical battles of the period between Boulton and Watt and the Cornish engineer Richard Trevithick and others. Development was complicated by much legal debate involving patents and claims concerning coal consumption and other aspects of engine performance.

Consequently Watt is generally credited with the ' Invention of the Steam Engine ' and sometimes even known as the ' Father of the Steam Engine.'

However, Trevithick, who advocated the use of steam at a higher pressure, contributed substantially to the practicability of more compact and powerful engines which we think of when considering engines in more general terms. His early locomotives and experimental traction engines could not have been developed on the lines they were had steam at higher pressure not been used.

So, as a direct result of the work of Watt, Trevithick and others, by the start of the 19th century many of these ' beam ' engines as they were now universally known, were to be seen operating pumping, crushing, winding and other machinery in mines and factories all over the world.

Made at various foundries and engineering works, many of which were situated in Cornwall, some remained in service until the 1930s and 40s and a few as late as the 50s. When, at the turn of the century, the discovery of more economically recoverable sources elsewhere led to the run-down of Cornish metal mining, many of the engines were transferred to the then-expanding china clay industry which did much to alleviate the hardship caused by tin's diminished role in Cornwall's economy. Some of the engines now preserved have been saved by the help of the English China Clays group of companies.

One of the earliest and most important of the builders of these huge engines was the firm of Harvey & Co., of Hayle, in the far west of the county. One of their biggest was a compound machine with cylinders weighing over 20 tons. Another Harvey engine is preserved in Holland where a museum has been established in the engine-house surrounding it.

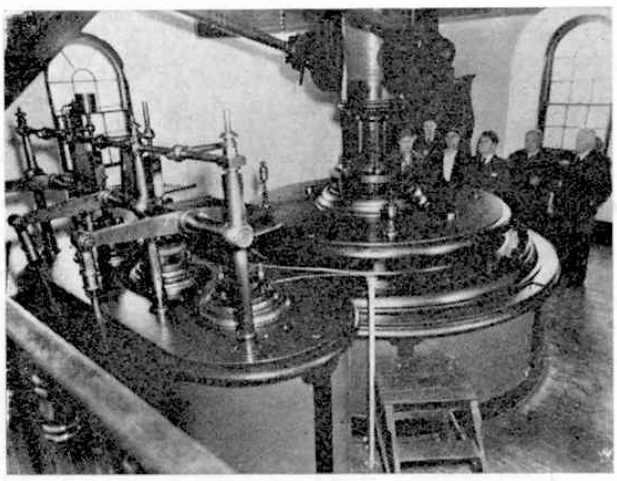
The Netherlands have, of course, always had problems of water encroachment and these engines have always been to the forefront in water-handling work. Pumping establishments everywhere used them; some of the most notable Harvey engines kept the Severn Tunnel dry for over 80 years. This involved maintaining a continuous service, sometimes pumping 30 million gallons every 24 hours.

Messrs Holman Bros. Ltd., of Camborne, who still produce mining machinery at their extensive plant there, also built these impressive monsters in their hey-day and have one on public display at their engineering college museum.

A fine Boulton and Watt rotative model built in 1797 can be seen and is sometimes operated in the Science Museum at South Kensington where, of course, there is a wealth of material on every aspect of this fascinating subject.

This particular exhibit has an impressive 12 foot diameter flywheel, 19.25 inch diameter cylinder with a four foot stroke, and ' sun and planet ' movement for converting the lateral movement to rotary motion. This interesting feature was evolved by Watt to avoid using a crank which was, at the time, protected by a patent held by another engineer. At both Camborne and the Science Museums movement is achieved by compressed air or electricity; no steam is used in preserved engines.

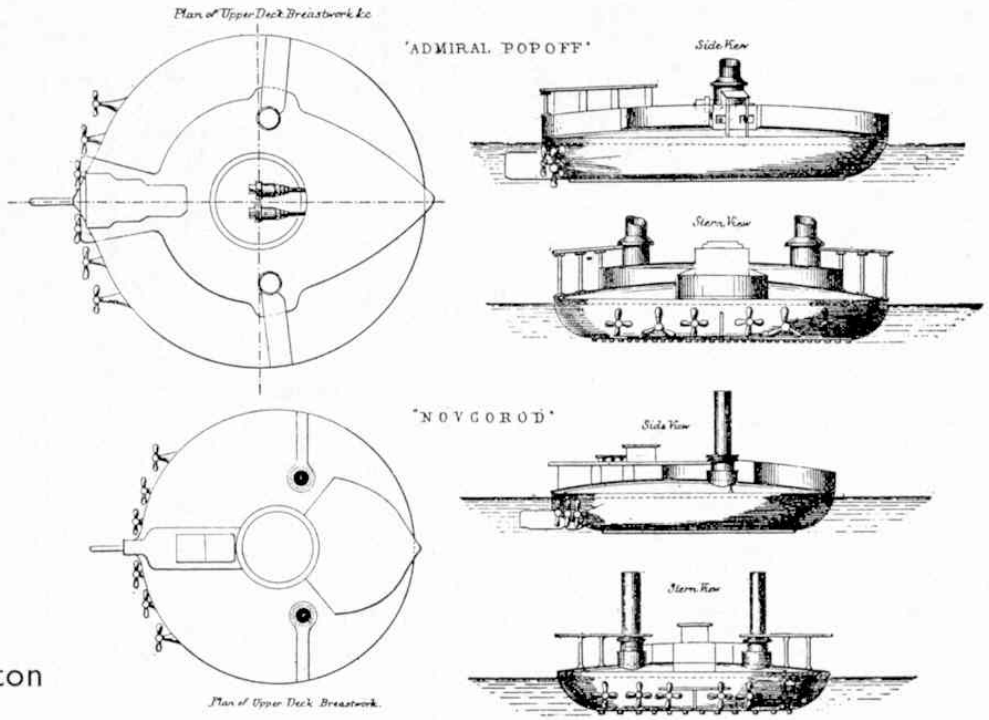
Several others, thanks to the National Trust and the Trevithick Society, are preserved in Cornwall, and fine models too numerous to itemise exist all over the world. In Cornwall the most accessible examples are adjoining the A30 Trunk Road at Camborne. One there worked winding men and ore from depths of nearly 1,300 feet until 1921. Built in 1887, this was Holman's last rotative beam engine. Nearby, a pumping version built by Harveys in 1892 which has a 90 inch cylinder and 10 foot stroke was erected at this present site in 1924 and worked until 1954. (See illustrations.)



Taken a few minutes before the engine ceased working in 1954, this view in the East Pool's middle chamber shows the 90in. cylinder. *Photos by permission of the Trevithick Society and National Trust.*

The "Popoff"

Introducing the Popoffskas, circular Russian warships, with full-size plans for a semi-scale model by A. J. Morton



A COMPLETELY circular ship may sound a strange idea, but when the Russians built two back in 1875, it was taken very seriously in naval circles (sorry!) and a naval expert M.P. actually visited Russia specifically to see them.

The two ships were built as coastal defence vessels, virtually to be used as floating forts but capable of moving under their own steam as necessary. The first of the two was the *Novgorod*, 101ft. diameter and almost 2,500 tons, with two 28 ton (11 in.) guns. This was followed by the larger *Admiral Popoff*, 121 ft. diameter, over 3,500 tons, with two 40 ton guns and four smaller ones. The draught of this ship was 14 ft. and she carried a crew of 120.

Apparently the design showed no particular advantages, or rather its disadvantages outweighed its good points, since no further development took place, and the ships thus remain as outstanding oddities, even in the atmosphere of peculiar designs which surrounded the arrival of ironclad warships.

The drawing overleaf shows how to make a working semi-scale model of these unusual vessels, using a circular biscuit tin or something similar as a basis. That used on the original was just under 8 in. diameter and about $3\frac{5}{8}$ in. deep.

Most of the work takes place on the lid, so we can dispose of the base by outlining the motor installation. Instead of the six propellers of the original we can reasonably use two, and if these are connected to the motor by pulley drive, line-up and construction are simplified. Before piercing the tin for the shafts, you may like to put equivalent ballast in the tin to check its waterline, although as the contemporary illustrations above show, there was very little freeboard and you will probably have to fit permanent ballast in the tin anyway.

A tinplate motor mount was used on the original model, but a wood one could be made, just soldering a couple of tinplate tags to the tin's bottom to secure it. A Mabuchi 15 or 25, or Orbit 105/205, or similar motor, will give adequate power. Use brass stern tubes, so that they can be soldered into the tin, though epoxy could be used with aluminium tubes. If you use $1\frac{1}{4}$ in. propellers and $\frac{3}{4}$ in. pulleys on their shafts, with a $\frac{3}{8}$ or $\frac{1}{2}$ in. pulley on the motor, good battery life and reasonable scale speed should be obtained. Solder or epoxy a bracket to support the inboard ends of the prop tubes, reasonably lined up with the motor, and use ordinary thin rubber bands as driving belts.

Most of the superstructure is $\frac{1}{16}$ in. sheet balsa, card, wire, and odds and ends. It is advisable to use epoxy resin to glue anything to the tin lid itself, though metal parts such as handrail stanchions and davits are obviously better soldered in place. Holes can be punched for these with a suitable nail, supporting the tin underneath where you're tapping with a block of hard wood. It is best to solder everything in place before starting on the wood work.

Fit the coffee jar lid to the centre and surround it with a strip of card. Glue the bottom decks in place. Make up the four separate deckhouses, two of which glue to the centre circle, and paint the sides, draw on the windows etc., before gluing in place. Add the top decks, which should just lap over the centre circle, and paint before attaching the details to them.

Suggestions for making the various bits and bobs are included on the drawing but their final appearance depends on your ingenuity and particularly how well you pick out the small details with paint. Run a strip of foam plastic draught-stop round the edge for a rubbing strip and you will be surprised how attractive and colourful a model results. You're bound to have a lot of questions asked at the pondside when you go to sail this most unusual vessel!

'The Popoff'

Imperial Russian Navy

POPOFFSKAS

2 Guns
paper + card, balsa end, black picked out with white

Balsa Cap

Bead

Circle of card grey, to fit in A, to allow rotation

Shirt Button Wheels

Funnel paper roll, plug with balsa, yellow, black top

Guys

Copper wire exhausts

J

K

B

B. Vents balsa, white black mouths

Flag paper, blue cross on white

1. Mast, wood, white Cap card, black

1 Binnacle balsa, 2 beads

White

Gold

Brown

Black

1 Wheel card rim, wire spokes, brown.

G

1 Skylight balsa, white

Doors card, brown, windows same both ends

Deck houses 1/16" sheet, white, same each side

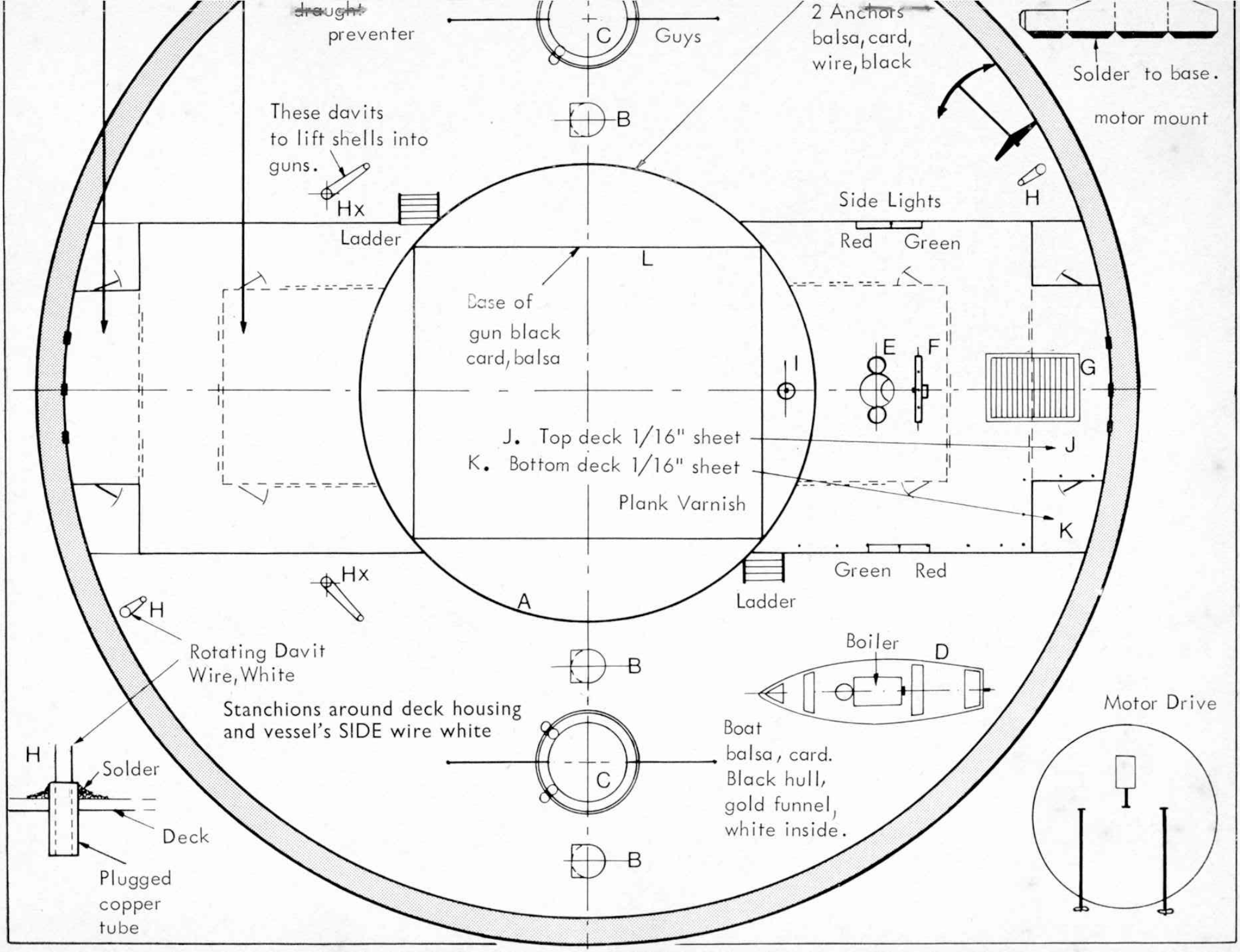
Top of biscuit tin grey

B

Foam strip fender draught

Top of coffee jar with card around outside, grey

2 Anchors


draught preventer
C
Guys
2 Anchors balsa, card, wire, black
Solder to base.
motor mount
These davits to lift shells into guns.
B
Hx
Ladder
Side Lights
H
Red Green
L
Base of gun black card, balsa
E
F
I
G
J. Top deck 1/16" sheet
K. Bottom deck 1/16" sheet
Plank Varnish
J
K
Hx
A
Ladder
Green Red
H
Rotating Davit Wire, White
Boiler
D
B
Stanchions around deck housing and vessel's SIDE wire white
Motor Drive
H
Solder
Deck
C
Boat balsa, card. Black hull, gold funnel, white inside.
B
Plugged copper tube